B.E. (Electrical and Electronics Engineering)

2015 Regulations, Curriculum & Syllabi

BANNARI AMMAN INSTITUTE OF TECHNOLOGY

(An Autonomous Institution Affiliated to Anna University, Chennai

Approved by AICTE - Accredited by NBA New Delhi, NAAC with 'A' Grade and ISO 9001:2008 Certified)

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REGULATIONS 2015

(CHOICE BASED CREDIT SYSTEM)

(Common to all B.E./B.Tech. Degree Programmes)

Regulation 2015 has been prepared in accordance with the guidelines given by the University Grants Commission, All India Council for Technical Education and affiliating University incorporating the features of the Choice Based Credit System (CBCS). The Regulation 2015 is applicable to the candidates admitted to the Bachelor of Engineering (B.E.) / Bachelor of Technology (B.Tech.) Degree Programmes of the Institution in the academic year 2015-2016 for Regular admission (Academic year 2016-2017 for Lateral Entry) and subsequently.

The regulations hereunder are subjected to amendments as may be decided by the Academic Council of the Institution from time to time. Any or all such amendments will be effective from such date and to such batches of students (including those already in the middle of the programme) as may be decided by the Academic Council.

1. ADMISSION

Candidate, seeking admission to the B.E./B.Tech. Programme, shall satisfy the conditions of admission prescribed by the Directorate of Technical Education and Anna University, Chennai as given below.

1.1 Regular Admission

Candidates, for admission to the first semester of the eight semesters B.E./B.Tech. Degree Programmes, shall be required to have passed:

- Higher Secondary Examination (10 +2) of Curriculum (Regular Academic Stream) prescribed by the Government of Tamil Nadu with Mathematics, Physics, and Chemistry as three of the four subjects of the study prescribed under Part-III or any other examinations of any Board or University or authority accepted by the Syndicate of the University / Directorate of Technical Education (DoTE), Chennai as equivalent thereto.

(or)

- Should have passed Higher Secondary Examination of Vocational Stream (Engineering/Technology), prescribed by the Government of Tamil Nadu.

1.2 Lateral Entry Admission

1.2.1 The candidates who possess Diploma in Engineering / Technology awarded by the State Board of Technical Education and Training, Tamil Nadu or its equivalent are eligible to apply for Lateral Entry admission to the third semester of B.E. / B.Tech. Programmes in the branch of study as per the eligibility criteria prescribed by the Directorate of Technical Education from time to time.

(or)

1.2.2 The candidates who possess the Bachelor Degree in Science (B.Sc.) (10+2+3 stream) with Mathematics as a subject in B.Sc. is eligible to apply for Lateral Entry admission to the third semester of B.E./B.Tech. Programmes, as per the eligibility criteria prescribed by the Directorate of Technical Education from time to time. Such candidates shall undergo two additional Engineering subject(s) one each in third and fourth semesters, as bridge courses.

2. PROGRAMMES OFFERED

A candidate may be offered admission to any one of the programmes offered by the Institution for the candidates specified in Clause 1.1 and as per the eligibility criteria of DoTE for the candidates under Clause 1.2 from the list given below:

B. E. Programmes

i. Aeronautical Engineering
ii. Agricultural Engineering
iii. Automobile Engineering
iv. Civil Engineering
v. Computer Science and Engineering
vi. Electrical and Electronics Engineering
vii. Electronics and Communication Engineering
viii. Electronics and Instrumentation Engineering
ix. Mechanical Engineering
x. Mechatronics

B. Tech. Programmes

i. Biotechnology
ii. Fashion Technology
iii. Information Technology
iv. Textile Technology
v. Food Technology

3. STRUCTURE OF THE PROGRAMME

3.1 Every programme shall have a distinct curriculum with syllabi consisting of theory, laboratory, mini-project, life-skills and personality development courses, as prescribed by the respective Boards of Studies, broadly categorized under:

(i) **Basic Science** courses including Mathematics, Physics, Chemistry and further specialization in these subjects

(ii) **Basic Engineering c**ourses including Engineering Graphics, Workshop Practices, Basics of Electrical, Electronics, Civil, Mechanical Engineering, Engineering Mechanics and Computer Programming.

(iii) **Humanities and Social Science c**ourses including Language Courses, Management Courses, Life Skills and Professional Ethics.

(iv) **Professional Courses** include Discipline Core Courses, Professional Electives, Core Electives and Open Electives.

(v) **Employability Enhancement Courses (EEC)** include Project Work and /or Internship, Seminar, Industrial /Practical Training, Value Added and Certificate Courses.

The assortment of different courses shall be designed that the student, at the end of the programme, would be able to be trained not only in his / her relevant professional field but also as a socially mindful human being.

The medium of instruction is English for all the Courses, Examinations, Seminar Presentation, Projects and any other courses that a student registers for.

3.2 Each course is normally assigned a certain number of credits, with 1 credit per lecture period per week, 1 credit for 2 periods of tutorial, 1 credit for 2 periods of laboratory courses, and 1 credit for 2 periods of seminar/project work per week.

3.3 A Diagnostic Test will be administered to all the B.E. / B.Tech. students after the admission to assess the proficiency in English and based on the score they will be brought under two streams namely, Stream A and Stream B. Students under Stream A will study **Communicative English I** and Stream B will study **Basic English I** under Language Elective I in the First Semester. In the Second Semester, Stream A will be further divided into two categories based on their English language proficiency assessed in the Continuous Assessment, while the upper segment can enroll and study **German / Japanese / French / Chinese / Hindi** and the remaining students of that Stream will study **Communicative English II**. The students under Stream B will study **Basic English II** or may opt for **Communicative English II** based on the assessment carried out at the end of the semester I.

3.4 Every student shall be required to opt for **Nine** electives from the list of electives. Students can opt for the electives (Core / Professional / Open Elective) from any branch of B.E/B.Tech. Programmes, besides his / her own discipline courses, during V to VIII Semesters, if he/she satisfies the prerequisite for that particular course.

3.5 However, out of nine electives, every student shall be required to opt for, a minimum of three electives as open electives from the list of open electives of the branch / branches other than his / her branch of specialisation. There shall be no pre-requisite course(s) for such open electives.

3.6 Students can also opt for **one-credit courses** of 15 to 20 hour duration, which will be offered by the experts from the industry on specialised topics. Students can opt for such **one-credit courses** during the semesters I to VII as and when these courses are offered. A student will also be permitted to register the **one-credit courses** offered by other Departments, provided the student has fulfilled the necessary pre-requisites or the courses that may not require any pre-requisites. Under no circumstances, the same one credit course shall be repeated in subsequent semesters in any Department / Centre and a maximum batch size for a given course shall not exceed 40. In the case of disciplines with multiple divisions (intake more than 60) different course(s) shall be offered to other batch(es) of students.

On successful completion of one credit courses, Credits will be indicated in the Grade Sheet, but will not be considered for computing the Cumulative Grade Point Average (CGPA). However, if a student wishes to avail the exemption from any one of the Electives (other than open elective) of the Semester VIII, he / she can do so by exercising his / her option in writing to the respective Head of the Department during the beginning of the VIII Semester, following the equivalence norm, that **one regular elective (**in the **VIII Semester)** is equivalent to **three one-credit courses** completed by the student during the previous semesters, IV to VII.

Details of the one credit courses offered by the department shall be forwarded to the Office of the Controller of Examinations. However one credit courses completed during I to III semesters shall be maintained in the Grade sheet as "Additional credits earned" (not considered for the computation of GPA/CGPA).

3.7 Fast Track System shall enable students to undergo a semester-long Internship or Special Training during Semester VIII. A student who secures a minimum CGPA of 8.50 in Semester IV with no current arrears, as on that date and maintains the CGPA of 8.50 till VI Semester without any arrears shall be eligible to opt for Fast Track System and such student is required to complete three elective courses satisfactorily, while completion of Semester VII, as additional Credits during the semesters V to VII.

3.8 Every student shall be required to carry out a Project Work in the Department / Industry or by exercising Fast track during VIII Semester in consultation with the Faculty Guide and submit the project report, in the prescribed format, at the end of the VIII Semester for the valuation.

3.9 A student can register for Self-Study Elective(s) over and above the electives from any branch of Engineering / Technology at the rate of one per semester starting from V semester onwards provided he/she maintains a Cumulative Grade Point Average (CGPA) of 8.50 or above till the previous semesters with no current arrears. Credits will be indicated for such courses in the grade sheets (additional credits) but will not be considered for computing the CGPA.

3.10 A Student may be permitted to credit online courses with the approval of the Departmental Consultative Committee constituted by the Head of the Department, subject to a maximum of three credits. Such students may be exempted from attending the classes, if such course(s) are offered in the semester. Summary of such on-line courses, taken by the students, along with the offering agency shall be presented to the Academic Council for information and further suggestions. However, those students need to obtain certification from the agency / agencies offering the course, to become eligible for writing or seeking exemption (core elective course) from the End Semester Examination. In case of credits earned through online mode, from the other Institute / University, the credits may also be transferred directly after due approval from the Departmental Consultative

Committee and the Office of the Controller of Examinations. A student can get exemption for a maximum of 3 credits during the entire programme (in lieu of Discipline elective or Open elective).

4. VALUE ADDED COURSES / ADD-ON COURSES

A Student can opt for the Value Added Courses / Add-on Courses offered by the various Department / Centres for which the batch size will not exceed 40 per course from Semester II to VII. Head of the Department / Centre shall submit the list of such courses, duly approved / ratified by the Academic Council, to the Controller of Examinations to administer the examination process. A separate Certificate will be issued on successful completion of the course by the Office of the Controller of Examinations.

5. DURATION OF THE PROGRAMME

5.1 A regular student (admitted after 10+2) or equivalent is normally expected to satisfactorily fulfil the requirements for award of the degree B.E. / B.Tech. within four academic years (8 semesters) from the date of admission but in any case not more than 7 years (14 Semesters); lateral entry students shall fulfil such requirements within three academic years (6 semesters) from the date of admission but in any case not more than six years (12 Semesters) leading to the award of Degree of Bachelor of Engineering (B.E.) / Bachelor of Technology (B.Tech.) of Anna University, Chennai.

5.2 The total period for completion of the programme from the commencement of the semester, to which the student was admitted, shall not exceed the maximum period (Clause 5.1), regardless to the break-of-study (vide Clause 15) or period of prevention in order.

5.3 Each semester shall consist of minimum 90 working days or 450 periods of 60 minutes each or equivalent. Head of the Department shall ensure that every faculty member teaches the subject / course as prescribed in the approved curriculum and syllabi.

5.4 Special Theory / Practical Sessions may be conducted for students who require additional inputs over and above the number of periods normally specified

(Remedial Classes), as decided by the Head of the Department, within the specified duration of the Semester / Programme.

6. COURSE ENROLLMENT AND REGISTRATION

6.1 Each student, on admission shall be assigned to a Faculty Advisor (vide Clause 8) who shall advise / counsel the student about the details of the academic programme and the choice of course(s) considering the student's academic background and career objectives.

6.2 Every student shall enroll for the courses of the succeeding semester, in the current semester. However, the student shall confirm the enrollment by registering for the courses within the first five working days after the commencement of the semester concerned.

6.3 After registering for a course, a student shall attend the classes, satisfy the attendance requirements, earn Continuous Assessment marks and appear for the End Semester Examinations.

6.3.1 Each student, on admission to the programme, shall register for **all the courses prescribed in the curriculum in** the **first Semester of study (III Semester** for students admitted under **lateral entry stream).**

6.3.2 The enrollment for all the courses of the Semester II will commence 10 working days prior to the last working day of Semester I. The student shall confirm the enrollment by registering for the courses within the first five working days after the commencement of the Semester II. In the case, if a student fails to register in the course(s), he/ she may be permitted to register the same, as specified in the Clause 6.5, in the subsequent semesters or when it is offered.

6.3.3 The enrollment for the courses of the Semesters III to VIII will commence 10 working days prior to the last working day of the preceding semester. The student shall enroll for the courses with the guidance of the student's Faculty Advisor. If a student wishes, the student may drop or add courses (vide Clause 6.4) within **five** working days after the commencement of the semester concerned and complete the registration process duly authorized by the Faculty Advisor.

6.4 Flexibility to Add or Drop courses

6.4.1 A student has to earn the total number of credits specified in the Curriculum of the respective Programme of study in order to be eligible to obtain the degree. However, if a student wishes, the student is permitted to earn more than the total number of credits prescribed in the curriculum by opting for one- credit courses, self study electives or additional courses.

6.4.2 From the III to VIII semesters (from IV to VIII Semesters in case of lateral entry students), the student has the option of registering for additional courses or dropping existing courses. Total number of credits of such courses cannot exceed 6 in a given Semester. However the maximum number of credits that a student can register in a particular semester shall not exceed 30 credits (regardless to the reappearance credits). In such cases, the attendance requirement as stated Clause 7 is mandatory.

6.4.3 The minimum number of credits that a student can register in a particular semester shall not be less than 18 credits (except VII / VIII semester).

6.4.4 The student shall register for the project work in the VIII semester only.

6.5 Reappearance Registration

6.5.1 If a student fails in a theory course, the student shall do reappearance registration (Examination) for that course in the subsequent semesters or when it is offered next.

6.5.2 On registration, a student may attend the classes for the reappearance registration courses, if the student wishes, and the attendance requirement (vide Clause 7) is not compulsory for such courses.

6.5.3 However, if a student wishes to improve his/ her continuous assessment, in the second attempt during reappearance, shall satisfy the Clause 6.5.5 and appear for continuous assessment as given for that particular course.

6.5.4 If the theory course, in which the student has failed, is either a professional elective or an open elective, the student may register for the same or any other professional elective or open elective course, respectively in the subsequent semesters. However, the change of elective courses is permitted only once.

6.5.5 In this case (Clause 6.5.4), the student shall attend the classes, satisfy the attendance requirements (vide Clause 7), earn Continuous Assessment marks and appear for the End Semester Examination.

6.5.6 The student who fails in any Laboratory Course/ Project work / Seminar or any other EEC courses (Specified in Clause 3.1) shall register for the same in the subsequent semesters or when offered next, and **repeat** the course as per Clause 6.5.5.

6.5.7 If a student is prevented from writing the end semester examination of a course or several courses due to lack of attendance, the student has to register for that / those course(s) again, when offered next, attend the classes and fulfill the requirements as per Clause 6.5.5 & 6.5.6. If the course, in which the student has 'lack of attendance', is a Core Elective or an Open Elective, the student may register for the same or any other Core Elective or Open Elective course(s) respectively in the subsequent semesters and appear in the examination as per Clause 6.5.5.

7. REQUIREMENTS FOR APPEARING FOR THE END SEMESTER EXAMINATION OF A COURSE

A student who has fulfilled the following conditions (vide Clause 7.1 and 7.2) shall be deemed to have satisfied the attendance requirements for appearing for End Semester Examination of a particular course.

7.1 Every student is expected to attend all the periods and earn 100% attendance. However, a student shall secure not less than 80% attendance course wise taking into account the number of periods required for that course as specified in the curriculum.

7.2 If a student, secures attendance between 70% and 79% in any course(s) in the current semester due to medical reasons (prolonged hospitalization / accident / specific illness) or participation in Institution/ University/ State/ National/ International level extra and co-curricular activities, with prior permission from the Head of the Department, shall be permitted to appear for the current semester examinations subject to the condition that the student shall submit the medical certificate / participation certificate attested by the Head of the Department (along with Condonation form). Such certificates along with the condonation forms shall be forwarded to the Controller of Examinations for verification and permission to attend the examinations. However during the entire programme of study, a student can avail such Condonation in any two semesters only (regardless the number of courses).

7.3 A student shall normally be permitted to appear for End Semester Examination of the course(s) if the student has satisfied the attendance requirements (vide Clause 7.1 – 7.2) and has registered for examination in those courses of that semester by paying the prescribed fee.

7.4 Students who do not satisfy Clause 7.1 and 7.2 and who secure less than 70% attendance in a course will not be permitted to write the End-Semester Examination of that course. The student has to register and repeat this course in the subsequent semesters or when it is offered next (vide Clause 6.5).

7.5 In the case of reappearance registration for a course (vide Clause 6.5), the student has to register for examination in that course by paying the prescribed fee.

7.6 A student who has already appeared for a course in a semester and passed the examination is not entitled to reappear in the same course for improvement of grades.

8. FACULTY ADVISOR

To help the students in planning their courses of study and for general advice on the academic programme, the Head of the Department will attach a certain number of students to a Faculty member of the Department who shall function as Faculty Advisor for those students. The Faculty Advisor shall advise and guide the students in registering of courses, reappearance of courses, monitor their attendance and progress and counsel them periodically. If necessary, the Faculty Advisor may also discuss with or inform the parents about the progress / performance of the students concerned.

9. COMMITTEES

9.1 Common Course Committee

9.1.1 A theory course handled by more than one faculty including the discipline with multiple divisions (greater than or equal to 2) shall have a “Common Course Committee” comprising of all members of faculty teaching that course with one of the members as the Course Coordinator, nominated by the Head of the Institution (Head of the Department in the case of multiple divisions of a discipline) and student representatives (one per specialization or division) registered for that course in the current semester.

First meeting of the Common Course Committee shall be held within fifteen days from the date of commencement of the semester. Two subsequent meetings in a semester may be held at suitable intervals. During these meetings, the student members shall meaningfully interact and express their opinions and suggestions of all the students to improve the effectiveness of the teaching-learning process. It is the responsibility of the student representatives to convey the proceedings of these meetings to all the students.

9.1.2 In addition, Common Course Committee (without the student representatives) shall meet to ensure uniform evaluation through the common question papers during Continuous Assessment and End Semester Examinations.

9.2 Class Committee Meeting

For all the courses taught, prescribed in the curriculum, Class Committee meeting shall be convened thrice in a semester (first meeting within 15 days from the commencement of the semester and other two meetings at equal interval after the first meeting) comprising members of the faculty handling all the courses and two student representatives from the class.

One of the members of the faculty (preferably not handling any courses to that class), nominated by the Head of the Department, shall coordinate the activities of the Committee. During these meetings, the student members shall meaningfully interact and express their opinions and suggestions of all the students to improve the effectiveness of the teaching-learning process. It is the responsibility of the student representatives to convey the proceedings of these meetings to all other students.

10. SYSTEM OF EXAMINATION

10.1 Performance in each course of study shall be evaluated based on (i) Continuous Assessment throughout the semester and (ii) End Semester examination at the end of the semester for the regular courses or as given in the Clause 16. However, the final examination in the case of one credit courses / certificate / value added courses may be conducted, as and when the course is completed, through the office of the Controller of Examinations.

10.2 Each course, both theory and practical including project work, shall be evaluated as per the Scheme of Assessment given in Clause 16.

10.3 The End Semester Examinations shall normally be conducted after satisfying the Clause 5.2. Supplementary Examinations may also be conducted, at such times, for the benefit of the students as decided by the Controller of Examinations.

10.4 For the End Semester examinations, both theory and practical courses including project work, the internal and external examiners (from Academia or Industry) shall be appointed by the Controller of Examinations as per the guidelines given by the Examination and Evaluation Board of the Institute.

11. PASSING REQUIREMENTS AND PROVISIONS

11.1 A student who secures not less than 50% of total marks prescribed for a course, vide Clause 16, comprising a minimum of 50% of the marks prescribed for the End Semester Examination, shall be declared to have passed the course successfully and earned the prescribed credits for that course, applicable for all registered courses.

11.1.1 If a student fails to secure a pass in a particular course, i.e., failing to obtain minimum marks, as stated above, it is mandatory that he/she shall register and reappear for the examination in that course in the subsequent semester(s) whenever the examinations are conducted for that course, till he / she secures a ‘Pass’.

11.1.2 Continuous Assessment (CA) marks obtained by the student in the first appearance shall be retained and considered valid for one subsequent attempt, except Clause 6.5.4, 6.5.5, 6.5.6 and 6.5.7. However, from the third attempt onwards, the student shall be declared to have passed the course if he/she secures a minimum of 6 Grade Points (B Grade) in the course prescribed during the End Semester Examinations.

11.2 The minimum number of total credits to be earned by a student to qualify for the award of Degree in the various branches of study as prescribed by the respective Boards of Studies is given below:

Branch of Study	Minimum Credits	
	Regular Admission	Lateral Entry
B.E. Programmes		
Aeronautical Engineering	178	134
Agricultural Engineering	177	133
Automobile Engineering	179	134
Civil Engineering	176	131
Computer Science and Engineering	176	131
Electrical and Electronics Engineering	176	132
Electronics and Communication Engineering	177	132
Electronics and Instrumentation Engineering	177	133
Mechanical Engineering	179	135
Mechatronics	177	133
B.Tech. Programmes		
Biotechnology	175	131
Fashion Technology	176	132
Information Technology	176	131
Textile Technology	175	131
Food Technology	175	131

11.2.1 Student Migration and Credit Transfer: Normalization of the Credits will be carried out in consultation with the Board of Studies of the programme concerned and approved by the Head of Institution, if a student migrates from other institutions to Bannari Amman Institution of Technology or rejoins from previous regulation to this regulation.

11.3 A student shall be declared to have qualified for award of B.E/B.Tech. Degree if he/she successfully completes the course requirements (vide Clause 7, 10 and 11) and passed all the prescribed courses of study of the respective programme (listed in Clause 2), within the duration specified in Clause 5.1.

12. ASSESSMENT AND AWARD OF LETTER GRADES

12.1 The assessment shall be based on the performance in the End Semester Examinations and / or Continuous Assessment, carrying marks as specified in

Clause 16. Letter Grades (based on Credit Point and Grade Point) are awarded to the students based on the performance in the evaluation process.

12.2 Credit Point is the product of Grade Point and number credits for a course and Grade Point is a numerical weight allotted to each letter grade on a 10-point scale (as specified in the Clause 12.3), while the Letter Grade is an index of the performance of a student in a said course.

12.3 The performance of a student will be reported using Letter Grades, each carrying certain points as detailed below:

Range of Total Marks (as specified in Clause 16) / Specific Reason	Grade Points	Letter Grade
91 to 100	10	O (Outstanding)
81 to 90	9	A + (Excellent)
71 to 80	8	A (Very Good)
61 to 70	7	B + (Good)
50 to 60	6	B (Above average)
0 to 49	0	RA (Reappearance Registration)
Incomplete	0	I
Withdrawal	0	W
Absent	0	AB
Shortage of Attendance	0	SA

‘RA’ ---Reappearance registration is required for that particular course

‘I’ --- Continuous evaluation is required for that particular course in the Subsequent examinations.

‘SA’ --- shortage of attendance (Clause 7) and hence prevented from writing end semester examination.

12.4 After completion of the evaluation process, Grade Point Average (GPA), and the Cumulative Grade Point Average (CGPA) is calculated using the formula:

$$GPA/CGPA = \frac{\sum_1^n C_i * g_i}{\sum_1^n C_i}$$

where

C_i : Credit allotted to the course.

g_i : Grade Point secured corresponding to the course.

n : number of courses successfully cleared during the particular semester in the case of GPA and all the semesters, under consideration, in the case CGPA.

12.5 A student who does not appear for the End Semester Examinations in a course, after registering for the same, shall be deemed to have appeared for that examination for the purpose of classification (Subject to Clause 14 and 15).

12.6 For the non credit courses Grades shall be indicated as given in the Clause 16 and shall not be counted for the computation of GPA/CGPA.

12.7 **Photocopy / Revaluation:** A student, who seeks the re-valuation of the answer script is directed to apply for the photocopy of his/her semester examination answer paper(s) in the theory course(s), within 2 working days from the declaration of results in the prescribed format to the Controller of Examinations through the Head of the Department. On receiving the photocopy, the student can consult with a competent member of faculty and seek the opinion for revaluation. Based on the recommendations, the student can register for the revaluation through proper application to the Controller of Examinations. The Controller of Examinations shall arrange for the revaluation and declare the results. Revaluation is not permitted to the courses other than theory courses. In the case of theory courses with laboratory component, a student can seek revaluation for the theory component only, following the procedure stated above.

13. CLASSIFICATION OF THE DEGREE AWARDED

For the purpose of the 'Award of Degree', the duration of completion of the programme shall be the total duration taken by a student for completing first time registration of all the required courses and satisfying Clause 11, regardless to the period of Break-of-study as per Clause 15 and satisfy any one of the conditions required as given below.

13.1 **First Class with Distinction**: A student who qualifies for the award of the Degree having passed all the courses of study of all the Eight Semesters (six semesters for lateral entry students) at the first opportunity, after the commencement of his / her study and securing a CGPA not less than 8.50 (vide clause 12.3) shall be declared to have passed with **First Class with Distinction**.

13.2 **First Class**: A student who qualifies for the award of the Degree having passed all the courses of study of all the eight semesters (six semesters for lateral entry students) after the commencement of his / her study and securing a CGPA not less than 6.50 shall be declared to have passed with **First Class** (not exceeded the total duration as specified in the Clause 5).

13.3 **Second Class**: All other students who qualify for the award of the Degree shall be declared to have passed in **Second Class.**

13.4 Course Completion Certificate shall be given to a student, provided he / she should have registered all the courses and also registered for the examinations in those courses (subject to Clause 6.0 and 7.0).

14. WITHDRAWAL FROM THE EXAMINATION

14.1 A student may, for valid reasons, be granted permission by the Head of the Department to withdraw from appearing in the examination in any course(s) only once during the entire duration of the degree programme.

14.2 Withdrawal application shall be valid only, if the student is eligible to write the examination as per Clause 7 and, if such request for withdrawal is made prior to the submission of the Continuous Assessment marks of the course(s) with the recommendations from the Head of the Department.

14.3 Withdrawal shall not be considered as an appearance in the examination for the eligibility of a student for First Class with Distinction or First Class.

15. AUTHORIZED BREAK OF STUDY FROM A PROGRAMME

15.1 A student is permitted to go on break of study for a maximum period of one year either as two breaks of one semester each or a single break of one year.

15.2 A student is normally not permitted to break the period of study temporarily. However, if a student happens to discontinue the programme temporarily during the middle of programme of study, for reasons such as personal accident or hospitalization due to ill health or in need of health care, he/she shall apply to the Head of the Institution in advance, in any case, not later than the last date for registering for the semester examination, through the Head of the Department stating the reasons for the break-of-study (for one academic semester or 6 months, whichever is earlier). However, a student detained for want of minimum attendance requirement as per Clause 7 shall not be considered as permitted ‘Break of Study’ and Clause 15.3 is not applicable for such case.

15.3 The student is permitted to rejoin the programme after the break shall be governed by the rules and regulations of DoTE and the Curriculum and Regulations in force at the time of rejoining, subject to the Clause 11.2.1.

15.4 Authorized break of study will be counted towards the duration specified for passing all the courses (vide Clause 5.1 and 5.2) and for the purpose of classification of Degree (vide Clause 13).

15.5 The total period for completion of the programme reckoned from the commencement of the first semester to which the student is admitted shall not exceed the maximum period specified in Clause 5.1, irrespective of the period of break of study in order that he / she may be eligible, for the award of the degree (vide Clause 13).

15.6 In case of valid reasons (as stated in Clause 15.2) extended break-of-study may be granted by the Head of the Institution for a period not more than one year (total duration or two semesters whichever is earlier) in addition to the earlier authorized break of study.

15.7 If a student does not report back to the Institute, even after the extended Break of Study, the name of the student shall be deleted permanently from the college enrollment. Such students are not entitled to seek readmission under any circumstances.

16. SCHEME OF ASSESSMENT

Courses offered under B.E. / B.Tech. Programmes are assessed as given below:

I	**THEORY COURSES**	**Marks**
	Continuous Assessment	**50**
	Distribution of marks for Continuous Assessment:	
	Test I (15)	
	Test II (15)	
	Open book test (10)	
	Library - Seminars / Assignments (Two) (10)	
	End Semester Examination	**50**
	Total Marks	**100**

II	**THEORY COURSES WITH LAB COMPONENT**	**Marks**
	Continuous Assessment	**50**
	Distribution of marks for Continuous Assessment:	
	Test I (10)	
	Test II (10)	
	<u>*Conduct of Experiment*</u>	
	Preparation(5)	
	Experiment and Results (5)	
	Record Note#	
	Final Lab Examination (20)	
	End Semester Examination (QP pattern as per (I))	**50**
	Total Marks	**100**

III	**LABORATORY COURSES**	**Marks**
	Continuous Assessment	**50**
	Distribution of marks for Continuous Assessment:	
	Conduct of Experiment	
	i. Preparation (5)	
	ii. Experiment and Results (10)	
	iii. Record / Observation# (5)	
	Test – Cycle I (15)	
	Test – Cycle II (15)	
	End Semester Examination	
	Experiments & Results (40)	**50**
	Viva Voce – (10)	
	Total Marks	**100**

IV	**TECHNICAL SEMINAR**	**Marks**
	Continuous Assessment	**50**
	Distribution of marks for Continuous Assessment:	
	Presentation I (25)	
	Presentation II (25)	
	End Semester Examination	
	Report# (20) *Presentation (20)* *Viva voce (10)*	**50**
	Total Marks	**100**

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V	**PROJECT**	**Marks**
	Continuous Assessment	**50**
	Distribution of marks for Continuous Assessment:	
	<u>*Review I*</u>	
	Literature survey (10)	
	Problem Identification (5)	
	Methodology (10)	
	<u>*Review II*</u>	
	Continuation in Methodology (10)	
	Results / Progress (15)	
	End Semester Examination	
	Report[#] (20) *Presentation (20)* *Viva voce (10)*	**50**
	Total Marks	**100**
VI	**LANGUAGE ELECTIVE**	**Marks**
	(CONTINUOUS ASSESSMENT ONLY)	
	<u>Test 1</u>	
	Listening (10) *Speaking (5)* *Reading (5)* *Writing (5)*	**25**
	<u>Test 2</u>	
	Listening (10) *Speaking (5)* *Reading (5)* *Writing (5)*	**25**
	Oral Exam	**50**
	Total Marks	**100**
VII	**ONE-CREDIT COURSE**	**Marks**
	Test	**30**
	Quiz	**20**
	Final Examination	**50**
	Total Marks	**100**

[#] *Reports / Record Note / Integrated Lab Manual to be retained for 1 year for Academic Audit, by respective Department*

VIII	**MINI-PROJECT (CONTINUOUS ASSESSMENT ONLY)**	**Marks**
	Review I	**25**
	Review II	**25**
	Project Evaluation	**50**
	Report (25)#	
	Presentation&Viva Voce (25)	
	Total Marks	**100**
IX	**LIFE SKILLS (CONTINUOUS ASSESSMENT ONLY)**	**Marks**
	Test I	**25**
	Test II	**25**
	Final Examination	**50**
	Total Marks	**100**
	Grades (Excellent / Good / Satisfactory/Not Satisfactory)	
X	**VALUE ADDED / CERTIFICATE COURSES (CONTINUOUS ASSESSMENT ONLY)**	**Marks**
	Test I	**25**
	Test II	**25**
	Final Evaluation / Test	**50**
	Total Marks	**100**
	Grades (Excellent / Good / Satisfactory / Not Satisfactory)	
XI	**ENGINEERING GRAPHICS**	**Marks**
	Continuous Assessment	**50**
	Distribution of marks for Continuous Assessment:	
	Class work (based on attendance) (5)	
	Assignments (Minimum 8 Assignments) (20)	
	Model Examination (25)	
	End Semester Examination	**50**
	Total Marks	**100**

Optional Test: *A student becomes eligible to appear for the one optional test conducted after the Periodical Test II, only under the following circumstances: (i) absent for Test I or Test II or both on account of medical reasons (hospitalization / accident / specific illness), or (ii) participation in the College / University / State /*

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National / International level Sports events with prior permission from the Head of the Institution and (iii) on satisfying the conditions (i) or (ii), the student should have registered for the Optional Test, through the concerned member of faculty who handles the course or through the respective Head of the Department, submitted to the Controller of Examinations. Such Optional Tests are not conducted for the courses under the categories III, IV, V, VI, VII, VIII, IX, X and XI listed above.

17. FIELD / INDUSTRIAL VISIT / INTERNSHIP

Heads of Departments, in order to provide the experiential learning to the students, shall take efforts to arrange at least two industrial visits / field visits in a semester. The students may also undergo in-plant training / internship during summer / winter vacation between III and VII semesters.

18. PERSONALITY AND CHARACTER DEVELOPMENT

Every student shall be required to undergo a minimum of 40 hours of Personality Development Programmes viz, NSS / NCC / YRC / YOGA / Sports and Games / Technical and Non-technical Club activities during the first year, failing which he/she shall not be permitted to appear for the End Semester examinations of semester II and there onwards. Such students are permitted to appear for the End Semester examinations of semester II and there onwards only after completing satisfactorily the requirements.

The attendance of the personality and character development courses / events shall be maintained on the regular basis by the concerned First Year Co-ordinators and made available in the Office of the Controller of Examinations before the commencement of Semester examinations of Semester I or Semester II.

19. DISCIPLINE

A student is expected to follow the rules and regulations laid down by the Institute and the affiliating University, as published from time to time. Any violations, if any, shall be treated as per the procedures stated thereof.

If a student indulges in malpractice in any of the End Semester / Continuous Assessments, he / she shall be liable for punitive action as prescribed by the Institution / University from time to time.

20. REVISION OF REGULATIONS, CURRICULUM AND SYLLABI

The Institution reserves the right to revise/amend/change the Regulations, Curriculum, Syllabi, Scheme of Examinations and date of implementation and to introduce Additional Electives, Open Electives, One Credit Courses and Value Added Courses through the Academic Council.

The Question Paper pattern (Theory Examination) for UG Programme is given below:

	PART A	
Objective Type Questions: 20	**(20X1 = 20 Marks)**	**20**
	PART B	
Short Answer Questions: 10	**(10X2 = 20 Marks)**	**20**
	PART C	
Long Answer Questions: 5	**(5X12 = 60 Marks)**	**60**

	Total	**100**

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)

On successful completion of four year BE degree programme quite a few years after graduation our graduates will

PEO1: Work in Energy/Power sectors / Software domain or be an Entrepreneur.

PEO2: Involve in Inter/multidisciplinary teams and assume position of leadership and responsibility in their career.

PEO3: Adapt to the world of constantly evolving technology.

PROGRAMME OUTCOMES (POs)

Engineering Graduates will be able to:

a. **Engineering Knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

b. **Problem Analysis**: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences

c. **Design/ Development of Solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for thepublic health and safety, and the cultural, societal, and environmental considerations.cultural, societal, and environmental considerations.

d. **Conduct Investigations of Complex Problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

e. **Modern Tool Usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

f. **The Engineer and Society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

g. **Environment and Sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

h. **Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

i. **Individual and Team Work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

j. **Communication**: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

k. **Project Management and Finance**: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one’s own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

l. **Life-long Learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

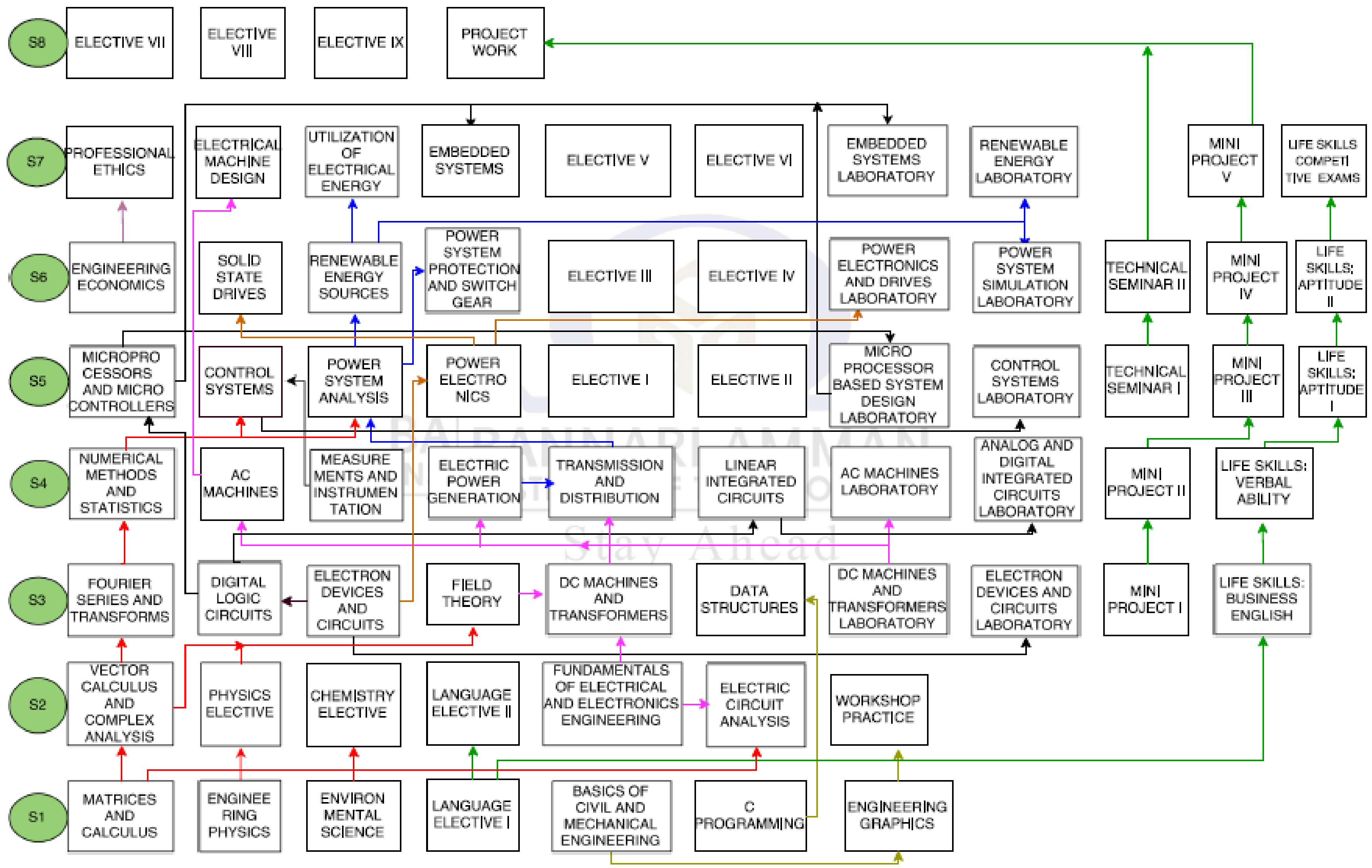
MAPPING OF PEOs AND POs

POs	a	b	c	d	e	f	g	h	i	j	k	l
PEO1	X	X	X	X	X		X	X	X	X		X
PEO2	X		X	X	X	X		X	X	X	X	
PEO3	X	X		X		X	X				X	X

PROGRAMME SPECIFIC OUTCOMES (PSOs)

1. Modeling, design and analysis of Electrical & Electronic Systems using design principles and software tools.
2. Develop electrical machineries/Appliances for various Domestic and industrial needs.

Department of Electrical and Electronics Engineering



B.E. ELECTRICAL AND ELECTRONICS ENGINEERING
Minimum Credits to be Earned :176

FIRST SEMESTER

Code No.	Course	Objectives & Outcomes		L	T	P	C	Maximum Marks			Category
		PEOs	POs					CA	ES	Total	
15MA101	MATRICES AND CALCULUS*	II	a,b	3	2	0	4	50	50	100	BS
15PH102	ENGINEERING PHYSICS*	II	a,b	2	0	2	3	50	50	100	BS
15CH103	ENVIRONMENTAL SCIENCE*	II	a,b,c, f,g	2	0	2	3	50	50	100	HSS
	LANGUAGE ELECTIVE I#	-	-	-	-	-	3	100	-	100	HSS
15GE205	BASICS OF CIVIL AND MECHANICAL ENGINEERING⊕	II	a,g	3	0	0	3	50	50	100	ES
15GE106	C PROGRAMMING±	II	a,b,e	3	0	2	4	50	50	100	ES
15GE207	ENGINEERING GRAPHICSλ	II	a,c,f	0	0	4	2	50	50	100	ES
Total				**13**	**2**	**10**	**22**	**400**	**300**	**700**	**-**

SECOND SEMESTER

Code No.	Course	Objectives & Outcomes		L	T	P	C	Maximum Marks			Category
		PEOs	POs					CA	ES	Total	
15MA201	VECTOR CALCULUS AND COMPLEX ANALYSIS*	II	a,b	3	2	0	4	50	50	100	BS
	PHYSICS ELECTIVE*	-	-	-	-	-	4	50	50	100	BS
	CHEMISTRY ELECTIVE*	-	-	-	-	-	4	50	50	100	BS
	LANGUAGE ELECTIVE II#	-	-	-	-	-	3	100	-	100	HSS
15EE205	FUNDAMENTALS OF ELECTRICAL AND ELECTRONICS ENGINEERINGΔ	I	a,b	3	0	0	3	50	50	100	ES
15EE206	ELECTRIC CIRCUIT ANALYSISΔ	I	a,b,d,e	2	0	2	3	50	50	100	ES
15GE107	WORKSHOP PRACTICEΩ	II	a,c,e	0	0	2	1	50	50	100	ES
Total				**8**	**2**	**4**	**22**	**400**	**300**	**700**	**-**

* Common to all branches of B.E./B.Tech
# Common to all branches of B.E./B.Tech (Continuous Assessment)
⊕ Common to CSE,ECE,EEE,EIE,FT,IT (I Semester) and to MTRS, BT,TT, FD (II Semester)
± Common to CSE,ECE,EEE,EIE,IT
λ Common to CE,CSE,ECE,EEE,EIE,IT (I Semester) and to AE, AG,AU,ME,MTRS, BT,FT,TT ,FD (II Semester)
Δ Common to EEE and EIE
Ω Common to AE, AG,AU,ME,MTRS, BT,FT,TT,FD (I Semester) and to CE,CSE,ECE,EEE,EIE,IT (II Semester)

THIRD SEMESTER												
Code No.	**Course**	**Objectives & Outcomes**		**L**	**T**	**P**	**C**	**Maximum Marks**			**Category**
		PEOs	**POs**					**CA**	**ES**	**Total**	
15MA301	FOURIER SERIES AND TRANSFORMS $^{\alpha}$	II	a,b	3	2	0	4	50	50	100	BS
15EE302	DIGITAL LOGIC CIRCUITS	I	a,c	3	0	0	3	50	50	100	ES
15EE303	ELECTRON DEVICES AND CIRCUITS	I	a,b,c	3	0	0	3	50	50	100	ES
15EE304	FIELD THEORY	I	a,b	3	2	0	4	50	50	100	ES
15EE305	DC MACHINES AND TRANSFORMERS	I	a,b,d,e,f	3	2	0	4	50	50	100	PC
15EE306	DATA STRUCTURES	II	d,f,l	2	0	2	3	50	50	100	ES
15EE307	DC MACHINES AND TRANSFORMERS LABORATORY	I	c,d	0	0	2	1	50	50	100	PC
15EE308	ELECTRON DEVICES AND CIRCUITS LABORATORY	I	a,b,c	0	0	2	1	50	50	100	ES
15EE309	MINI PROJECT I	III	a,l	0	0	2	1	100	-	100	EEC
15GE310	LIFE SKILLS: BUSINESS ENGLISH $^{\Phi}$	III	j	0	0	2	-	100	-	100	EEC
Total				**17**	**6**	**10**	**24**	**600**	**400**	**1000**	**-**

FOURTH SEMESTER												
Code No.	**Course**	**Objectives & Outcomes**		**L**	**T**	**P**	**C**	**Maximum Marks**			**Category**
		PEOs	**POs**					**CA**	**ES**	**Total**	
15MA401	NUMERICAL METHODS AND STATISTICS $^{\beta}$	II	a	2	2	0	3	50	50	100	BS
15EE402	AC MACHINES	I	a,b	3	2	0	4	50	50	100	PC
15EE403	MEASUREMENTS AND INSTRUMENTATION	I	a,b	2	0	2	3	50	50	100	PC
15EE404	ELECTRIC POWER GENERATION	I	a,b,e,g	3	0	0	3	50	50	100	PC
15EE405	TRANSMISSION AND DISTRIBUTION	I	a,b,c	3	2	0	4	50	50	100	PC
15EE406	LINEAR INTEGRATED CIRCUITS	I	a,b,c	3	0	0	3	50	50	100	PC
15EE407	AC MACHINES LABORATORY	I	a,b,c ,d,g	0	0	2	1	50	50	100	PC
15EE408	ANALOG AND DIGITAL INTEGRATED CIRCUITS LABORATORY	I	a,c,i	0	0	2	1	50	50	100	PC
15EE409	MINI PROJECT II	II, III	a-l	0	0	2	1	100	-	100	EEC
15GE410	LIFE SKILLS: VERBAL ABILITY $^{\Phi}$	III	j	0	0	2	-	100	-	100	EEC
Total				**16**	**6**	**10**	**23**	**600**	**400**	**1000**	**-**

$^{\alpha}$ Common to all branches of B.E./B.Tech. except CSE
$^{\Phi}$ Common to all branches of B.E./B.Tech (Non-Credit Course)
$^{\beta}$ Common to AG,AU,ME,MTRS,EEE,EIE,BT,TT,FT,FD

FIFTH SEMESTER

Code No.	Course	Objectives & Outcomes		L	T	P	C	Maximum Marks			Category
		PEOs	POs					CA	ES	Total	
15EE501	MICROPROCESSORS AND MICROCONTROLLERS	I	a,b,c,h	3	0	0	3	50	50	100	PC
15EE502	CONTROL SYSTEMS	I	a,b,c,d	3	2	0	4	50	50	100	PC
15EE503	POWER SYSTEM ANALYSIS	I	a,e	3	2	0	4	50	50	100	PC
15EE504	POWER ELECTRONICS	I	a,b,c,d	3	0	0	3	50	50	100	PC
	ELECTIVE I	-	-	-	-	-	3	50	50	100	PE
	ELECTIVE II	-	-	-	-	-	3	50	50	100	PE
15EE507	MICROPROCESSOR BASED SYSTEM DESIGN LABORATORY	I	a,c,e	0	0	2	1	50	50	100	PC
15EE508	CONTROL SYSTEMS LABORATORY	I	c,d,e	0	0	2	1	50	50	100	PC
15EE509	TECHNICAL SEMINAR I	II, III	b,e,f, h,i,j,l	0	0	2	1	50	50	100	EEC
15EE510	MINI PROJECT III	II, III	a-l	0	0	2	1	100	-	100	EEC
15GE511	LIFE SKILLS: APTITUDE I[Φ]	III	a	0	0	2	-	100	-	100	EEC
Total				**12**	**4**	**10**	**24**	**650**	**450**	**1100**	

SIXTH SEMESTER

Code No.	Course	Objectives & Outcomes		L	T	P	C	Maximum Marks			
		PEOs	POs					CA	ES	Total	Category
15GE701	ENGINEERING ECONOMICS[$]	I,II	f,g,k,l	3	0	0	3	50	50	100	HSS
15EE602	SOLID STATE DRIVES	I	a,b,d	3	0	0	3	50	50	100	PC
15EE603	RENEWABLE ENERGY SOURCES	I	a,b,c,f,g	3	0	0	3	50	50	100	PC
15EE604	POWER SYSTEM PROTECTION AND SWITCH GEAR	I	a,b,f	3	0	0	3	50	50	100	PC
	ELECTIVE III	-	-	-	-	-	3	50	50	100	PE
	ELECTIVE IV	-	-	-	-	-	3	50	50	100	PE
15EE607	POWER ELECTRONICS AND DRIVES LABORATORY	I	a,c,d,i	0	0	2	1	50	50	100	PC
15EE608	POWER SYSTEM SIMULATION LABORATORY	I	b,c,e	0	0	2	1	50	50	100	PC
15EE609	TECHNICAL SEMINAR II	II,III	b,e,f,	0	0	2	1	50	50	100	EEC
15EE610	MINI PROJECT IV	II,III	a-l	0	0	2	1	100	-	100	EEC
15GE611	LIFE SKILLS: APTITUDE II[Φ]	III	a	0	0	2	-	100	-	100	EEC
Total				**12**	**0**	**10**	**22**	**650**	**450**	**1100**	**-**

[Φ] Common to all branches of B.E./B.Tech (Non-Credit Course)
[$] Common to CSE,ECE,EEE,EIE,IT (VI Semester) and to AE, AG,AU,CE,ME,MTRS,BT,FT,TT,FD (VII Semester)

SEVENTH SEMESTER

Code No.	Course	Objectives & Outcomes		L	T	P	C	Maximum Marks			
		PEOs	**POs**					**CA**	**ES**	**Total**	**Category**
15GE601	PROFESSIONAL ETHICS+	I,II	h,k	2	0	0	2	50	50	100	HSS
15EE702	ELECTRICAL MACHINE DESIGN	I	a,b,d	3	2	0	4	50	50	100	PC
15EE703	UTILIZATION OF ELECTRICAL ENERGY	I	a,b,c,g	3	0	0	3	50	50	100	PC
15EE704	EMBEDDED SYSTEMS	I	a,b,c, e,f,g	3	0	0	3	50	50	100	PC
	ELECTIVE V	-	-	-	-	-	3	50	50	100	PE
	ELECTIVE VI	-	-	-	-	-	3	50	50	100	PE
15EE707	EMBEDDED SYSTEMS LABORATORY	I	c,e,f	0	0	2	1	50	50	100	PC
15EE708	RENEWABLE ENERGY LABORATORY	I	b,e,f,g	0	0	2	1	50	50	100	PC
15EE709	MINI PROJECT V	II,III	a-l	0	0	2	1	100	-	100	EEC
15GE710	LIFE SKILLS : COMPETITIVE EXAMS$^{\Phi}$	III	a,b,l	0	0	2	-	100	-	100	EEC
Total				**11**	**2**	**8**	**21**	**600**	**400**	**1000**	**-**

EIGHT SEMESTER

Code No.	Course	Objectives & Outcomes		L	T	P	C	Maximum Marks			
		PEOs	**POs**					**CA**	**ES**	**Total**	**Category**
	ELECTIVE VII	-	-	-	-	-	3	50	50	100	PE
	ELECTIVE VIII	-	-	-	-	-	3	50	50	100	PE
	ELECTIVE IX	-	-	-	-	-	3	50	50	100	PE
15EE804	PROJECT WORK	I,II,III	a-l	-	-	-	9	50	50	100	EEC
Total				**-**	**-**	**-**	**18**	**200**	**200**	**400**	**-**

+ Common to AE, AU, CE, ME,MTRS, BT,FT,TT,FD (VI Semester) and to CSE,ECE,EEE,EIE,IT (VII Semester)

$^{\Phi}$ Common to all branches of B.E./B.Tech (Non-Credit Course)

ELECTIVES							
Code No.	Course	Objectives & Outcomes		L	T	P	C
		PEOs	POs				
LANGUAGE ELECTIVES							
15LE101	BASIC ENGLISH I	II	j	3	0	0	3
15LE102	COMMUNICATIVE ENGLISH I	II	j	3	0	0	3
15LE201	BASIC ENGLISH II	II	j	3	0	0	3
15LE202	COMMUNICATIVE ENGLISH II	II	j	3	0	0	3
15LC203	CHINESE	II	j	3	0	0	3
15LF203	FRENCH	II	j	3	0	0	3
15LG203	GERMAN	II	j	3	0	0	3
15LH203	HINDI	II	j	3	0	0	3
15LJ203	JAPANESE	II	j	3	0	0	3
PHYSICS ELECTIVES							
15PH201	PHYSICS OF MATERIALS	I	a,b,i	3	0	2	4
15PH202	APPLIED PHYSICS	I	a,b,i	3	0	2	4
15PH203	MATERIALS SCIENCE	I	a	3	0	2	4
15PH204	PHYSICS OF ENGINEERING MATERIALS	I	a	3	0	2	4
15PH205	SOLID STATE PHYSICS	I	a	3	0	2	4
CHEMISTRY ELECTIVES							
15CH201	ENGINEERING CHEMISTRY	I	a,b,d		0	2	4
15CH202	APPLIED CHEMISTRY	I	a,b,d		0	2	4
15CH203	APPLIED ELECTROCHEMISTRY	I	a,b		0	2	4
15CH204	INDUSTRIAL CHEMISTRY	I	a,b		0	2	4
15CH205	WATER TECHNOLOGY AND GREEN CHEMISTRY	I	a,b		0	2	4
DISCIPLINE ELECTIVES							
15EE001	ADVANCED POWER SEMICONDUCTOR DEVICES	I	a,b,c	3	0	0	3
15EE002	SPECIAL ELECTRICAL MACHINES	I	a,b,c,e	3	0	0	3
15EE003	COMPUTER NETWORKS	I	b,d,e	3	0	0	3
15EE004	NETWORK ANALYSIS AND SYNTHESIS	I	a,b,c,d,e	3	0	0	3
15EE005	HIGH VOLTAGE ENGINEERING	I	a,c,e	3	0	0	3
15EE006	ENERGY AUDITING CONSERVATION AND MANAGEMENT	I	a,b,g	3	0	0	3
15EE007	FLEXIBLE AC TRANSMISSION SYSTEMS	I	a,b,c	3	0	0	3
15EE008	SWITCHED MODE POWER CONVERTERS	I	a,c,d,e	3	0	0	3
15EE009	POWER ELECTRONICS APPLICATIONS TO	I	a,b,c,d	3	0	0	3

	POWER SYSTEM						
15EE010	POWER SYSTEM OPERATION AND CONTROL	I	a,b,e	3	0	0	3
15EE011	WIND ENERGY CONVERSION SYSTEMS	I	a,b,c,g	3	0	0	3
15EE012	SOLAR ENERGY CONVERSION SYSTEMS	I	a,b,c,d,e	3	0	0	3
15EE013	POWER ELECTRONIC INTERFACES FOR RENEWABLE ENERGY SYSTEMS	I	a,b,c	3	0	0	3
15EE014	ENERGY STORAGE SYSTEMS	I	a,c,e,f,g	3	0	0	3
15EE015	POWER PLANT INSTRUMENTATION AND CONTROL	I	a,b,c,e	3	0	0	3
15EE016	HIGH VOLTAGE DIRECT CURRENT TRANSMISSION	I	a,b,d	3	0	0	3
15EE017	DIGITAL CONTROL OF ELECTRIC DRIVES	I	a,b	3	0	0	3
15EE018	VLSI DESIGN	I	a,b,c	3	0	0	3
15EE019	ILLUMINATION ENGINEERING	I	a,b,c,e,h	3	0	0	3
15EE020	POWER QUALITY	I	a,b,c,e	3	0	0	3
15EE021	COMPUTER AIDED DESIGN OF ELECTRICAL APPARATUS	I	a,b,c,e	3	0	0	3
15EE022	SMART GRID TECHNOLOGIES	I	a,b	3	0	0	3
15EE023	DIGITAL SIGNAL PROCESSING	I	a,c,d,e	3	0	0	3
15EE024	ORGANIZATIONAL BEHAVIOR AND MANAGEMENT	I	f,g,i,j	3	0	0	3
15EE025	TOTAL QUALITY MANAGEMENT	I	e,f,g,j	3	0	0	3
15EE026	CONCEPTS OF ENGINEERING DESIGN	I	b,c,d,f,g,h,j,k	3	0	0	3
15EE027	ENTREPRENEURSHIP DEVELOPMENT	I,II	f,k,l	3	0	0	3
15EE028	ELECTRIC TRACTION	I	a,b	3	0	0	3
15EE029	INDUSTRIAL AUTOMATION	I	a,b	3	0	0	3
15EE030	POWER SYSTEM DEREGULATION	I	a,b	3	0	0	3
ENTREPRENEURSHIP ELECTIVES							
15GE001	ENTREPRENEURSHIP DEVELOPMENT I	II	b,c,d,e,f & k	3	0	0	3
15GE002	ENTREPRENEURSHIP DEVELOPMENT II	II	b,e,h,i,j & k	3	0	0	3
PHYSICAL SCIENCE ELECTIVES							
15GE0P1	NANOMATERIALS SCIENCE	I,II	a,b	3	0	0	3
15GE0P2	SEMICONDUCTOR PHYSICS AND DEVICES	I,II	a,b	3	0	0	3
15GE0P3	APPLIED LASER SCIENCE	I,II	a,b	3	0	0	3
15GE0C1	CORROSION SCIENCE	I,II	a,b,g	3	0	0	3
15GE0C2	ENERGY STORING DEVICES AND FUEL CELLS	I,II	a,b,d	3	0	0	3
15GE0C3	POLYMER CHEMISTRY AND PROCESSING	I,II	a,b,c	3	0	0	3
OPEN ELECTIVES							
15EE0YA	ENERGY CONSERVATION AND MANAGEMENT	I,II	a,b,g,i,k	3	0	0	3

15EE0YB	ILLUMINATION SYSTEMS	I,II	a,b,c	3	0	0	3
15EE0YC	VALUE ENGINEERING	I,II	j,k,l	3	0	0	3
15EE0YD	INDUSTRIAL DRIVES AND CONTROL	I,II	a,b,c,e	3	0	0	3
ONE CREDIT COURSES							
15EE0XA	EMBEDDED CONTROL OF ELECTRIC DRIVES	I	a,c,d	0	0	0	1
15EE0XB	DESIGN OF EMBEDDED SYSTEM FOR DC MOTOR CONTROL	I	a,b,c,d	0	0	0	1
15EE0XC	AUTOMOTIVE ELECTRONICS	I	a,b,c,e	0	0	0	1
15EE0XD	QUALITY MANAGEMENT SYSTEM	I	a,e,f,g,k	0	0	0	1
15EE0XE	PRODUCT LIFECYCLE MANAGEMENT	I	g,k	0	0	0	1
15EE0XF	APPLICATIONS OF SYNCHRONOUS GENERATOR IN INDUSTRIES	I	a,c,d,e	0	0	0	1
15EE0XG	REACTIVE POWER MANAGEMENT AND ENERGY STORAGE DEVICES	I	a,c,d,	0	0	0	1
15EE0XH	SUBSTATION DESIGN	I	a,b	0	0	0	1
15EE0XI	FUNDAMENTALS OF LAB VIEW	I	a,b	0	0	0	1
15EE0XJ	AUTOMOTIVE ELECTRONIC SYSTEMS	I	a,b,c,e	0	0	0	1
15EE0XK	SOLAR ON GRID SYSTEM DESIGN	I	a,b	0	0	0	1
ADDITIONAL ONE CREDIT COURSES (I to III Semesters)							
15GE0XA	HEALTH AND FITNESS	-	-	-	-	-	1
15GE0XB	FOUNDATION COURSE IN COMMUNITY RADIO TECHNOLOGY	-	-	-	-	-	1
15GE0XC	VEDIC MATHEMATICS	-	-	-	-	-	1
15GE0XD	INTRODUCTION TO ALGORITHMS	-	-	-	-	-	1
15GE0XE	ETYMOLOGY	-	-	-	-	-	1
15GE0XF	HINDUSTANI MUSIC	-	-	-	-	-	1
15GE0XG	CONCEPT, METHODOLOGY AND APPLICATIONS OF VERMICOMPOSTING	-	-	-	-	-	1
15GE0XH	AGRICULTURE FOR ENGINEERS	-	-	-	-	-	1
15GE0XI	INTRODUCTION TO DATA ANALYSIS USING SOFTWARE	-	-	-	-	-	1
15GE0XJ	ANALYSIS USING PIVOT TABLE	-	-	-	-	-	1
15GE0XL	INTERVIEW SKILLS	-	-	-	-	-	1
15GE0XN	JOURNALISM AND MASS COMMUNICATION	-	-	-	-	-	1
15GE0XO	VISUAL MEDIA AND FILM MAKING	-	-	-	-	-	1
15GE0XP	YOGA FOR HUMAN EXCELLENCE	-	-	-	-	-	1
15GE0XQ	CARNATIC MUSIC	-	-	-	-	-	1
15GE0XR	GENERAL PSYCOLOGY	-	-	-	-	-	1

15GE0XS	NEURO BEHAVIOURAL SCIENCE	-	-	-	-	-	1
15GE0XT	NEW AGE INNOVATION AND ENTREPRENEURSHIP	-	-	-	-	-	1
15GE0XW	DISRUPTIVE INNOVATION BASED START UP ACTIVITIES	-	-	-	-	-	1
15GE0XX	VISION INDIA	-	-	-	-	-	1
VALUE ADDED COURSES							
15EEV01	VIRTUAL INSTRUMENTATION FOR ELECTRICAL ENGINEERING						
15EEV02	INDUSTRIAL AUTOMATION						
15EEV03	AUTOCAD ELECTRICAL						
15EEV04	ORCAD						
15EEV05	HANDS ON TRAINING ON DESIGN OF CONTROLLERS FOR POWER CONVERTERS						
BRIDGE COURSES							
15EEB01	FUNDAMENTALS OF ELECTRICAL AND ELECTRONICS ENGINEERING						
15EEB02	ELECTRIC CIRCUIT ANALYSIS						

SUMMARY OF CREDIT DISTRIBUTION

S.No	CATEGORY	CREDITS PER SEMESTER								TOTAL CREDIT	CREDITS in %	Range of Total Credits	
		I	II	III	IV	V	VI	VII	VIII			Min	Max
1	BS	7	12	4	3	-	-	-	-	26	15%	15%	20%
2	ES	9	7	14	-	-	-	-	-	30	17%	15%	20%
3	HSS	6	3	-	-	-	3	2	-	14	8%	5%	10%
4	PC	-	-	5	19	16	11	12	-	63	36%	30%	40%
5	PE	-	-			6	6	6	9	27	15%	10%	15%
6	EEC	-	-	1	1	2	2	1	9	16	9%	10%	15%
Total		22	22	24	23	24	22	21	18	176	100%	-	-

BS - Basic Sciences
ES - Engineering Sciences
HSS - Humanities and Social Sciences
PC - Professional Core
PE - Professional Elective
EEC - Employability Enhancement Course
CA - Continuous Assessment
ES - End Semester Examination

15MA101 MATRICES AND CALCULUS

3 2 0 4

Course Objectives

- Interpret the introductory concepts of Matrices and Calculus, which will enable them to model and analyze physical phenomena involving continuous changes of variables
- Summarize and apply the methodologies involved in solving problems related to fundamental principles of Matrices and Calculus.
- Develop enough confidence to identify and model mathematical patterns in real world and offer appropriate solutions, using the skills learned in their interactive and supporting environment.

Programme Outcomes (POs)

a. **Engineering Knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

b. **Problem Analysis:** Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

Course Outcomes (COs)

1. Analyze the characteristics of a linear system with eigen values and vectors.
2. Identify and model the real time problem using first order linear differential equations.
3. Recognize and solve the higher order ordinary differential equations.
4. Characterize the functions and get the solutions of the same.
5. Evaluate the functions to get the surface area and volume using multiple integral.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	1												1	
2	1	2											2	
3	1												1	
4	1	2											2	
5	3												1	

UNIT I **9 Hours**

MATRICES

Eigen Values and Eigen Vectors of a real matrix - Properties of Eigen Values-Stretching of elastic membranes. Cayley - Hamilton Theorem - Quadratic form: Reduction of a quadratic form to a canonical form.

UNIT II **8 Hours**

ORDINARY DIFFERENTIAL EQUATIONS OF FIRST ORDER

Leibnitz's Equations - Modelling and solutions using Newtons law of cooling of bodies - solutions to R-L and R-C electric circuits.

UNIT III **11 Hours**

ORDINARY DIFFERENTIAL EQUATIONS OF HIGHER ORDER

Linear differential equations of second and higher order with constant coefficients. Linear differential equations of higher order with variable coefficients: Cauchys linear differential equation - Method of variation of parameters for second order differential equations.

UNIT IV **9 Hours**

MULTIVARIABLE CALCULUS

Functions of Two Variables and their solutions- Total Differential - Derivative of implicit functions-Jacobians Unconstrained maxima and minima.

UNIT V **8 Hours**

MULTIPLE INTEGRALS

Double integration with constant and variable limits-Region of integration -Change the order of integration -Area as double integral in cartesian coordinates. Triple integral in Cartesian coordinates.

FOR FURTHER READING

Applications of mass spring system in ordinary differential equations of higher order

Total: 75 Hours

Reference(s)

1. C. Ray Wylie and C Louis Barrett, Advanced Engineering Mathematics, Sixth Edition, Tata McGraw-Hill Publishing Company Ltd, 2003.
2. Erwin Kreyszig , Advanced Engineering Mathematics, Tenth Edition, Wiley India Private Limited,New Delhi 2015.
3. Peter V. O Neil , Advanced Engineering Mathematics, Seventh Edition , Cengage Learning India Private Limited, 2012.
4. B.S. Grewal, Higher Engineering Mathematics, Forty Third Edition, Khanna Publications , New Delhi 2014.
5. Glyn James, Advanced Engineering Mathematics, Third Edition,Wiley India, 2014.
6. T.Veerarajan, Engineering mathematics for First Year,Tata McGraw-Hill Publishing company Limited, New Delhi, 2014.

Assessment Pattern

Unit/RBT	Remember				Understand				Apply				Analyse				Evaluate				Create				Total
	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	
1	2					6					6			6											20
2	2					2				4					4				6						18
3		2			2						6			6					6						22
4		2					6				8				6										22
5	2						4			6									6						18
																								Total	100

Remember :

1. Define spectral values of a matrix. (F)
2. State Cayley - Hamilton theorem.(F)
3. List out five natures of a quadratic form.(C)
4. Reproduce the solution for the first order linear differential equation $\frac{dy}{dx} + Py = Q$. (C)
5. State Newton's Law of cooling in ordinary differential equation.(F)
6. Define Jacobian in three dimensions.(F)

7. State Wronskian determinant.(F)
8. List two sufficient conditions for extermum of a function $z = f(x,y)\ at\ \ (a,b)$.(C)
9. Define Jacobian of $u\ \ and\ \ v$ with respect to $x\ \ and\ \ y$. (F)
10. Recall any two properties of Jacobians.(F)

Understand

1. Identify whether there exist a square matrix without eigenvalues? Give reason (C)
2. Indicate the matrix which has real eigenvalues and real eigenvectors?(F)
3. Identify in which cases can we expect orthogonal eigenvectors?.(C)
4. Compare second and higher order ordinary differential equation(F)
5. A condenser of capacity C discharged through an inductance L and resistance R in series and the charge q at the time t satisfies the equation L$\frac{d^2q}{dt^2}$+R$\frac{dq}{dt}+\frac{q}{c}$=0. given that L=0.25 henries, R=250 ohms,C=2×10^{-6} farads,and that when t=0, charge q is 0.002 coulombs and the current $\frac{dq}{dt}$=0, Identify the value of q in terms of t. (C)
6. Represent the area bounded by the parabolas y^2=4-x and y^2=4-4x as a double integral.(C)
7. Formulate Leibnitz's equation where R=100 ohms L=0.05 henry E=100 Cos300t volts.(C)
8. A condenser of capacity C discharged through an inductance L and resistance R in series and the charge q at the time t satisfies the equation L$\frac{d^2q}{dt^2}$+R$\frac{dq}{dt}+\frac{q}{c}$=0. The circuit consists of an inductor of 1H,a resistor of 12Ω, capacitor of 0.01F, and a generator having voltage given by E(t)=24 sin10t. Identify the charge q and the current I at time t,if q=0 and i=0 at t=0 where i=$\frac{dq}{dt}$. (C)
9. Formulate the area between the curves y^2=4x and x^2=4y. (C)
10. Indicate and change the order of integration for $\int_0^1\int_{x^2}^{2-x} xydydx$

Apply

1. Find three engineering applications of eigen value of a matrix.(F)
2. Compute the eigen values and eigen vectors of the matrix A = $\begin{pmatrix} 11 & -4 & -7 \\ 7 & -2 & -5 \\ 10 & -4 & -6 \end{pmatrix}$ and hence find the eigen values of A^2, 5A and A^{-1} using properties.(P)

3. Use Cayley Hamilton theorem to find inverse of A = $\begin{pmatrix} 1 & 3 & 7 \\ 4 & 2 & 3 \\ 1 & 2 & 1 \end{pmatrix}$. (P)
4. Find the points of the function $f(x,y) = x^2 y + xy^2 - axy$ where f is a maximum or minimum.
5. A body originally at 80^0C cools down to 60^0C in 20 minutes, the temperature of the air being 40^0C. Find the temperature of the body after 40 minutes from the original?(C)
6. If the temperature of a cake is 300^0F when it leaves the oven and is 200^0F 10 minutes later, when will it be practically equal to the room temperature of 60^0F, say, when will it be 61^0F? Use Newton's law of cooling.(C)
7. In an L-C-R circuit,the change q on a plate of a condenser is given by L$\frac{d^2q}{dt^2}$ +R$\frac{dq}{dt}$ $\frac{q}{c}$ =Esinpt,where i=$\frac{dq}{dt}$ .the circuit is tuned to resonance so that p^2=1/LC. If initially the current I and the charge q be zero.showthat ,for small values of R/L, the current in the circuit at time t is given by (Et/2L)sinpt. (P)
8. Construct the solution for the equation $(D^3 - D)y = xe^x$(P)
9. Apply the method of variation of parameters to solve $(D^2+4)y = \cot 2x$.(P)
10. Construct the equation $x^2y'' + xy' = x$ into a linear differential equation with constant coefficients.(F)

Analyze

1. Justify whether the matrix B = $\begin{pmatrix} \cos\theta & \sin\theta & 0 \\ -\sin\theta & \cos\theta & 0 \\ 0 & 0 & 1 \end{pmatrix}$ is orthogonal or not? .(P)
2. Suppose that in Winter the daytime temperature in a certain office building is maintained at 70°F, The heating is shut off at 10 P.M. and turned on again at 6 A.M. On a certain day the temperature inside the building at 2 A.M. was found to be 65°F. The outside temperature was 50°F at 10 P.M. and had dropped to 40°F by 6 A.M. Conclude the temperature inside the building when the heat was turned on at 6 A.M. (P)
3. Experiment show that the radio active substance decomposes at a rate proportional to the amount present. Starting with 2grms at time t=0 find the amount available at a later time. (P)
4. Differentiate RL and RC electric circuit.(F)
5. Resolve the equation $x^2y'' + xy' = x$ into a linear differential equation with constant coefficients.(P)
6. If the voltage in the RC circuit is E = E_0cosωt, conclude the charge and the current at time t.(P)
7. Resolve $(x^2D^2-2xD+2)y = (3x^2-6x+6)e^x$, y(1) = 2 +3e, $y'(1)$ =3e. (P)
8. In a circuit the resistance is 12Ω and the inductance is 4 H. The battery gives a constant voltage of 60 V and the switch is closed when t = 0, so the current starts with I(0) = 0. Conclude (a) I(t) (b)what happens to the current after a long time(c) justify the current after 1 s.(P)
9. If $g(x,y)=\psi(u,v)$ where $u = x^2 - y^2$, $v = 2xy$ Justify

$$\frac{\partial^2 g}{\partial x^2}+\frac{\partial^2 g}{\partial y^2}=4(x^2+y^2)\left(\frac{\partial^2 \psi}{\partial u^2}+\frac{\partial^2 \psi}{\partial v^2}\right). \text{ (P)}$$

10. Resolve the triple integral $\int_0^a \int_0^{\sqrt{a^2-x^2}} \int_0^{\sqrt{a^2-x^2-y^2}} x\,dxdydz$ (P)

Evaluate

1. Check the usage of Cayley-Hamilton theorem to find the value of $A^8-5A^7+7A^6-3A^5+A^4-5A^3+8A^2-2A+I$ if the matrix A = $\begin{pmatrix} 2 & 1 & 1 \\ 0 & 1 & 0 \\ 1 & 1 & 2 \end{pmatrix}$ (P) .
2. Determine the nature, index, rank and signature by reducing the quadratic form $2x^2+2y^2+2z^2+2yz$ to canonical form by an orthogonal transformation.
3. Determine the value of y from the equation $\frac{dy}{dx}=\frac{x^2+y^2+1}{2xy}$ (P)
4. Determine the solution of y of the equation $\sqrt{1-y^2}dx=(\sin^{-1}x-x)dy$. (P)
5. Judge the value of y from the equation $\frac{dy}{dx}-\frac{\tan y}{1+x}=(1+x)\,e^x \sec y$.(P)
6. Determine the complete solution for y from the equation $\frac{d^2y}{dx^2}+\frac{1}{x}\frac{dy}{dx}=\frac{12\log x}{x^2}$.(P)
7. Determine the complete solution for y of $(x^2D^2-xD+4)y=x^2\sin(\log x)$.(P)
8. Check the solution of the initial value problem $y''+y'-6y=0$ with the initial conditions y(0)=10 and $y'(0)=0$. (P)
9. Evaluate $\iiint (x^2+y^2+z^2)\,dxdydz$ taken over the region of space defined by $x^2+y^2\le 1$ and $0\le x\le 1$.(P)
10. Evaluate $\int_0^a\int_y^a \frac{x}{x^2+y^2}dxdy$ by changing into polar coordinates (P)

15PH102 ENGINEERING PHYSICS

2 0 2 3

Course Objectives

- To impart knowledge in properties of matter, crystallography and ultrasonics
- To understand the applications of lasers and fiber optics
- To implement the principles of quantum physics in the respective engineering fields

Programme Outcomes (POs)

a. **Engineering Knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

b. **Problem Analysis:** Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

Course Outcomes (COs)

1. Analyze the concept of properties of matter and apply the same for practical applications
2. Identify the suitable laser source for fiber optic communication applications
3. Analyze the properties of ultrasonic waves and apply the same for day today applications
4. Classify the different types of crystal structures and analyze their properties
5. Apply the Schrodinger wave equation to illustrate the motion of quantum particles

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	1	2											1	
2	1	2											1	
3	2	1											2	
4	1	1											2	
5	1	1											1	

UNIT I **8 Hours**

PROPERTIES OF MATTER

Elasticity: elastic and plastic materials - Hooke's law - elastic behavior of a material -stress -strain diagram- factors affecting elasticity. Three moduli of elasticity- Poisson's ratio-torsional pendulum-twisting couple on a cylinder. Young's modulus- uniform bending -non- uniform bending. Viscosity: coefficient of viscosity -streamline and turbulent flow -experimental determination of viscosity of a liquid -Poiseuille's method.

UNIT II **6 Hours**

APPLIED OPTICS

Interference: air wedge- theory- uses- testing of flat surfaces- thickness of a thin wire. Laser: introduction- principle of laser- characteristics of laser- types: CO2 laser -semiconductor laser (homo junction). Fiber optics: principle of light transmission through fiber- expression for acceptance angle and numerical aperture- types of optical fibers (refractive index profile and mode)- fiber optic communication system (block diagram only).

UNIT III **5 Hours**

ULTRASONICS

Ultrasonics: introduction- properties of ultrasonic waves-generation of ultrasonic waves-magnetostriction- piezo electric methods- detection of ultrasonic waves. Determination of velocity of ultrasonic waves (acoustic grating). Applications of ultrasonic waves: SONAR- measurement of velocity of blood flow -study of movement of internal organs.

UNIT IV **5 Hours**

SOLID STATE PHYSICS

Crystal Physics: lattice -unit cell -crystal systems- Bravais lattices- Miller indices- 'd' spacing in cubic lattice- calculation of number of atoms per unit cell, atomic radius, coordination number and packing density for SC, BCC, FCC and HCP structures- X-ray diffraction: Laue's method - powder crystal method.

UNIT V **6 Hours**

QUANTUM MECHANICS

Quantum Physics: development of quantum theory- de Broglie wavelength -Schrodinger's wave equation- time dependent and time independent wave equations- physical significance. Application: particle in a box (1d)- degenerate and non-degenerate states. Photoelectric effect: quantum theory of light work function- problems.

FOR FURTHER READING

Neutrions - expanding universe

1 **2 Hours**

INTRODUCTION

Exposure to Engineering Physics Laboratory and precautionary measures

2 **4 Hours**

EXPERIMENT 1

Determine the moment of inertia of the disc and calculate the rigidity modulus of a given wire using torsion pendulum (symmetrical masses method).

3 **4 Hours**

EXPERIMENT 2

Find the elevation of the given wooden beam at the midpoint by loading at the ends and hence calculate the Youngs modulus of the material.

4 **4 Hours**

EXPERIMENT 3

Find the depression at the midpoint of the given wooden beam for 50g, 100 g, 150 g, 200 g and 250 g subjected to non-uniform bending and determine the Youngs modulus of the material of the beam.

5 **4 Hours**

EXPERIMENT 4

Determine the coefficient of viscosity of the given liquid by Poiseulles method.

6 **4 Hours**

EXPERIMENT 5

Form the interference fringes from the air wedge setup and calculate the thickness of the given wire.

7 **4 Hours**

EXPERIMENT 6

By applying the principle of diffraction, determine the wavelength of given laser and the average particle size of lycopodium powder using laser source.

8 **4 Hours**

EXPERIMENT 7

Determine the
(i) wavelength of ultrasonics in a liquid medium,
(ii) velocity of ultrasonic waves in the given liquid
(iii) compressibility of the given liquid using ultrasonic interferometer.

Total: 60 Hours

Reference(s)

1. D. S. Mathur, Elements of Properties of Matter, 5th edition, S Chand & Company Ltd., New Delhi, 2012.
2. Charles Kittel, Introduction to Solid State Physics, 8th edition, Wiley India Pvt. Ltd., New Delhi, 2012.
3. Arthur Beiser, Shobhit Mahajan and S Rai Choudhury, Concepts of Modern Physics, 6th Edition, Tata McGraw Hill Education Pvt. Ltd., New Delhi, 2010.
4. B. K. Pandey and S. Chaturvedi, Engineering Physics, 1st edition, Cengage Learning India Pvt. Ltd., New Delhi, 2012.
5. Halliday and Resnick, Fundamentals of Physics, John Wiley and Sons, Inc, 2011.
6. Ian Morison, Introduction to Astronomy and Cosmology, John Wiley and Sons, Ltd., 2013.

Assessment Pattern

Unit/RBT	Remember				Understand				Apply				Analyse				Evaluate				Create				Total
	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	
1	2	2				4	2				6				4				4						24
2		2				2	6			2	4			4											20
3		4				4	2			4				2				2							18
4	2	2				4					6			2				2							18
5	2	2				4	4			4					4										20
																								Total	100

Assessment Questions

Remember

1. Reproduce Hooke's law
2. Name the three types of moduli of elasticity
3. List the two applications of air wedge
4. Recall the two conditions required for achieving total internal reflection
5. Define magnetostriction effect
6. Recognize the four applications of ultrasonics in medical field
7. Write the Bragg's condition necessary for obtaining X-ray diffraction in crystals
8. Retrieve the seven types of crystal system
9. Recall four physical significance of wave function
10. Define photoelectric effect

Understand

1. Explain the procedure adopted for determining the Young's modulus of the given material by non-uniform bending method
2. Illustrate the effect of temperature on elasticity of a material
3. Classify the fiber optics based on refractive index profile
4. Indicate the role of optical resonators in the production of laser
5. Compare the merits of magnetostriction and piezo-electric oscillators
6. Summarize the four applications of ultrasonic waves in day-today life
7. Identify the closely packed cubic crystal structure with an example
8. Compare Laue method and powder crystal method used in X-ray diffraction
9. Infer the significance of photoelectric effect
10. Represent the two assumptions involved in solving the Schrödinger time dependent wave equation

Apply

1. Show that when a cylinder is twisted the torsional couple depends on torsional rigidity
2. Using torsional pendulum, explain the rigidity modulus of the wire
3. Design an experimental setup used for determining the thickness of a thin material
4. A silica optical fiber has a core refractive index of 1.50 and a cladding refractive index of 1.47. Find the numerical aperture for the fiber.
5. Construct the piezo electric oscillator circuit and explain the generation of ultrasonic waves
6. Find the depth of submerged submarine if an ultrasonic wave is received after 0.33 s from the time of transmission.(given v=1400 m/s)
7. Show that the axial ratio for an ideal HCP structure is 1.633
8. Sketch the planes having Miller indices (100) and (111).
9. Assess the various energy levels of an electron enclosed in a one dimensional potential well of finite width 'a'
10. Compute the relation between de Broglie wavelength and velocity of a particle

Analyse

1. Differentiate uniform bending from non-uniform bending
2. Straight lined fringes are formed only in flat glass plates. Justify.
3. Conclude that the thickness of thin wire is influenced by band width of a material
4. Outline the merits and demerits of magnetostriction oscillator method.

5. Five fold symmetry is not possible in crystal structures. Justify your answer.
6. Compare the degenerate state with non-degenerate state

Evaluate

1. Determine the viscosity of a given liquid using Poiseuille's method (Given: water, burette, stop clock, capillary tube, stand and travelling microscope)
2. When ultrasonic waves are passed through liquids, cavitations are produced. Criticize the statement
3. Check the packing factor for a simple cubic structure is 0.52

15CH103 ENVIRONMENTAL SCIENCE

2 0 2 3

Course Objectives

- Realize the interdisciplinary and holistic nature of the environment
- Understand how natural resources and environment affect the quality of life and stimulate the quest for sustainable development
- Recognize the socio-economic, political and ethical issues in environmental science

Programme Outcomes (POs)

a. **Engineering Knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

b. **Problem Analysis:** Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

c. **Design/ Development of Solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for thepublic health and safety, and the cultural, societal, and environmental considerations.cultural, societal, and environmental considerations.

f. **The Engineer and Society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

g. **Environment and Sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

Course Outcomes (COs)

1. Assess the importance of interdisciplinary nature of environment studies, uses and exploitation of natural resources.
2. Analyze the different types of ecosystems and biodiversity, its values and also role of professionals in protecting the environment from degradation.
3. Identify the existing environmental challenges related to pollution and its management.
4. Select suitable strategies for sustainable management of components of environmental.
5. Correlate the impacts of population and human activities on environment.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3		2										2	
2		2											2	
3			3			3	1						3	
4			2			1	3						3	
5			2			2	2						2	

UNIT I 6 Hours

NATURAL RESOURCES

Forest resources: Use - over exploitation - deforestation - case studies. Water resources: Use - over utilization of surface and ground water - conflicts over water. Mineral resources: Use - exploitation - environmental effects of extracting and using mineral resources - case studies. Food resources: Effects of modern agriculture - fertilizer-pesticide problems (eutrophication, blue baby syndrome, biomagnification) - water logging - salinity - case studies. Energy resources: renewable(solar, wind, tidal, geothermal and hydroelectric power) - non renewable energy sources

UNIT II 6 Hours

ECOSYSTEMS AND BIODIVERSITY

Concept of an ecosystem: Structure and function of an ecosystem - producers - consumers - decomposers - food chains - food webs and ecological pyramids - Types of ecosystem: Introduction - characteristic features: forest ecosystem - desert ecosystem - ecological succession. Biodiversity - value of biodiversity - threats to biodiversity - endangered and endemic species - Conservation of biodiversity: In-situ and ex-situ conservation of biodiversity - field study

UNIT III 6 Hours

ENVIRONMENTAL POLLUTION

Pollution: Definition - causes - effects - control measures of air pollution - water pollution : (Sewage water treatment by activated sludge and trickling filter process) - marine pollution - thermal pollution - noise pollution. Disaster management: causes - effects - control measures of floods - earthquake - cyclone - landslides

UNIT IV 7 Hours

SOCIAL ISSUES AND ENVIRONMENT

Sustainable development : Definition - Unsustainable to sustainable development - urban problems related to energy. Environmental ethics - issues and possible solutions - solid waste management - causes - effects - 3R Principles (landfills, incineration, composting). Water conservation - rain water harvesting - watershed management. Climate change - global warming - acid rain - ozone layer depletion. Environment protection act: Air (Prevention and control of pollution) act - wildlife protection act

UNIT V 5 Hours

HUMAN POPULATION AND ENVIRONMENT

Human population: Population growth - characteristics - variation among nations - population explosion - women and child welfare programmes - value education - HIV / AIDS. Role of information technology in environment and human health - occupational safety and health administration (OSHA)

FOR FURTHER READING

Human rights:E - waste and biomedical waste -Identification of adulterants in food materials

1 2 Hours

EXPERIMENT 1

General instructions to students for handling the reagents and safety precautions.

2 4 Hours

EXPERIMENT 2

Estimation of dissolved oxygen in a water sample/sewage by Winklers method

EXPERIMENT 3

Estimation of chloride content in water by argentometric method

4 **4 Hours**

EXPERIMENT 4

Estimation of calcium in lime by complexometric method

5 **4 Hours**

EXPERIMENT 5

Estimation of chromium in leather tannery effluents

6 **4 Hours**

EXPERIMENT 6

Determination of percentage purity of washing soda

7 **4 Hours**

EXPERIMENT 7

Estimation of heavy metals in the given solution by EDTA method

8 **4 Hours**

EXPERIMENT 8

Determination of Prussian blue dye concentration by spectrophotometer

Total: 60 Hours

Reference(s)

1. Anubha Kaushik, C.P. Kaushik, Environmental Science and Engineering , 4th Multi Colour Edtion, New Age International Publishers, New Delhi, 2014
2. A. Ravikrishnan, Environmental Science and Engineering, 5th revised Edition, Sri Krishna Hitech Publishing company (P) Ltd, Chennai, 2010
3. T. G. Jr. Miller, S. Spoolman, New Environmental Science, 14th Edition, Wadsworth Publishing Co, New Delhi, 2014
4. E. Bharucha, Textbook of Environmental studies, second Edition, Universities Press Pvt. Ltd., New Delhi, 2013
5. A. K. De, Environmental Chemistry, 7th Edition , New age international publishers, New Delhi, 2014

Assessment Pattern

Unit/RBT	Remember				Understand				Apply				Analyse				Evaluate				Create				Total
	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	
1	3	3			4	5				1			1	3											20
2	4	1			5	7							1	2											20
3	3				4	6	2		1	1			1	1				1							20
4	1	2			3	8	1			4			2	4											25
5	1	2			2	5				1			1	2				1							15
																								Total	100

Assessment Questions

Remember

1. Define the term bio-magnification.
2. Name any four major gases responsible for air pollution.
3. Recall four gases responsible for greenhouse effect.
4. State environmental ethics.
5. List any two impacts of water pollution.
6. Mention the two objectives of value education.
7. List any four consequences of air pollution on human health.
8. Recall any two endangered and endemic species of India.

9. List any two disadvantages of nuclear energy production.

Understand

1. Summarize the structural and functional attributes of an ecosystem.
2. With the help of neat flow chart explain waste water treatment process using activated sludge process.
3. Explain the modern method of rain water harvesting technique diagrammatically and discuss the various strategies adopted for water conservation.
4. Summarize the abstracts of Wildlife (protection) Act, 1972.
5. Indicate the three consequences of noise pollution.
6. Classify the ecosystems on the basis of energy sources
7. Infer two types of photochemical reactions involved in formation and destruction of ozone in the stratosphere.
8. Explain how the impacts of natural disasters can be minimized on human communities with on representative example.
9. Summarize four major effects caused on forests and tribal people due to big dam construction.
10. Infer the any two conflicts over water, confining to our nation.
11. Identify three major threats to Indian biodiversity
12. Relate the concept of food chain and food web with tropic level and mention their three significances.

Apply

1. Identify any seven impacts caused if ground water is used enormously.
2. Select the proper disaster management techiques that can be implemented to manage. a) Earthquake b) Floods
3. Summarize the concept age-structure pyramids as a tool to achieve stabilized population in our nation.
4. Predict the significances of child welfare programmes in India.
5. Implement the 3R approach to manage solid waste.
6. Assess the four adverse effects of solid waste.
7. Assess how climate change affects human health.

Analyse

1. Differentiate between confined and unconfined aquifers.
2. Distinguish between critical and strategic minerals with two examples for each.
3. Outline variations in population growth among nations with necessary diagram.
4. “Day by day our atmosphere gets prone to serious effects” and “deterioration of environment affects human health”. Justify these two statements.
5. Compare the major two advantages and limitations of major greenhouse pollutant CO2.

Evaluate

1. Choose any one suitable method to minimize the impact of acid rain on environment.
2. Determine the doubling time of population, if annual growth rate of a nation is 25 years.

15GE205 BASICS OF CIVIL AND MECHANICAL ENGINEERING 3 0 0 3

Course Objectives

- To impart basic knowledge in the field of Civil Engineering
- To guide students to select the good building materials
- To create awareness on various types of water supply and transportation systems
- To impart basic knowledge in the various engineering materials and manufacturing Processes.
- To understand the working principles of various Internal Combustion Engines, Refrigeration, Boiler and power plants.

Programme Outcomes (POs)

a. **Engineering Knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

g. **Environment and Sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

Course Outcomes (COs)

1. Illustrate the concepts and fundamental philosophies of Civil Engineering
2. Classify the components of building with its functions and material qualities
3. Explain the sources of water supply and transportation systems
4. Identify various engineering materials and manufacturing processes.
5. Classify the working principles and operations of Internal Combustion Engines and Refrigeration cycles.
6. Identify different Energy sources and classify types of boilers ,turbine and power plants .

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3												1	
2	3						2						1	
3	3						2						2	
4	3												3	
5	3						2						3	

UNIT I **7 Hours**

INTRODUCTION TO CIVIL ENGINEERING

History, development and scope of Civil Engineering Functions of Civil Engineers.Construction Materials Characteristics of good building materials such as Stones Bricks -Cement - Aggregates and concrete. Surveying: Definition and purpose Classification Basic principles Measurement of length by chains and tapes.

UNIT II **7 Hours**

GENERAL FEATURES RELATING TO BUILDINGS

Selection of site Basic functions of buildings Major components of buildings. Types of foundation Bearing capacity of soils General Principles of Brick masonry Stone masonry Beams Lintels Columns Doors and windows Introduction to Green Building and Interior Design

UNIT III **7 Hours**

WATER SUPPLY AND TRANSPORTATION SYSTEMS

Sources of water Supply Methods of Rain Water Harvesting Flow Diagram of Water treatment Process Modes of Transportation Systems. Classification of Highways-Components of roads Bituminous and cement concrete roads. Importance of railways - Gauges Components of permanent way Types of bridges.

UNIT IV **8 Hours**

ENGINEERING MATERIALS AND MANUFACTURING PROCESSES

Materials classification, mechanical properties of cast iron, steel and high speed steel Casting process-Introduction to green sand moulding, pattern, melting furnace electric furnace Introduction to metal forming process and types Introduction to arc and gas welding Centre lathe, Drilling and Milling machines principal parts, operations.

UNIT V **8 Hours**

INTERNAL COMBUSTION ENGINES AND REFRIGERATION

Internal Combustion (IC) Classification, main components, working principle of a two and four stroke petrol and diesel engines, differences Refrigeration working principle of vapour compression and absorption system Introduction to Air conditioning.

UNIT VI **8 Hours**

ENERGY, BOILERS, TURBINE AND POWER PLANTS

Energy-Solar,Wind,Tidal,Geothermal,Biomass and Ocean Thermal Energy Conversion (OTEC)Boilers classification, Babcock and Wilcox and La-Mont Boilers, differences between fire tube and water tube boiler Steam turbines- working principle of single stage impulse and reaction turbines Power plant classification, Steam, Hydel, Diesel, and Nuclear power plants.

Total: 45 Hours

Reference(s)

1. N. Arunachalam, Bascis of Civil Engineering, Pratheeba Publishers, 2000
2. M. S. Palanichamy, Basic Civil Engineering, TMH, 2009
3. G. Shanmugamand M. S. Palanichamy, Basic Civil and Mechanical Engineering,Tata McGraw Hill Publishing Co., New Delhi, 2009
4. Pravin Kumar, Basic Mechanical Engineering, Pearson Education India, Pearson,2013.
5. G. Shanmugam and S. Ravindran, Basic Mechanical Engineering, Tata McGraw- Hill Publishing Company Limited, New Delhi, 2013.
6. S. R. J. Shantha Kumar, Basic Mechanical Engineering, Hi-tech Publications, Mayiladuthurai, 2015

Assessment Pattern

Unit/RBT	Remember				Understand				Apply				Analyse				Evaluate				Create				Total
	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	
1	7					10																			17
2	7					10																			17
3	4					6			4																14
4	7					12																			19
5	5					10																			15
6	6					12																			18
																								Total	100

Assessment Questions

Remember

1. Classify Boiler.
2. What are the uses of high carbon steel?
3. Define welding
4. Define soldering.

5. Define Brazing.
6. What do you mean by milling?
7. Classify IC Engines.
8. List the various components of IC Engines.
9. Define Refrigeration.
10. Classify Boiler.
11. What is turbine?
12. Define water tube boiler.
13. Name the main parts of a turbine.
14. Classify power plants.
15. Writedown the scope of Civil Engineering.
16. Define surveying.
17. List the ingredients of concrete.
18. State the basic principles of survey.
19. What is meant by lintel?
20. Write down the components of buildings.
21. List the functions of foundation.
22. What is meant by bearing capacity of soil?
23. What are the factors to be considered in selection of site?
24. Define gauges.
25. Name the components of permanent way.
26. State the importance of railway.
27. List out the types of bridge.
28. Write down the classification of highway.
29. What do you meant by rain water harvesting
30. What are the factors to be considered in design of green building?

Understand

1. Compare reaction and impulse turbines.
2. What is the difference between renewable and non-renewable sources of energy?
3. What is the function of a hydraulic turbine?
4. What is the function of a surge tank in Hydel power plant?
5. What is the function of a moderator in Nuclear power plant?
6. How to select the boiler?
7. Why air is pre-heated before enter into boiler?
8. How does a fusible plug function in boiler?
9. What is the function of a spark plug in IC engine?
10. What is the function of a fuel injector in diesel engine?
11. Compare and contrast 4 stroke and 2 stroke engine.
12. Describe the characteristics of good building stone.
13. Explain the various functions of Civil Engineer.
14. Discuss in detail about principles of surveying.
15. Describe the characteristics of cement and concrete.
16. Differentiate the English and Flemish bonds brick masonry.
17. What are the points to be observed in the construction of brick masonry?
18. Discuss about any four super structure components.
19. Distinguish between shallow and deep foundation.
20. Distinguish between stone and brick masonry.
21. Differentiate bituminous and cement concrete roads.
22. Elucidate the components of permanent way.
23. Describe the cross section of bituminous pavement.
24. Elucidate different sources of water supply.

Apply

1. Explain in detail about rain water harvesting.
2. Explain the process of water treatment.

3. Enumerate the procedure for construction of water bound macadam road.

15GE106 C PROGRAMMING

3 0 2 4

Course Objectives

- Understand the basics of C primitives, operators and expressions.
- Gain knowledge about the different primitive and user defined data types.
- Impart knowledge about the structural programming concepts.

Programme Outcomes (POs)

a. **Engineering Knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

b. **Problem Analysis:** Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

e. **Modern Tool Usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

Course Outcomes (COs)

1. Implement C programs using operators, type conversion and input-output functions.
2. Apply decision making and looping statements in writing C programs.
3. Develop C programs using the concepts of Arrays and strings
4. Apply the concepts of functions and pointers in writing C programs
5. Design applications using structures, unions and files in C

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3	3			3								1	
2	2	3			3								2	
3	2	3			3								2	
4	1	3			3								3	
5	1	3			3									

UNIT I **9 Hours**

INTRODUCTORY CONCEPTS

C Primitives: Introduction to C- Planning and writing a C program- Character Set - Keywords and Identifiers - Data Types - Variables and Constants - Compiling and executing the C program Operators and Expressions: Arithmetic - Relational - Logical - Increment and decrement - Conditional - Bitwise - Comma - Sizeof() - Assignment - Shift operator - Precedence and order of evaluation - Type Conversion Input and Output Operations: Formatted I/O functions - getchar and putchar function - gets and puts functions

UNIT II **7 Hours**

CONTROL STATEMENTS

Decision Making and Branching: simple if statement - if else statement - nesting of if else Statement - Switch Statement. Decision Making and Looping: while statement - do while statement - for statement - Nested for statementJump Statements: goto - break - continue - return statement

UNIT III **9 Hours**

ARRAYS AND STRINGS

Arrays: Introduction, one dimensional array, declaration - Initialization of one dimensional array, two-dimensional arrays, initializing two dimensional arrays, multi dimensional arrays. Strings: Declaring and initializing string variables- Reading strings from terminal - writing string to screen - String handling functions.

UNIT IV **10 Hours**

FUNCTIONS AND POINTERS

User Defined Functions: Elements of user defined functions - Definition of functions - return values and their types - function calls - function declaration - categories of function - call by value and call by reference - recursion - Pre-processor directives and macros.Pointers: Understanding Pointers - accessing the address of the variable - declaring pointer variables - Initialization of pointer variables - Accessing a variable through its pointer

UNIT V **10 Hours**

STRUCTURES AND FILES

Storage Class Specifiers: Auto - registers - static - extern - typedef Structures and Unions: Introduction - defining a structure - declaring structure variables - accessing structure members - structure initialization - Unions - Enumerated data type File Management in C: Defining and opening a file - closing a file - Input/output operations on files - Command line arguments

FOR FURTHER READING

Problem solving - Logical thinking - logic - symbolic logic - truth tables - Math puzzles - magic triangles - magic squares - alphabetic puzzles - Cross number puzzles. Creating and manipulating document using word - Mail merge - Creating spread sheet with charts and formula using excel - developing power point presentation with Animations.

1 **3 Hours**

EXPERIMENT 1

Write a C program to perform arithmetic operations on integers and floating point numbers.

2 **3 Hours**

EXPERIMENT 2

Write a C program to implement ternary operator and relational operators.

3 **3 Hours**

EXPERIMENT 3

Write a C program to read the values of A,B,C through the keyboard. Add them and after addition check if it is in the range of 100 to 200 or not. Print separate message for each.

4 **3 Hours**

EXPERIMENT 4

Write a C program to display the roots of a quadratic equation with their types using switch case.

5 **3 Hours**

EXPERIMENT 5

Write a C program to generate the following triangle.

1
1 2 3

1 2 3 4 5
1 2 3 4 5 6 7

6

3 Hours

EXPERIMENT 6

Write a C program to get a matrix of order 3x3 and display a matrix of order of 4x4, with the fourth row and column as the sum of rows and columns respectively.

7 **3 Hours**

EXPERIMENT 7

Write a C program to remove the occurrence of "the" word from entered string.

8 **3 Hours**

EXPERIMENT 8

Write a C program to find the factorial of given number.

9 **3 Hours**

EXPERIMENT 9

Design a structure to hold the following details of a student. Read the details of a student and display them in the following format Student
details: rollno, name, branch, year, section, cgpa.

****
NAME:
ROLL NO:
BRANCH:
YEAR:
SECTION:
CGPA:

10 **3 Hours**

EXPERIMENT 10

Create two files test1.txt and test2.txt and write a C program to read the file text1.txt character by character on the screen and paste it at the end of test2.txt.

Total: 75 Hours

Reference(s)

1. Herbert Schildt, C -The complete Reference, Tata McGraw-Hill, 2013
2. Byron Gottfried , Programming with C, Schaum's Outlines, Tata Mcgraw-Hill, 2013
3. E.Balagurusamy, Programming in ANSI C, Tata McGraw-Hill, 2012
4. Kernighan B W and Ritchie O M, The C programming Language. Prentice-Hall of India, 2009
5. Kelley A and I. Pohl, A Book on C : Programming in C, Pearson Education, 1998
6. Ashok.N.Kamthane,Programming in C,Pearson education,2013

Assessment Pattern

Unit/RBT	Remember				Understand				Apply				Analyse				Evaluate				Create				Total
	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	
1	4	4			4	4																			16
2	2				2	4				6				2				2				2			20
3	2				2					6				2	3							6			21
4		2			2					6				2	3							6			21

5		2				2				6				6								6			22
																								Total	100

Assessment Questions
Remember

1. List the rules for defining a variable.
2. State the associativity property of an operator.
3. List the three constructs for performing loop operations.
4. Recall return statement.
5. Define an array.
6. Recognise strings.
7. Define functions.
8. Define pointers.
9. Define a structure.
10. List the functions used for opening and closing a file.

Understand

1. Classify the operators in C.
2. Identify the functions used for formatted I/O in C.
3. Summarise the branching statements in C.
4. Summarise the branching statements in C.
5. Summarise the looping statements in C.
6. Claasify the types of arrays in C.
7. Summarise the string handling functions in C.
8. Exemplify call by value and call by reference.
9. Illustrate the pointer concepts in C.
10. Summarise the four storage classes.
11. Explain the concept of files in C.

Apply

1. Compute the greatest of two numbers using ternary operators in C.
2. Demonstrate the concept of type conversion in C.
3. Implement a C program to find the roots of a quadratic equation using Switch case statement.
4. Implement a C program to check whether a number is prime or not.
5. Compute matrix multiplication using two dimentional arrays in C.
6. Execute a C program to check whether a string is a palindrome or not.
7. Implement a C program using functions to find factorial of a number.
8. Implement a C program to use pointers in C.
9. Execute a C program to generate a pay slip for an employee using structures.
10. Implement a C program to copy the content of one file to the other.

Analyse

1. Differentiate getchar and putchar functions.
2. Differntiate while and do while loop in C.
3. Compare strupr and strlwr functions.
4. Differntiate function definition and function call.
5. Differntiate function definition and function call.
6. Compare structure and union.

Evaluate

1. Determine the output of the following code.
   #include
   int main()

```
{
int var = 010;
printf("%d", var);
}
```

2. Determine the value of the logical expressionÂ a>b && a
3. Determine the output of the C code

```
#include
int main()
{
int a[5] = {5, 1, 15, 20, 25};
int i, j, m;
i = ++a[1];
j = a[1]++;
m = a[i++];
printf("%d, %d, %d", i, j, m);
return 0;
}
```

4. Determine the output of this C code.

```
#include
int main()
{
int a = 10, b = 10;
if (a = 5)
b--;
printf("%d, %d", a, b--);
}
```

5. Evaluate the expression c=(a+b*(c/d)%e) wih a=10, b=3, c=5, d=6 and e=1

Create

1. Generate a structure to store the following details: Rollno, Name, Mark1, Mark2, Mark3, Total, Average, Result and Class. Write a program to read Rollno, name and 3 subject marks. Find out the total, resultÂ and class as follows:
   a) Total is the addition of 3 subject marks.
   b) Result is "Pass" if all subject marks are greater than or equal to 50 else "Fail".
   c) Class will be awarded for students who have cleared 3 subjects
   i. Class "Distinction" if average >=75
   ii. Class "First" if average lies between 60 to 74 (both inclusive)
   iii. Class "Second" if average lies between 50 & 59 (both inclusive)
   d) Repeat the above program to manipulate 10 students' details and sort the structures as per rank obtained by them.
2. Create a structure that can describe the employees with the fields Eno, Ename. Basic. Write a program to calculate DA = 32% of Basic. HRA = 15% of Basic. CCA = 10% of BASIC, PF = 15%Â of Basic and print all details with Net pay. All processing should be using pointer notation.
   b) Result is "Pass" if all subject marks are greater than or equal to 50 else "Fail".
   c) Class will be awarded for students who have cleared 3 subjects
   i. Class "Distinction" if average >=75
   ii. Class "First" if average lies between 60 to 74 (both inclusive)
   iii. Class "Second" if average lies between 50 & 59 (both inclusive)
   d) Repeat the above program to manipulate 10 students' details and sort the structures as per rank obtained by them.

15GE207 ENGINEERING GRAPHICS

0 0 4 2

Course Objectives

- To learn conventions and use of drawing tools in making engineering drawings.
- To draw orthographic projections of points, line and solids.
- To draw the section of solids and development of surfaces of the given objects.
- To draw the isometric projections and perspective projections of the given solids.
- To introduce CAD software to draw simple two dimensional drawings.

Programme Outcomes (POs)

a. **Engineering Knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

c. **Design/ Development of Solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for thepublic health and safety, and the cultural, societal, and environmental considerations.

f. **The Engineer and Society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

Course Outcomes (COs)

1. Recognize the conventions and apply dimensioning concepts while drafting simple objects.
2. Draw the orthographic projection of points, line, and solids.
3. Draw the section of solid drawings and development of surfaces of the given objects.
4. Draw the isometric and perspective projection of the given objects.
5. Draw the simple two dimensional drawings using computer aided drawing tool.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	1					1		1		2		1	2	
2	2					2		2		2		1	2	
3	2					2		2		2		1	1	
4	2					3		3		3		2	2	
5	1					2		**1**		**1**		**2**	**3**	

UNIT I **12 Hours**

CONVENTIONS AND BASIC DRAWINGS

Importance - conventions - ISO and BIS - drawing tools and drawing sheets - lettering, numbering, dimensioning, lines and Symbols-Conic sections - types constructions -ellipse, parabola and hyperbola - eccentricity and parallelogram method.

UNIT II **14 Hours**

ORTHOGRAPHIC PROJECTIONS

Principles - first and third angle projections - Points - first angle projection of points, straight lines - parallel, perpendicular and inclined to one reference plane, solid - cylinders, pyramids, prisms and cones.

UNIT III **12 Hours**

SECTION OF SOLIDS AND DEVELOPMENT OF SURFACE

Section of solids - simple illustrations. Development of surfaces - cylinders, pyramids, prisms, cones and simple truncated objects.

UNIT IV **12 Hours**

ISOMETRIC AND PERSPECTIVE PROJECTIONS

Importance - orthographic to isometric projection - simple and truncated solids- perspective projections of simple solids.

UNIT V **10 Hours**

INTRODUCTION TO COMPUTER AIDED DRAWING (NOT FOR END SEMESTER EXAMINATION)

Basics commands of AutoCAD - two dimensional drawing, editing, layering and dimensioning - coordinate Systems -Drawing practice - orthographic views of simple solids using AutoCAD.

Total: 60 Hours

Reference(s)

1. K Venugpoal, Engineering Drawing and Graphics, Third edition, New Age International, 2005.
2. Basant Agrawal, Mechanical drawing, Tata McGraw-Hill Education, 2008.
3. Engineering Drawing Practice for Schools & Colleges, BUREAU OF INDIAN STANDARDS-SP46, 2008.
4. N. D. Bhatt and V. M. Panchal, Engineering Drawing, Charotar Publishing House Pvt. Limited, 2008.
5. K.V.Natarajan, A Text Book of Engineering Graphics, Dhanalakshmi Publishers, 2013.
6. George Omura, Brian C. Benton, Mastering AutoCAD 2015 and AutoCAD LT 2015: Autodesk Official Press, Wiley Publisher, 2015.

15MA201 VECTOR CALCULUS AND COMPLEX ANALYSIS **3 2 0 4**

Course Objectives

- Implement the Complex Analysis, an elegant method in the study of heat flow, fluid dynamics and electrostatics.
- Summarize and apply the methodologies involved in solving problems related to fundamental principles of Calculus viz: Differentiation, Integration and Vectors.
- Develop enough confidence to identify and model mathematical patterns in real world and offer appropriate solutions, using the skills learned in their interactive and supporting environment.

Programme Outcomes (POs)

a. **Engineering Knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. **Problem Analysis:** Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

Course Outcomes (COs)

1. Determine & apply the important quantities associated with vector fields such as the divergence, curl and scalar potential.
2. Apply the theoretical aspects of vector integral calculus in their core areas.
3. Recognize the differentiation properties of vectors.

4. Identify the complex functions and their mapping in certain complex planes.
5. Use the concepts of integration to complex functions in certain regions.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	1												1	
2	1	2											1	
3	1												2	
4	1	2											2	
5	3												1	

UNIT I **10 Hours**

VECTOR CALCULUS

Gradient -Divergence -Curl - Directional derivative- Solenoidal -Irrotational vector fields -Line Integral -Surface integrals.

UNIT II **9 Hours**

INTEGRAL THEOREMS OF VECTOR CALCULUS

Green's theorem in a plane- Stoke's Theorem- Gauss divergence theorem- Applications involving cubes and parallelepiped.

UNIT III **8 Hours**

ANALYTIC FUNCTIONS

Analytic Functions- Necessary and Sufficient conditions of Analytic Function- Properties of Analytic function - Determination of Analytic Function using Milne Thompson method -Applications to the problems of Potential Flow.

UNIT IV **8 Hours**

MAPPING OF COMPLEX FUNCTIONS

Physical interpretation of mapping- Application of transformation: translation, rotation, magnification and inversion of multi valued functions - Linear fractional Transformation (Bilinear transformation).

UNIT V **10 Hours**

INTEGRATION OF COMPLEX FUNCTIONS

Cauchy's Fundamental Theorem - Cauchy's Integral Formula - Taylor's and Laurent's series- Classification of Singularities - Cauchy's Residue Theorem.

FOR FURTHER READING

Applications to Electrostatic and Fluid Flow.

Total: 75 Hours

Reference(s)

1. C. Ray Wylie and C. Louis Barrett, Advanced Engineering Mathematics, Tata McGraw-HillPublishing Company Ltd, 2003
2. Erwin Kreyszig , Advanced Engineering Mathematics, Tenth Edition, Wiley India Private Limited,New Delhi 2015
3. J. A. Brown and R. V. Churchill, Complex Variables and Applications , Sixth Edition, McGraw Hill,New Delhi, 1996
4. B. S. Grewal, Higher Engineering Mathematics, Forty third Edition, Khanna Publications , New Delhi 2014

5. Peter V. O. Neil, Advanced Engineering Mathematics, Seventh Edition ,Cengage Learning India Private Limited, 2012
6. Glyn James, Advanced Engineering Mathematics, Third Edition,Wiley India,2007.

Assessment Pattern

Unit/RBT	Remember				Understand				Apply				Analyse				Evaluate				Create				Total
	F	**C**	**P**	**M**	**F**	**C**	**P**	**M**	**F**	**C**	**P**	**M**	**F**	**C**	**P**	**M**	**F**	**C**	**P**	**M**	**F**	**C**	**P**	**M**	
1	2					6					8			4			2								22
2	2					4				4					4				6						20
3		2									10								6						18
4	2						4				6				6										18
5	2						4			6				4					6						22
																								Total	100

Assessment Questions

Remember

1. Define gradient of a vector.(F)
2. Define irrotational of a vector.(F)
3. State Green's theorem.(F)
4. State Gauss divergence theorem.(F)
5. State whether the function f(z)=z^3 is analytic.(C)
6. List the necessary condition for a function f(z) to be analytic. (F)
7. Define Bilinear transformation.(F)
8. List the condition for the transformation w = f(z) to be conformal at a point.(F)
9. State the formula for finding the residue of a double pole?(C)
10. State Cauchy's integral formula.(F)

Understand

1. If $\vec{F} = x^2\,\vec{i} + xy^2\,\vec{j}$ Illustrate the line integral $\int \vec{F}.\vec{dr}$ from (0,0) to (1,1) along the path y=x. (C)
2. Identify the unit normal vector to the surface $x^2 + xy + z^2 = 4$ at the point(1,-1,2).(F)
3. Identify the value of $\nabla x \nabla \Phi$ by using Stoke's theorem. (F)
4. Formulate the area of a circle of radius a using Green's theorem . (C)
5. Explain any two properties of analytic function.(F)
6. Indicate the analyticity of the function w = sin z.(C)
7. Identify the fixed points of the transformation w = z^2 . (F)
8. Identify the image of the triangular region in the z plane bounded by the lines x= 0, y = 0, and x + y = 1 under the transformation w = 2z (P)
9. Infer $\int_c \frac{dz}{(z-3)^2}$ where c is the circle $|z| = 1$.(C)
10. Identify the residues of the function $f(z) = \frac{4}{z^3(z-2)}$ at its simple pole.(F)

Apply

1. Find $\int_c \overline{F}.dr$ where $\overline{F} = (2y+3)i + xzj + (yz-x)k$ along the line joining the points (0,0,0) to (2,1,1). (F)
2. If $\vec{F} = 3xy\,\vec{i} - y^2\,\vec{j}$, find $\int_C \vec{F}\cdot d\vec{r}$ where C is the curve in the xy-plane y=2x^2 from (0,0) to (1, 0). (F)
3. Apply Green's theorem in the plane to Compute $\int_c (3x^2 - 8y^2)dx + (4y - 6xy)dy$ where C is the boundary of the region defined by x=0, y=0 and x+y=1.(P)
4. Using Gauss divergence theorem,Compute $\iint_s \vec{F}\cdot\hat{n}ds$ where $\vec{F} = 4xz\vec{i} - y^2\vec{j} + yz\vec{k}$ and S is the surface of the cube bounded by x=0,y=0,z=0,x=1,y=1,z=1.(P)
5. If ω=φ+iψ represent the complex potential for an electric field and $\psi = x^2 - y^2 + \frac{x}{x^2+y^2}$, find the function φ.(P)
6. If $u = \log(x^2 + y^2)$, find v and f (z) such that f (z) =u+iv is analytic. (P)
7. Find bilinear transformation which maps the points I,-1,I of the z plane into the Points 0,1,∞ of the w plane respectively.(P)
8. Find the image of the circle $|z-1| = 1$in the complex plane under the transformation w = $\frac{1}{z}$. (C)
9. Find Taylor's series f(z) = cos z about z = $\frac{\pi}{3}$. (P)
10. Find the nature of singularity $z\, e^{\left(\frac{1}{z}\right)^2}$. (C)

Analyze.

1. Conclude $div\,grad(r^n) = \nabla^2(r^n) = n(n+1)r^{n-2}$.(P)
2. Compare irrotational vector and solenoidal vector with an example.(C)
3. Justify stokes's theorem for $\overline{F} = -yi + 2yzj + y^2k,$ where S is the upper half of the sphere $x^2+y^2+z^2=1$.(P)
4. Justify Gauss divergence theorem for $\vec{F} = x^2\,\vec{i} + y^2\,\vec{j} + z^2\,\vec{k}$ where S is the surface of the cuboid formed by the planes x= 0, x= a, y = 0, y = b, z = 0 and z = c.(P)
5. The complex potential f(z)=z^2 describes a flow with constant equipotential lines and streamlines ,conclude the velocity vector.(P)
6. Conclude that the function $u = x^3 + x^2 - 3xy^2 + 2xy - y^2$ is harmonic and find the corresponding analytic function. (P)

7. Resolve the image of the rectangle whose vertices are (0,0), (1,0), (1,2), (0,2) by means of linear transformation w = (1+i)z+2-i. Also compare the images.(P)

8. Resolve $f(z)=\dfrac{z}{(z-1)(z-3)}$ as Laurent's series valid in the regions: $1<|z|<3$ and $0<|z-1|<2$. (P)

9.Integrate using Cauchy's integral formula $\int_C \dfrac{e^z\,dz}{(z+2)\,(z+1)^2}$ where C is the circle $|\,z\,|=3$. (P)

10. Integrate $\int_C \dfrac{z+4}{z^2+2z+5}dz$ where C is $|z+1+i|=2$. (C)

Evaluate

1. Determine $\iint_s (xdydz+2ydzdx+3zdxdy)$,where s is the closed surface of the sphere $x^2+y^2+z^2=a^2$. (P)
2. Defend $curl(curl\vec{F})=grad(div\vec{F})-\nabla^2\vec{F}$.(C).
3. Check Stokes theorem for $\vec{F}=(x^2+y^2)\vec{i}-2xy\vec{j}$ taken around the rectangle bounded by x=±a,y=0 y=b.(P)
4. Check Green's theorem in the plane to determine $\int_c (3x^2-8y^2)dx+(4y-6xy)\,dy$ where c is the boundary of the region defined by $(i)\,x=0,y=0,x+y=1\,(ii)\,y=\sqrt{x}\ and\ y=x^2$.(P)
5. Determine the analytic function f(z) = P + iQ, if Q = $\dfrac{\sin x\sinh y}{\cos 2x+\cosh 2y}$, if f(0) = 1.(C)
6. Determine f(z) and the conjugate harmonic v such that w = u + iv is an analytic function of z given that u = $e^{x^2-y^2}\cos 2xy$.(C)
7. Determine the image of the infinite strip $\frac{1}{4}\le y\le\frac{1}{2}$ under the transformation w = $\frac{1}{z}$ (P)
8. Determine the Laurent's series expansion $f(z)=\dfrac{z-1}{(z+2)(z+3)}$ $for\ 2<|z|<3$.(P)

9. Determine $\int_C \frac{z+4}{z^2+2z+5}dz$ where C is $|z+1+i|=2$ (P)

10. Choose Cauchy's integral formula to determine $\int_C \frac{e^z dz}{(z+2)(z+1)^2}$ where C is $|z|=1$ (C)

15EE205 FUNDAMENTALS OF ELECTRICAL AND ELECTRONICS ENGINEERING 3 0 0 3

Course Objectives

- To understand the basic concepts of electric circuits
- To analyze the difference between DC and AC circuits
- To Learn the fundamentals of semiconductors and BJT.

Programme Outcomes (POs)

a. **Engineering Knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

b. **Problem Analysis:** Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

Course Outcomes (COs)

1. Apply the concept of current and voltage law for DC circuits.
2. Analyze the parameters of alternating current and examine the behavior of linear circuits.
3. Explain the constructional details and working of DC machines.
4. Explain the characteristics of semiconductor diodes and design the rectifier circuits.
5. Classify the three different characteristics of BJT.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3	2											3	1
2	3	2											2	1
3	2	1											2	3
4	2	3											2	3
5	1	3											3	2

UNIT I **9 Hours**

DC CIRCUITS

Definition of Voltage, Current, Power, Energy, Resistor, Inductor and Capacitor-Ohm's law-statement, Illustration and limitation - Kirchoff's Laws statement and Illustration-Resistance in series and voltage division technique - Resistance in parallel and current division technique-Simple problems.

UNIT II **9 Hours**

AC CIRCUITS

Generation of single phase alternating emf - RMS value, average value, peak factor and form factor - Analysis of Pure Resistive, Inductive and Capacitive circuits - J operator - Representation of alternating quantities in rectangular and polar forms - Star-Delta transformation -Simple problems

UNIT III **11 Hours**

ELECTRICAL MACHINES

Constructional details of DC Machines - Principle of operation of D.C. generator - EMF equation - Methods of excitation - Self and separately excited generators - Principle of operation of D.C. motor - Back EMF and torque equation - Transformer Constructional details - Principle of operation- EMF equation - Transformation ratio

UNIT IV **8 Hours**

SEMICONDUCTOR DIODE AND ITS APPLICATIONS

Semiconductor theory - Theory of P-N junction diode - Volt-Ampere Characteristics - PN junction diode current equation - Zener diode - Half wave and full wave rectifier - Average value - RMS value - Form factor - Peak factor - Ripple factor - Efficiency - Peak inverse voltage - Transformer utilization factor - Comparison between Half wave and full wave rectifier circuits.

UNIT V **8 Hours**

BIPOLAR JUNCTION TRANSISTOR

Structure and working of Bipolar Junction Transistor, Input and output characteristics of CE, CB and CC configurations, relation between alpha and beta - Concepts of transistor as an amplifier and transistor as a switch.

FOR FURTHER READING

Light Emitting Diode - Simple House wiring - Clipper and Clampers

Total: 45 Hours

Reference(s)

1. T. K. Nagsarkar and M. S. Sukhija, Basic Electrical and Electronics Engineering, Oxford University Press, 2014
2. Smarjith Ghosh, Fundamentals of Electrical and Electronics Engineering, Prentice Hall (India) Pvt. Ltd., 2012
3. A. Sudhakar, Shyammohan S Palli, Circuits and Networks Analysis and Synthesis, Tata McGraw Hill, 2010
4. William H.Hayt Jr, Jack E.Kemmerly, and Steven M.Durbin, Engineering Circuit Analysis, Tata McGrawHill Publishing Co Ltd, New Delhi, 2012.
5. Jacob. Millman, Christos C.Halkias, Satyabrata Jit, Electronic Devices and Circuits, Tata McGraw Hill Publishing Limited, New Delhi, 3rd Edition 2011
6. R. S. Sedha, A Textbook of Applied Electronics, S.Chand & Company Ltd, 2013

Assessment Pattern

Unit/RBT	Remember				Understand				Apply				Analyse				Evaluate				Create				Total
	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	
1	2					2					6				4				6						20
2	4					4				2				6					4						20
3	2				4					4					4				6						20
4	4					6				4					6										20
5	4					4				12															20
																								Total	100

Assessment Questions

Remember

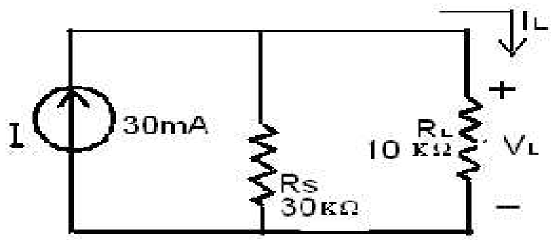
1. State Ohm's law.
2. State Lenz law.
3. State Faraday's law of electromagnetic induction.
4. Recall the properties of flux lines.
5. Define reluctance
6. Define average value.
7. List the advantages of three phase system.
8. Define aspect ratio.
9. State the need for modulation.
10. List the applications of diode.

Understand

1. Explain Ohm's law relating to (V), (I) and (R).
2. Compare series and parallel circuits.
3. Interpolate domestic appliances connected in parallel.
4. Classify the magnetic circuits.
5. Explain the concepts of self and mutually induced emf.
6. Explain the laws of electromagnetic induction.
7. Indicate the action of diode in forward and reverse biasing with the help of V-I characteristics.
8. Explain the switching characteristics of diode.
9. Explain briefly the need for modulation.
10. Summarize the advantages of FM over AM.

Apply

1. Three resistors are connected in series across a 12V battery. The first resistance has a value of 2 ohm, second has a voltage drop of 4V and third has power dissipation of 12 W. Calculate the value of the current in the circuit.
2. A 25 ohm resistor is connected in parallel with a 50ohm resistor. The current in 50ohm resistor is 8A. What is the value of third resistance to be added in parallel to make the total line current as 15A.
3. The self inductance of a coil of 500turns is 0.25H.If 60% of the flux is linked with a second coil of 10500 turns. Calculate a) the mutual inductance between the two coils and b) emf induced in the second coil when current in the first coil changes at the rate of 100A/sec.
4. An air cored toroidal coil has 480 turns, a mean length of 30cm and a cross-sectional area of 5 cm2.Calculate a)the inductance of the coil and b) the average induced emf, if a current of 4 A is reversed in 60 milliseconds.
5. A toroidal air cored coil with 2000 turns has a mean radius of 25cm, diameter of each turn being 6cm. If the current in the coil is 10A, find mmf, flux, reluctance, flux density and magnetizing force.
6. Demonstrate the block diagram of the television and explain each block.
7. Show the block diagram of the optical fibre communication and explain each block.
8. Show the block diagram of the satellite communication and explain each block.
9. Convert the current source into voltage source in the below circuit and verify that the voltage **VL** across the load is the same for each source.



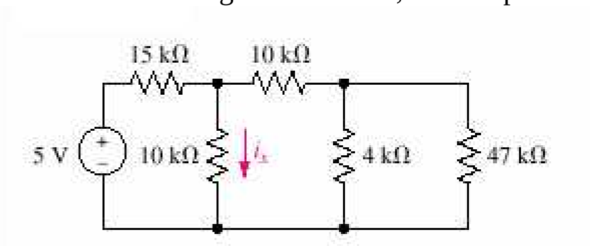
10. Demonstrate the applications of diodes.

Analyse

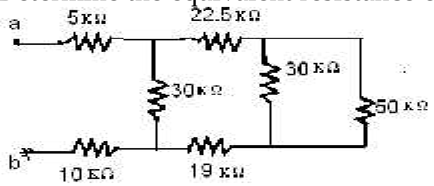
1. Criticize the equations for the equivalent star network resistances for a given delta network.
2. Differentiate the expressions for self inductance and mutual inductance.
3. Contrast the series and parallel magnetic circuit and derive the total mmf required.
4. Compare electric and magnetic circuits.
5. Attribute the expression for RMS, average value, peak and form factor of sinusoidal voltage.
6. Identify the voltage, current in a series RL circuit supplied with an alternating voltage.
7. Resolve the phase relation in pure resistor.
8. Resolve the expression for diode current equation.
9. Identify the effect of temperature on P-N junction diode characteristics.
10. Organize the equation of transition capacitance.

Evaluate

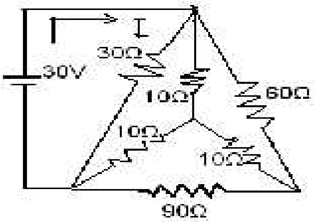
1. For the circuit in Fig. determine *i*x,and compute the power dissipated by the 15-kohm resistor.



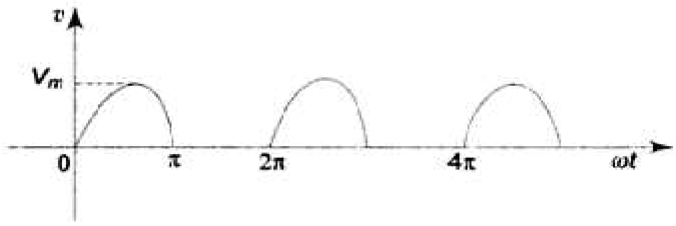
2. An iron rod of 1cm radius is bent to a ring of mean diameter 30cm and wound with 250 turns of wire. Assume the relative permeability of iron as 800. An air gap of 0.1cm is cut across the bent ring. Calculate the current required to produce a useful flux of 20,000 lines if leakage is neglected.
3. The effective resistance of two resistors connected in series is 100ohm. When connected in parallel, then effective value is 24 ohm's. Determine the value of two resistors.
4. Determine the equivalent resistance of the following circuit.



5. Calculate the total resistance RT, and total current I in the following circuits using star delta transformation technique.



6. Determine the form factor of the half-wave rectified sine wave as shown in fig.



7. Find the total impedance and line current in the circuit shown in

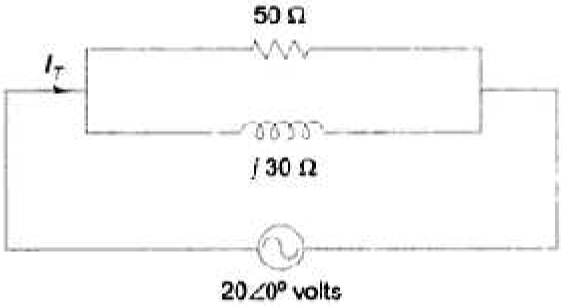
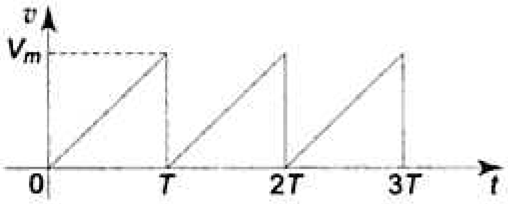
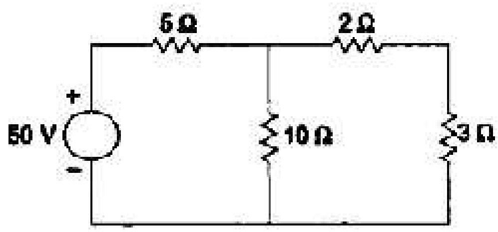


fig.

8. Determine the effective value of saw tooth waveform shown in fig.



9. A series circuit consisting of 25ohm resistor, 64mH inductor and 80μF capacitor, is connected to a 110V, 50Hz, single phase supply.Calculate the current and the voltage across individual elements.
10. Determine the value of current flowing through 3ohm resistor.



15EE206 ELECTRIC CIRCUIT ANALYSIS **2 0 2 3**

Course Objectives

- To apply the concept of Graph theory and analyze the electric circuits.
- To compute electrical parameters like current, voltage and power using network theorems for AC and DC circuits.
- To differentiate single phase and three phase circuits.
- To analyze R, L, C components for resonance, coupling and transient response.

Programme Outcomes (POs)

a. **Engineering Knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

b. **Problem Analysis:** Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

d. **Conduct Investigations of Complex Problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

e. **Modern Tool Usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

Course Outcomes (COs)

1. Apply the concept of Graph theory to analyze the electric circuits.
2. Apply the network theorems to compute various parameters of electric network.
3. Analyze the three phase circuit with different types of loads.
4. Design of tank circuit for given frequency and analyze the coupled circuits in series and parallel.
5. Analyze the transient response of RL, RC and RLC circuits with DC and AC input.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2	3		1									2	
2	1	3		1									3	
3		2		1									2	
4	1			2	2								2	2
5	2	2		1									1	1

UNIT I **7 Hours**

GRAPH THEORY AND BASIC CIRCUIT ANALYSIS

The graph of a Network, definitions of tree, co-tree, link, basic loop and basic cut set, Incidence matrix, cut set matrix, Tie set matrix - Duality - Concepts of Impedance and Admittance - Source Transformation - Mesh and Nodal analysis.

UNIT II **5 Hours**

NETWORK THEOREMS FOR DC AND AC CIRCUITS

Superposition theorem - Thevenin's and Norton's theorem - Maximum power transfer theorem- Reciprocity theorem- Millman's theorem.

UNIT III **5 Hours**

THREE PHASE CIRCUITS

Three Phase balanced and unbalanced systems - Analysis of 3 wire and 4 wire circuit with star and delta connected loads - Phasor diagram - power and power factor measurement.

UNIT IV **7 Hours**

RESONANCE AND COUPLED CIRCUITS

Series and parallel resonance - Q factor and bandwidth - Resonant frequency of a tank circuit - Coupled circuits - Self and mutual inductances - Coefficient of Coupling - Analysis of coupled circuits - Dot rule for coupled circuits - Equivalent circuit of coupled circuits - Coupled circuits in Series and Parallel.

UNIT V **6 Hours**

TRANSIENTS

Introduction - Transient Response of RL, RC and RLC Circuits with step and sinusoidal inputs - Time Constant Analysis.

FOR FURTHER READING

Tuned Circuits - Tank circuits - application of second order differential equations.

1 **6 Hours**

EXPERIMENT 1

Verification of Mesh and Nodal analysis.

2 **6 Hours**

EXPERIMENT 2

Verification of superposition theorem.

3 **6 Hours**

EXPERIMENT 3

Verification of Thevenin and Norton theorems.

4 **6 Hours**

EXPERIMENT 4

Power measurement using two wattmeter method.

5 **6 Hours**

EXPERIMENT 5

Frequency Response of a series R-L-C Circuit.

Total: 60 Hours

Reference(s)

1. William H. Hayt, Jack E. Kemmerly, and Steven M. Durbin, Engineering Circuit Analysis, Eighth Edition, Tata McGraw Hill, 2013
2. Sudhakar and S. P. Shyam Mohan, Circuits and Network Analysis and Synthesis, Fifth Edition, Tata McGraw Hill, 2015
3. Charles K.Alexander, Fundamentals of Electric Circuits, Fifth Edition, Tata McGraw Hill Publishing Co Ltd, 2013

Assessment Pattern

Unit/RBT	Remember				Understand				Apply				Analyse				Evaluate				Create				Total
	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	
1	2					2					6			4				6							20
2	4					4				2				6					4						20
3	2					4					4				4				6						20
4	4					6				4					6										20
5	4					4				12															20
																								Total	100

Assessment Questions

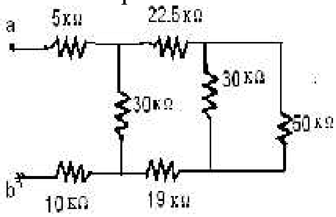
Remember

1. List the types of tree.
2. Define Pole and zero.
3. Define resonance.
4. List the types of filters.
5. Define positive real function
6. Retrive the conversion formula to convert from ABCD parameter to hybrid parameters.
7. Label the Norton's equivalent circuit.
8. State the Super position theorem.
9. Write the Thevenin's current equation.
10. Define dielectric strength.

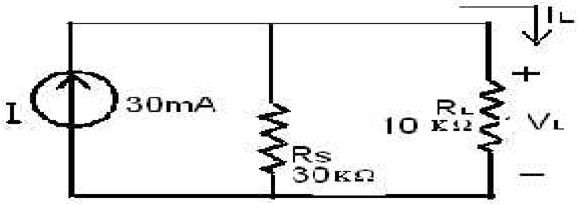
Understand

1. Compare ideal and practical voltage and current sources.

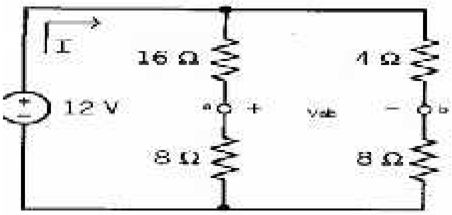
2. Interpolate Which parameters are preferred for cascade connected networks and why?
3. Illustrate necessary conditions for transfer functions.
4. Indicate basic equations representing transmission parameters.
5. Justify duality.
6. Represent the expression of resonant frequency of tank circuit.
7. Summerize the expression for open circuit parameters.
8. Find the equivalent resistance of the following circuit.



9. Convert the current source into voltage source in the below circuit and verify that the voltage ,**VL** across the load is the same for each source

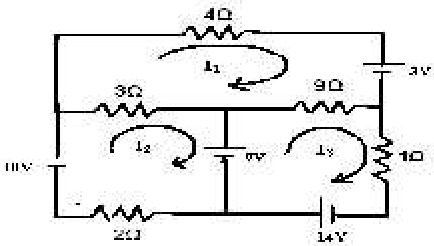


10. Determine the current I and voltage Vab in the attached circuit. Also find the power dissipated in the 16 Ω resistor and 4 Ω resistor

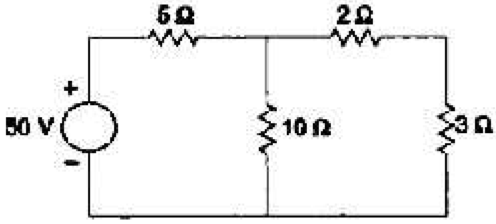


Apply

1. Use mesh analysis to find the loop currents in the circuit shown below.

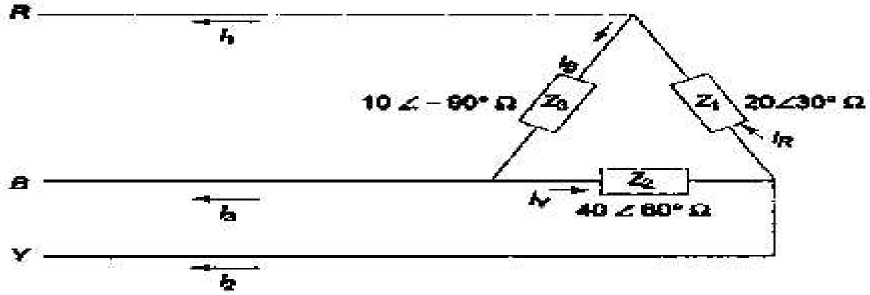


2. A series circuit consisting of 25ohm resistor, 64mH inductor and 80µF capacitor, is connected to a 110V,
50Hz, single phase supply. Calculate the current, voltage across individual element and the overall power factor of the circuit.
3. Find the current through 4ohm resistor by using loop current method.

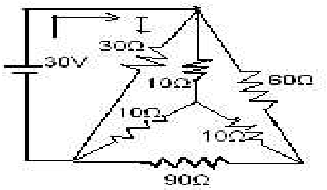


4. A series RLC circuit has R=20ohm, L=0.005H and C=0.2×10-6F. It is fed from a 100V variable frequency source. Find (i) frequency at which current is maximum (ii) impedance at this frequency and (iii) voltage across inductance at this frequency.

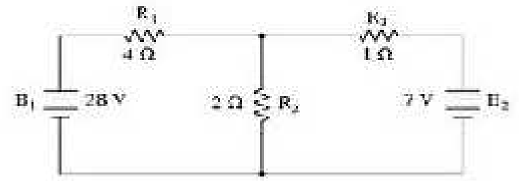
5. Three impedances Z1=20+j30ohm, Z2=40+j60ohm and Z3=10-j90ohm are delta-connected to a 400 V, 3Φ system as shown in Figure. Determine the (i) phase currents (ii) line currents, and (iii) total power consumed by the load.



6. The input power to a three phase load is10 KW at 0.8 pf. Two wattmeters are connected to measure the power, find the individual readings of the wattmeter.
7. A 400V, three phase supply feeds an unbalanced three-wire, star-connected load. The branch impedances of the load are ZR =4+j8) ohm, ZY =(3+j4)ohm, ZB =(15+j20)ohms. Find the line currents and voltage across each phase impedance. Assume RYB phase sequence.
8. With a neat circuit and phasor diagram assess the three phase power measurement by two wattmeter Methods.
9. To calculate the total resistance RT, and total current I in the following circuits using star delta transformation technique.

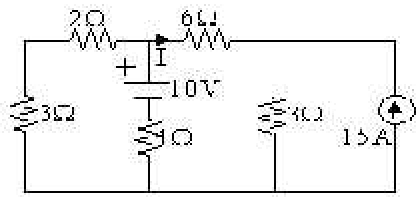


10. To calculate the current through 2Ω, and 1Ω resistor in the following circuitUsingsuperposition theorem

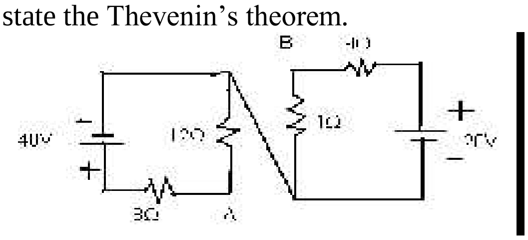


Analyse

1. To calculate the current in the 6ohm resistor in the below circuit using super position theorem



2. To calculate thevenin's equivalent across the terminals A & B in the following circuit. Also state the Thevenin's theorem.



3. A series RLC circuit consists of a resistance 1K ohm and inductance of 100mH in series with capacitance of 10pF. If 100V is applied as input across the combination ,Determine i)The

resonant frequency ii) Maximum current in the circuit iii)Q-Factor of the circuit iv)The Half-Power frequencies

4. Three resistors 12 ohm, 18 ohm and 36 ohm are connected in parallel. This parallel circuit is connected in series with a resistor ‘R’. The whole circuit is connected is supplied at 60 Volt and it is found that power developed in 12 ohm resistor is 48 watts. Determine the value of R and total power.
5. A circuit consists of two resistors 20 ohm and 30 ohm connected in parallel. They connected in series with a resistor of 15 ohm. If the current through the 15 ohm resistor is 3 A, find the current in the other resistors and supply voltage.Show that Rt =R0 (1+α0t)
6. The alternating current passing through a circuit is given by 141.4 sin 314.2t. Find the values of (a) r.m.s current, (b) the frequency (c) the instantaneous value of the current when t=0.02 second.
7. From the fundamental principle show that the R.M.S. value of a sinusoidal alternating current is 0.707 times the maximum value.
8. A current of 5**A** flows through a non-inductive resistance in series with a choking coil when supplied at 250**V**, 50Hz. If the voltage across the resistance is 125**V** and across the coil 200**V**, calculate (a) the impedance, reactance and resistance of coil (b) the power absorbed by the coil and (c) the total power. Draw the vector diagram
9. A circuit contains two impedances Z1 = (3 + J4) ohms and Z2 = (4 + J3) ohms in parallel and Connected to 50V, 50 Hz supply. Determine the currents through impedances, total current, Power and power factor.
10. A coil of 10 ohm and 0.4 Henry is in series with a capacitor of 40 mfd. A voltage of 200 volt at variable frequency is applied to the circuit. At what frequency will the current be maximum? Also calculate current, voltage across the coil and capacitor at this frequency.

Evaluate

1. Determine the relation between the line and phase current in a delta connected circuit
2. A balance delta connected load of (8+j6) ohms per phase is connected to a three phase 400V supply. Calculate the total power consumed. Also find out the readings of the two wattmeters connected to measure power.
3. A balanced load connected to a three phase supply comprises three identical coils in star. The line current is 25 A, KVA input is 20, KW input is 11. Find the phase voltage, line voltage, KVAr input, resistance and reactance of each coil of the load.
4. A resistor of 10 ohm is connected in series with two resistors of 15 ohm arranged in parallel. What resistance must be shunted across the parallel combination so that the total current taken shall be 1.5A with 20V applied?
5. An aluminium wire has a resistance of 3.6 ohm at 20°C. What is its resistance at 50°C, if the temperature coefficient of resistance is 0.00403 at 20°C?
6. Critiquing energy stored in a capacitor.
7. A circuit consists of a pure resistance and a coil in series. The power dissipated in the resistance is 500W and the drop across it is 100 V. The power dissipated in the coil is 100W and the drop across it is 50V. Find the reactance and resistance of the coil and the supply voltage.
8. Two coils A and B are connected in series across a 240V, 50 Hz supply. The resistance of A is 5 ohm and the inductance of B is 0.015H. If the input from the supply is 3KW and 2KVAr, find the inductance of A and resistance of B.
9. A circuit consists of a 10 ohm resistor, a 300 mfd capacitor, an inductor having an inductance of 0.96H all in parallel across a 200V, 25Hz supply. Calculate (a) the current in each branch (b) the total current (c) the power factor of the complete circuit and (d) the total power.
10. An inductive circuit of resistance 2 ohm and inductance of 0.01 H is connected to a 250V, 50Hz supply. What capacitance placed in parallel will produce resonance? Also find the total current taken from the supply, Q factor and dynamic resistance.

15GE107 WORKSHOP PRACTICE

0 0 2 1

Course Objectives

- To provide hands on training for fabrication of components using carpentry, sheet metal and welding equipment / tools.
- To gain the skills for making fitting joints and household pipe line connections using suitable tools.
- To develop the skills for preparing the green sand mould and to make simple household electrical connection
- To provide hands on training for dismantling and assembling of petrol engines, gear box and pumps.
- To develop the skills for making wood/sheet metal models using suitable tools

Programme Outcomes (POs)

a. **Engineering Knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

c. **Design/ Development of Solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for thepublic health and safety, and the cultural, societal, and environmental considerations.

e. **Modern Tool Usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

Course Outcomes (COs)

1. Fabricate simple components using carpentry, sheet metal and welding equipment/tools.
2. Make fitting joints and household pipe line connections using suitable tools.
3. Prepare green sand mould and make simple household electrical connections using suitable tools.
4. Dismantle and assemble petrol engines, gear box and pumps.
5. Make simple models using wood and sheet metal.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2				2				2		1		1	2
2	2				2				2		1		2	
3	2				2				2		1			3
4	2				2				2		1			3
5	2				2				2		1		1	

1 **2 Hours**

EXPERIMENT 1

Forming of simple object in sheet metal using suitable tools (Example: Dust Pan / Soap Box)

2 **4 Hours**

EXPERIMENT 2

Fabrication of a simple component using thin and thick plates. (Example: Book rack)

3 **2 Hours**

EXPERIMENT 3

Making a simple component using carpentry power tools. (Example: Pen stand/Tool box/ Letter box].

4 **2 Hours**

EXPERIMENT 4

Prepare a "V" (or) Half round (or) Square joint from the given mild Steel flat.

5 **4 Hours**

EXPERIMENT 5

Construct a household pipe line connections using pipes, Tee joint, Four way joint, elbow, union, bend, Gate way and Taps (or) Construct a pipe connections of house application centrifugal pump using pipes, bend, gate valve, flanges and foot valve.

6 **4 Hours**

EXPERIMENT 6

Prepare a green sand mould using solid pattern/split pattern.

7 **4 Hours**

EXPERIMENT 7

Construct a domestic electrical wire connections using indicator, one way switch with calling bell, two way switch with lamp, one way switch with fan regulator and one way switch with socket.

8 **4 Hours**

EXPERIMENT 8

Dismantling and assembly of Centrifugal Monoblock / Gear Pump / Gear box.

9 **2 Hours**

EXPERIMENT 9

Dismantling and assembly of two stroke and four stroke petrol engine.

10 **2 Hours**

EXPERIMENT 10

Mini Project(Fabrication of Small Components).

Total: 30 Hours

15MA301 FOURIER SERIES AND TRANSFORMS **3 2 0 4**

Course Objectives

- Understand the concepts of Fourier series, Transforms and Boundary Conditions, which will enable them to model and analyze the physical phenomena
- Implement the Fourier analysis, an elegant method in the study of heat flow, fluid mechanics and electromagnetic fields.
- Summarize and apply the mathematical aspects that contribute to the solution of one dimensional wave equation
- Develop enough confidence to identify and model mathematical patterns in real world and offer appropriate solutions, using the skills learned in their interactive and supporting environment.

Programme Outcomes (POs)

a. **Engineering Knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. **Problem Analysis:** Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

Course Outcomes (COs)

1. Recognize the periodicity of a function and formulate the same as a combination of sine and cosine using Fourier series.
2. Formulate a function in frequency domain whenever the function is defined in time domain.
3. Apply the Fourier transform, which converts the time function into a sum of sine waves of different frequencies, each of which represents a frequency component.
4. Classify a partial differential equation and able to solve them.
5. Use the Z-transform to convert a discrete-time signal, which is a sequence of real or complex numbers, into a complex frequency domain representation.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	1												3	
2	1	2											3	
3	1												2	
4	1	3											2	
5	1												2	

UNIT I **9 Hours**

FOURIER SERIES

Dirichlet's conditions - General Fourier series - Odd and even functions - Half range cosine and sine series - Root mean square value.

UNIT II **13 Hours**

LAPLACE TRANSFORM

Laplace Transform- Existence Condition -Transforms of Standard Functions - Unit step function, Unit impulse function- Properties- Transforms of Derivatives and Integrals - Initial and Final Value Theorems - Laplace transform of Periodic Functions - Inverse Laplace transforms.

UNIT III **8 Hours**

FOURIER TRANSFORM

Fourier Integral Theorem- Fourier Transform and Inverse Fourier Transform- Sine and Cosine Transforms - Properties - Transforms of Simple Functions - Convolution Theorem - Parseval's Identity

UNIT IV **8 Hours**

APPLICATIONS OF PARTIAL DIFFERENTIAL EQUATIONS

Classification of Second Order Quasi Linear Partial Differential Equations - Fourier Series Solutions of One Dimensional Wave Equation - One Dimensional Heat Equation - Steady State Solution of Two-Dimensional Heat Equation - Fourier Series Solutions in Cartesian Coordinates.

7 Hours

UNIT V

Z -TRANSFORM

Z-Transform - Elementary Properties - Inverse Z-Transform - Convolution Method- Partial fraction method - Solution of Difference Equations using Z-Transform.

FOR FURTHER READING

Solutions of one dimensional wave equation and heat equations using Laplace transforms method.

Total: 75 Hours

Reference(s)

1. Larry.C.Andrews and Bhimsen.K.Shivamoggi, Integral Transforms for Engineers, First Edition, PHI Learning, New Delhi, 2007
2. Ian.N.Sneddan, The Use of Integral Transforms, Second Edition, McGraw Hill companies, 1972.
3. E. Kreyszig, Advanced Engineering Mathematics, Eighth Edition, John Wiley and Sons, Inc, Singapore, 2008.
4. Peter V. O. Neil,Advanced Engineering Mathematics, Seventh Edition, Cenage Learning India Private Ltd, 2012.
5. B.S. Grewal, Higher Engineering Mathematics, Fortieth Edition, Khanna Publications, New Delhi 2007.
6. C. Ray Wylie and C. Louis Barrett,Advanced Engineering Mathematics, Tata McGraw-Hill Publishing Company Ltd, 2003.

Assessment Pattern

Unit/RBT	Remember				Understand				Apply				Analyse				Evaluate				Create				Total
	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	
1	2					2					6				6				6						22
2	2					6				6					6				6						26
3		2					2				6							6							16
4		2					6				6				6										20
5	2						2			6									6						16
																								Total	100

Remember

1. State the Dirichlet's Conditions. (F)
2. Define even and odd function graphically. (C)
3. List out the complex Fourier transform pair. (F)
4. State convolution theorem in Fourier transforms. (F)
5. Write the condition for the existence of Laplace Transform. (F)
6. Reproduce L (t sin at). (C)
7. State the conditions for classifications of PDE. (F)
8. State the value of a^2 in one dimensional wave equation. (C)
9. Recognize $z\left\{ f(n+1) \right\}$ $in\,terms\,of$ $\overline{f}(z)$.(C)
10. Recall the Z – Transform of $\cos\left(\frac{n\pi}{2}\right)$.(P)

Understand

1. Infer the half-range cosine series for the function $f(x) = x, 0 < x < \pi$.(P)

2. Interpret the Fourier series of period 2 for the function $f(x) = \begin{cases} \pi x & 0 \le x \le 1 \\ \pi(2-x) & 1 \le x \le 2 \end{cases}$. (P)

3. Identify the Fourier transform of $f(x) = \begin{cases} 1-|x| & \text{for } |x| \le 1 \\ 0 & \text{for } |x| > 1 \end{cases}$. Hence evaluate $\int_0^\infty \left(\frac{\sin x}{x}\right)^2 dx$ and $\int_0^\infty \left(\frac{\sin x}{x}\right)^4 dx$. (P)

4. Illustrate the Fourier Sine and Cosine transform of e^{-ax} and evaluate $\int_0^\infty \frac{dx}{(a^2+x^2)}$. (P)

5. Exemplify $\int_0^t \sin u \cos(t-u)\, du$ using Laplace Transform .(P)

6. Indicate the inverse Laplace transform of $\frac{z}{(z-1)(z-2)(z-3)}$ by the method of partial fraction.(P)

7. Interpret the inverse Laplace transform of $\frac{8z^2}{(2z-1)(4z+1)}$. using convolution theorem (P)

8. Classify the possible solutions of one dimensional wave equation.(C)

9. Formulate $z\{nf(t)\} = -z\frac{dF}{dz}(z)$ (P)

10. Summarize Z-transform. (C)

Apply

1. Execute the function $f(x) = |\cos x| \ \ in \ \ (-\pi, \pi)$ to represent as a Fourier series of periodicity 2π. (C)

2. A taut string of length L is fastened at both ends. The midpoint of the string is taken to a height of b and then released from rest in this position. Find the displacement of the string at any time t. (C)

3. Find the Fourier transform of $f(x) = \begin{cases} a-|x| & for \ |x| \le a \\ 0 & for \ |x| > a \end{cases}$. Hence evaluate $\int_0^\infty \left(\frac{\sin x}{x}\right)^2 dx$ and $\int_0^\infty \left(\frac{\sin x}{x}\right)^4 dx$. (P)

4. Find the Fourier transform of $f(x) = \begin{cases} 1, & for \ |x| < a \\ 0, & for \ |x| > a \end{cases}$ hence evaluate $\int_0^\infty \frac{\sin x}{x} dx$ and $\int_0^\infty \left(\frac{\sin^2 x}{x^2}\right) dx$ (P)

5. Assess the initial and final value theorem for the function $1 + e^{-2t}$. (C)

6. Find $L\left(\frac{\cos 2t - \cos 3t}{t}\right)$ (P)

7. Using Convolution theorem find the inverse Laplace transform of $\frac{1}{s^2(s^2+25)}$. (C)

8. Find $L^{-1}\left(\frac{p^2-p+2}{p(p+2)(p-3)}\right)$ using Partial fraction method. (P)

9. Using Convolution theorem evaluate $z^{-1}\left(\frac{z^2}{(z-1)(z-3)}\right)$. (P)

10. Resolve the difference equation $y(n+3)-3y(n+1)+2y(n)=0$ *given that* $y(0)=4,\ y(1)=0$ *and* $y(2)=8$. (C)

Analyze

1. Conclude the sine series for $f(x)=\begin{cases} x \text{ in } 0<x<l/2 \\ l-x \text{ in } l/2<x<l \end{cases}$ in the interval $(0,l)$. (P)
2. A tightly stretched string of length 'λ' fastened at both ends. The mid-point of the string taken to a height 'b' and justify that the displacement at any time 't' is given by
$$y(x,t)=-\frac{8b}{\pi^2}\left[\frac{1}{1^2}\sin\left(\frac{\pi x}{\lambda}\right)\cos\left(\frac{\pi at}{\lambda}\right)-\frac{1}{3^3}\sin\left(\frac{3\pi x}{\lambda}\right)\cos\left(\frac{3\pi at}{\lambda}\right)+........\right].$$ (P)
3. Organize the Fourier transform of f(x) given by $f(x)=\begin{cases} a^2-x^2 & \text{for } |x|\le a \\ 0 & \text{for } |x|\ge a \end{cases}$. Hence evaluate $\int_0^\infty\left[\frac{\sin t-t\cos t}{t^3}\right]dt=\frac{\pi}{4}$. (C)
4. Integrate $\int_0^\infty \frac{dx}{(x^2+a^2)(x^2+b^2)}$ using transform method.(P)

5. Conclude the Fourier sine and cosine transform for $f(x)=\begin{cases} x, & 0<x<1 \\ 2-x, & 1<x<2 \\ 0, & x>2 \end{cases}$.(P)

6. Justify that the Laplace Transform of the triangular wave of period 2π defined by

f (t) = $\begin{cases} t & , 0\le t\le \pi \\ 2\pi-t & , \pi<t<2\pi \end{cases}$ is $\frac{1}{s^2}\tanh\left(\frac{\pi s}{2}\right)$.(C)

7.Resolve the inverse Laplace transform of $\frac{s+2}{s^2-4s+13}$ using partial fraction. (P)

8. Resolve using Laplace Transforms $\frac{d^2y}{dt^2}+4\frac{dy}{dt}+4y=te^{-t}$; $y(0)=0;\ y'(0)=-1$ (P).

9. Conclude $z^{-1}\left(\frac{z^2}{(z+2)(z^2+4)}\right)$ by the method of partial fraction. (P)

10. Resolve the following by using Z – Transform $y(n)+3y(n-1)-4y(n-2)=0,\ n\ge 2$ *given that* $y(0)=3$ *and* $y(1)=-2$.(C)

Evaluate

1. Determine the Fourier series of the function f(x) of Period 2π given by $f(x) = \begin{cases} 1+\frac{2x}{\pi} & in \quad -\pi \le x \le 0 \\ 1-\frac{2x}{\pi} & in \quad 0 \le x \le \pi \end{cases}$ (P)

2. A string is stretched between two fixed points at a distance 2λ apart and the points of the string are given initial velocities 'u' where $u = \begin{cases} \frac{cx}{\lambda}, & in\ 0<x<\lambda \\ \frac{c}{\lambda}(2\lambda - x) & in\ \lambda<x<2\lambda \end{cases}$ x being the distance from one end point. Judge the displacement of the string at any subsequent time.(C)

3. Evaluate $\int_0^\infty \frac{dx}{(x^2+1)(x^2+4)}$ using transforms method . (C)

4.Determine the Fourier cosine transform of $e^{-a^2x^2}$. Hence prove $e^{-\frac{x^2}{2}}$ is a self-reciprocal.(P)

5. Choose the Laplace transform of the function f(t) with period $\frac{2\pi}{\omega}$, where f(t) = $\begin{Bmatrix} \sin\omega t & , for\ 0<t<\pi/\omega \\ 0 & , for\ \pi/\omega < t < 2\pi/\omega \end{Bmatrix}$.(P)

6. Evaluate $\int_0^\infty te^{-3t} \sin 2t\ dt$ by Using Laplace Transform (P)

7. Determine the inverse Laplace transform of $\frac{1}{s^2(s^2+25)}$ by using Convolution theorem. (P)

8.Determine the solution of $\frac{d^2y}{dt^2} + 4\frac{dy}{dt} + 4y = te^{-t}$; $y(0) = 0;\ y'(0) = -1$. using Laplace Transforms. (P)

9. Judge the solution of the equation $y_{n+2} - 7y_{n+1} + 12y_n = 2^n$, *given that* $y_0 = y_1 = 0$. (C)

10. Evaluate inverse Z-transform of $\frac{z}{(z-1)(z-2)(z-3)}$ by the method of partial fraction. (C)

15EE302 DIGITAL LOGIC CIRCUITS **3 0 0 3**

Course Objectives

- To learn concepts of Boolean algebra and number systems.
- To understand and design the Combinational and sequential circuits.
- To implement the Boolean finctions using memory devices.

Programme Outcomes (POs)

a. **Engineering Knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

c. **Design/ Development of Solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for thepublic health and safety, and the cultural, societal, and environmental considerations.cultural, societal, and environmental considerations.

Course Outcomes (COs)

1. Apply Boolean algebra principles and different types of number systems to design the digital circuits.
2. Design and realize the combinational circuits using logic gates.
3. Design and construct synchronous sequential circuits using basic flip flops.
4. Analyze and formulate the asynchronous sequential circuit for the given logic functions.
5. Analyze the various memory devices, Programmable Logic Devices and logic families

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2		3										3	
2	1		3										3	1
3	1		3										3	1
4	1		3										2	1
5	2		2										2	1

UNIT I **10 Hours**

NUMBER SYSTEM AND BOOLEAN ALGEBRA

Review of number system; Types and conversion codes-BCD, Gray code, Excess 3 code, Error detection and correction codes, Parity, Hamming codes, Boolean algebra: De-Morgan's theorem, switching functions and simplification using K-maps- Quine McCluskey method.

UNIT II **9 Hours**

COMBINATIONAL CIRCUITS

Design using logic gates, Design of adders, subtractors, comparators, code converters, encoders, decoders, multiplexers and demultiplexers- Function realization using multiplexers.

UNIT III **9 Hours**

SYNCHRONOUS SEQUENTIAL CIRCUITS

Flip flops - SR, JK - MSJK and D and T, Analysis of synchronous sequential circuits;Design of synchronous sequential circuits-Counters, state diagram; state reduction; state assignment.

UNIT IV **8 Hours**

ASYNCHRONOUS SEQUENTIAL CIRCUITS

Analysis of asynchronous sequential machines, State assignment, Asynchronous design problem.

UNIT V **9 Hours**

MEMORY DEVICES, PROGRAMMABLE LOGIC DEVICES AND LOGIC FAMILIES

Memories: ROM, PROM, EPROM, Programmable Logic Devices: PLA, PAL, PLD, Logic families: TTL, ECL,IIL, CMOS.

FOR FURTHER READING

Johnson counter, Shift registers: shift register operations, SISO, SIPO, PISO and PIPO.

Total: 45 Hours

Reference(s)

1. Malvino and Leach, Digital Principles and Applications, Tata McGraw Hill, New Delhi, 7th edition, 2011.
2. A.Anand kumar, Fundamentals of digital circuits, 3rd Edition, PHI Learning Pvt Ltd, 2014.

3. John M.Yarbrough, Digital Logic, Application & Design, Thomson, 2010.
4. John F.Wakerly, Digital Design Principles and Practice, Pearson Education, 4th edition, 2008.
5. Floyd, Digital Fundamentals, Pearson Education, 10 th edition, 2011.
6. M. Morris Mano, Digital Logic and Computer Design, Prentice Hall of India, 4th edition, 2013.

Assessment Pattern

Unit/RBT	Remember				Understand				Apply				Analyse				Evaluate				Create				Total
	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	
1	2	2			2	2				4			2	2				4							20
2	2	2			2	2				2			4	2					4						20
3		2	2			2	2			4	2			4	2										20
4		2	2			2	2			4	2			4	2										20
5	2	2			2	2			4	4			2	2											20
																								Total	100

Assessment Questions

Remember

1. Define Binary Logic
2. Recognise the terms weighted and non-weighted coding
3. List the different classification of binary codes.
4. Define Logic Gates.
5. Define Duality Property.
6. State Demorgan’s theorem
7. Recall the term don’t care conditions.
8. State the term combinational circuits
9. Give an example of a switching function that contains only cyclic prime implicant.
10. Define mintermsÂ and maxterms
11. List the characteristics of digital logic family
12. Define Half Adder
13. Define Full Adder
14. Define Binary Adder.
15. State the term Overflow.
16. Define Magnitude Comparator.
17. Recognise the term decoder.
18. Recall the term encoder.
19. Define multiplexer.
20. Define priority encoder.
21. What do you meant by comparator?
22. Give the comparison between combinational circuits and sequential circuits.
23. Define sequential circuit.
24. List the types of sequential circuits.
25. Define flip-flop
26. List the various types of flip-flop.
27. State the difference between a latch and a flip-flop.
28. Define the critical rate and non critical rate.
29. What is mean by the term ‘edge triggered’?
30. List any three types of counter.
31. List the two models in synchronous sequential circuits.
32. Define Moore circuit.
33. Define Mealy circuit.
34. What is meant by race condition in digital circuit?
35. Define Asynchronous sequential circuit.

36. Define Successor.
37. Define strongly connected machine.
38. List basic types of programmable logic devices.
39. Reproduce the definition of ROM.
40. Define address and word.
41. List the five types of ROM.
42. What is programmable logic array?

Understand

1. Explain the mod-10 synchronous counter using Jk ff with tabulation.
2. Discuss the importance of NAND and NOR gates.
3. Exemplify the operation of a full adder.
4. Explain the operation of half subtractor with neat sketch and write the truth table.
5. Draw the circuit of half adder.
6. Draw the combinational circuit with 3 inputs and 1 output.
7. Compare decoder and demultiplexer.
8. Draw the logic diagram of 8 to 1 line multiplexer.
9. Exemplify the operation of a T flip flop with excitation table.
10. Formulate the characteristic equation of a SR flip flop.
11. Illustrate the excitation tables of SR, JK, D, andT Flip flops
12. Draw the state diagram of 'T' FF, 'D' FF.
13. Derive the characteristic equation of a JK flip flop.
14. Illustrate the procedure to convert a JK flip flop into a D flip flop
15. Explain the design procedure of asynchronous sequential circuit
16. Explain the design procedure of asynchronous sequential circuit
17. Explain the operation of TTL logic with neat sketch.
18. Draw the wave forms showing static 1 hazard.
19. Compare factory and field programmable logic device.
20. Draw PAL Structure.
21. Explain the terms ROM, PROM and EEPROM.

Apply

1. Simplify the following Boolean functions by using K'Map in SOP & POS.
   F (w, x, y, z) = _m (1, 3, 4, 6, 9, 11, 12, 14).
2. Realize D and T flip flops using Jk flip flops.
3. Implement a counter with the following repeated binary sequence:0, 1, 2, 3, 4, 5, 6 using JK Flip-flop.
4. Implement the following function using PLA.
   A (x, y, z) = _m (1, 2, 4, 6)
   B (x, y, z) = _m (0, 1, 6, 7)
   C (x, y, z) = _m (2, 6) Â
5. Implement the following function using PAL.
   W (A, B, C, D) = _m (2, 12, 13)
   X (A, B, C, D) = _m (7, 8, 9, 10, 11, 12, 13, 14, 15)
   Y (A, B, C, D) = _m (0, 2, 3, 4, 5, 6, 7, 8, 10, 11, 15)
   Z (A, B, C, D) = _m (1, 2, 8, 12, 13)Â
6. Execute the Boolean function using 8:1 mux
   F (A, B, C, D) =A'BD'+ACD+B'CD+A'C'D.

Analyse

1. Interpret hexadecimal equivalent of the decimal number 256.
2. Express x+yz as the sum of minterms.
3. Find the complement of x+yz.
4. How will you use a 4 input NAND gate as a 2 input NAND gate?
5. Implement AND gate and OR gate using NAND gate.
6. Differentiate ROM and RAM.
7. Differentiate PAL and PLA.

Evaluate

1. Construct the state diagram and primitive flow table for an asynchronous network that has two inputs and one output. The input sequence X1X2 Â = 00, 01, 11 causes the output to become 1.The next input change then causes the output to return to 0.No other inputs will produce a 1 output.
2. Find the octal equivalent of the decimal number 64.
3. Find the value of X = A B C (A+D) if A=0; B=1; C=1 and D=1.

Create

1. Develop the state diagram and primitive flow table for a logic system that has 2 inputs x and y and an output z and reduce primitive flow table. The behavior of the circuit is stated as follows. Initially x=y=0 whenever x=1 and y = 0 then z=1, whenever x = 0 and y = 1 then z = 0.When x = y = 0 or x = y = 1 no change in z it remains in the previous state. The logic system has edge triggered inputs with out having a clock 1. The logic system changes state on the rising edges of the 2 inputs. Static input values are not to haveÂ any effect in changing the Z output.
2. Derive logic gates based circuits for traffic signal control requirements.

15EE303 ELECTRON DEVICES AND CIRCUITS 3 0 0 3

Course Objectives

- To understand the characteristics, operations, and application of solid state devices like diode, BJT, FET, MOSFET and various optoelectronic devices.
- To analyze the different types of amplifier, oscillator and multivibrator Circuits.
- To design power supply circuits using electronic devices.

Programme Outcomes (POs)

a. **Engineering Knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

b. **Problem Analysis**: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

c. **Design/ Development of Solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for thepublic health and safety, and the cultural, societal, and environmental considerations.

Course Outcomes (COs)

1. Assess the characteristics of different types of electronic devices and analyze the small signal model of BJT & FET.
2. Design voltage amplifiers and analyze its performance for low, medium and high frequency applications.
3. Apply amplifiers for tuning, feedback and multistage applications and analyze its gain, stability and efficiency.
4. Analyze the Oscillator and Multivibrator circuits for sine and square wave generation.
5. Design and analyze rectifier circuits with filters and voltage regulators for power supply applications and explain the principle of operation of various optoelectronic devices.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3	2											3	
2	1	3											3	2
3	2	3											3	2
4	2	3	1										3	2
5	1		3										3	3

UNIT I **8 Hours**

SEMICONDUCTOR DEVICES

Construction, Operation and characteristics of Diode, Zener diode, BJT, FET, MOSFET and UJT-Small signal model analysis of BJT and FET.

UNIT II **8 Hours**

VOLTAGE AMPLIFIERS

RC-coupled amplifiers - Analysis at low, medium and high frequencies- DC amplifiers-problems in DC amplifiers, BJT Differential amplifier - Differential and Common mode gain, CMRR, MOS Differential amplifier- Cascade and Darlington Amplifiers.

UNIT III **11 Hours**

POWER AND FEED BACK AMPLIFIERS

Amplifiers-Classification, Class A/B/C, Single ended and Push-pull Configuration, Power dissipation, output power and Conversion efficiency, Class AB operation-Tuned amplifiers- Basic concepts of feedback amplifiers-Effect of negative feedback on input and output resistances, gain, gain stability, distortion and bandwidth -Voltage and current feedback circuits.

UNIT IV **9 Hours**

OSCILLATOR AND MULTIVIBRATOR

Oscillators-condition of oscillations, RC-phase shift oscillators, Wien bridge & Hartley oscillators, Colpitt's oscillators and UJT based saw tooth oscillator-Multivibrators-Bistable, Monostable & Astable multivibrators.

UNIT V **9 Hours**

POWER SUPPLY CIRCUITS AND OPTOELECTRONIC DEVICES

Half wave and full wave rectifier analysis-Design and Analysis of filter circuits - Voltage regulator using zener diode and transistor-Optoelectronic devices principle and working - photo diode, photo transistor, solar cell, opto couplers & LCD.

FOR FURTHER READING

Biasing of transistor-BJT AC analysis-biasing of FET.

Total: 45 Hours

Reference(s)

1. Jacob. Millman, Christos C.Halkias, Electronic Devices and Circuits, 3rd Edition ,Tata McGraw Hill Publishing Limited, New Delhi, 2010.
2. David A. Bell, Electronic Devices and Circuits,5th Edition,Oxford University Press,2009.
3. Allen Mottershead, Electronic Devices and Circuits-An Introduction, Prentice Hall of India Private Limited, New Delhi, 2003.

4. N.P.Deshpande, Electronic Devices and Circuits,1st Edition,Tata McGraw Hill Publishing Limited, New Delhi,2013.
5. R.L.Boylestad and Louis Nashelsky,Electronic Devices and Circuits , 9th Edition, Pearson/Prentice Hall,,2013.
6. Thomas L Floyd, Electronic Devices, Prentice Hall of India, New Delhi, 2011.

Assessment Pattern

Unit/RBT	Remember				Understand				Apply				Analyse				Evaluate				Create				Total
	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	
1	2										6				6				4						18
2		2					2								6								8		18
3		2					4			6									12						24
4	2						12			6															20
5	4									8					8										20
																								Total	100

Assessment Questions
Remember

1. Define ripple factor.
2. List out the advantages of transistor over vacuum tubes.
3. Recall why collector region is greater than emitter region?
4. List the applications of Photo diode.
5. Recall the function of solar cell.
6. Define feed back amplifier.
7. Recall positive and negative feedback.
8. List out the parameters used in Transistor ratings.
9. Reproduce any four applications of BJT.
10. Draw the output characteristics of BJT.
11. Draw the symbol of JFET and MOSFET.

Understand

1. Explain the operation of switched mode power supply with the suitable block diagram.
2. With the volt-ampere characteristics, explain the theory of PN junction and working principle of the diode.
3. Illustrate the input and output characteristics of CE configuration.
4. Illustrate different types of feedback topologies.
5. Explain the transistor hybrid model for CE configuration
6. Illustrate the operation and characteristics of depletion MOSFET
7. Compare BJT and FET.
8. Illustrate in detail about Light emitting diodes and Photo conductivity cell.
9. Explain any four methods of transistor construction.
10. Intrepret the working principle of NPN transistor.
11. Explain the classification of power amplifiers according to operational modes
12. Exemplify the input and output characteristics of CE and CB configuration.
13. With suitable equivalent circuit, explain transistor hybrid model for CE configuration.
14. Explain RC phase shift oscillator.
15. Differentiate voltage amplifier and power amplifier
16. Differentiate half wave and full wave rectifier.
17. Classify the PN diode and BJT.
18. Explain Colpitt’s oscillator and derive the expression for frequency of oscillation.
19. With neat diagram explain emitter coupled astable Multivibrator

Apply

1. Construct Hartly oscillator and derive the equation for oscillation.
2. Show how frequency stability can be improved Colpitt's oscillator?
3. Construct the V- I characteristics of PN junction diode.
4. Explain about speedup capacitors or commutating capacitors.
5. Demonstrate the working of collector coupled astable Multivibrator.
6. Construct a RC-coupled amplifier. Explain its behaviour at low, mid and high frequencies by drawing separate equivalent circuit for each requency region.
7. Construct the FET small signal model.
8. Compute the value of collector current for transistor α=0.98 and Icbo = 5µA. the base current is 100 µA.
9. Construct a Hartley oscillator for a frequency of 10KHz. Indicate the necessary conditions and assumptions made.

Analyse

1. Contrast the concept of UJT oscillator
2. Compare the characteristic of all negative feed back amplifiers
3. Justify that Transition capacitance, CT=ε A/W of a diode.
4. Differentiate single tuned and double tuned amplifier.
5. Contrast the working of UJT based sawtooth oscillator.
6. Differentiate the amplifiers based on frequency response
7. Differentiate the Photo emissivity and photo electric theory.
8. What is power amplifier? Give the classification of power amplifier. Compare directly coupled class A and transformer coupled class A amplifier.
9. Contrast the fundamental difference between audio amplifiers and tuned amplifiers? How is bandwidth related to resonant frequency (fr) and the quality factor (Q).
10. Calculate the maximum operating frequency of a diode whose reverse recovery time is 9ns.

Evaluate

1. Derive the transistor current equation.
2. A 230 Volts, 50HZ Voltage is applied to the primary of 8:1 step-down transformer used in a full wave rectifier having a load of 750 Ohms. If the diode resistance is of 50 Ohms determine a) DC voltage across the load d) PIV across each diode e) ripple voltage and its frequency b) DC current flowing through the load c) DC power delivered to the load.
3. A common base transistor amplifier is driven by a voltage source Vs and internal resistance Rs = 1200?. The load impedance is a resistor RL of 1000 ?. The 'h' parameters are given below hib = 220, hrb = 3 x 104 , hfb = -0.98, hob = 0.5 µA/ V. Compute current gain (Ai) , Input impedance (Ri), Voltage gain Av input impedance (R0) and power gain Ap.
4. Derive the expressin for current gain, voltage gain, input and output resistance of a transistor amplifier operating in the common emitter mode.
5. Derive the expression for the frequency of oscillation and the minimum gain required for sustained oscillations of the RC phase shift oscillation.
6. An amplifier has a midband gain Avmidof 1000 with fL=50Hz and fH= 50 Khz. If 5% feedback is applied then calculate
   (a) Gain with feedback
   (b) fL with feedback
   (c) fH with feedback
7. Derive the expression for maximum efficiency transformer couple class A amplifier.
8. For a transistor colpitt oscillator, L3=100µH, C1=0.005µF andÂ C2=0.01µF.Calculate the frequency of oscillation generated.
9. In Hartley oscillator calculate L2 if L1=15mH, C=50pF, mutual inductance of coil is 5µH and frequency of oscillation is 168Hz.
10. Derive the expression for frequency of oscillation. A wein bridge oscillator has a frequency of 500 kHz, if the value of C is 100pf, determine the value of R.
11. Derive the expresion for the maximum efficiency of Class-B transformer coupled push pull amplifier.

12. Derive mathematical expressions to illustrate the effects of negative feedback (i) to improve gain stabilization (ii) to reduce distortion (iii) to modify input and output impedance.
13. Derive the expression for the voltage gain at the tuned frequency and draw the circuit diagram of a collector tuned amplifier.

Create

1. Design the 12v voltage regulator circuit for IC uA 741.
2. Design and Construct full wave rectifier circuit which drives 8V voltage regulator.
3. Design a series voltage regulator and find its load and line regulation.
4. Design audio amplifier using any type of power amplifier
5. Design the light dimming circuit using SCR, DIAC and TRIAC.

15EE304 FIELD THEORY

3 2 0 4

Course Objectives

- To develop a skill set in analyzing and solving problems of static electric field and magnetic field using vector calculus.
- To manipulate Maxwell's equations using vector calculus for the purpose of investigating static, time varying electric and magnetic fields.
- To examine Electromagnetic wave propagation in different media.

Programme Outcomes (POs)

a. **Engineering Knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

b. **Problem Analysis:** Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

Course Outcomes (COs)

1. Compute differential length, area and volume for different coordinate systems.
2. Apply Coulomb's Law to compute Electric field intensity
3. Apply Biot-savart Law and Ampere's Law to find Magnetic field intensity
4. Analyze Static and dynamic Electromagnetic fields.
5. Analyze Electromagnetic wave propagation in different media

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2	3											2	
2	3	2											2	
3	3	2											2	
4	2	3											3	1
5	3	2											3	1

UNIT I **10 Hours**

INTRODUCTION

Different co-ordinate systems: Cartesian coordinates, cylindrical coordinates, spherical coordinates - Vector calculus: Differential length, area and volume, line surface and volume integrals - gradient of a scalar, divergence of a vector and divergence theorem - curl of a vector and Stoke's theorem - Laplacian of a scalar.

UNIT II **10 Hours**

ELECTROSTATICS

Coulomb's Law - Electric field intensity - Field due to point and continuous charges - Gauss's law and it's applications to calculate electric field - Electric scalar potential - Polarization-Boundary conditions-Poisson's and Laplace's equations - Capacitance-energy density.

UNIT III **9 Hours**

MAGNETOSTATICS

Magnetic field intensity - Biot-savart Law - Ampere's Law - Magnetic field due to straight conductors, circular loop, infinite sheet carrying current - Magnetic flux density in free space, conductor, magnetic materials - Magnetization-Boundary conditions-Magnetic vector potential-Magnetic force-Torque -Inductance-Energy density.

UNIT IV **8 Hours**

ELECTRODYNAMIC FIELDS

Faraday's laws, induced EMF - Static and dynamic EMF, Maxwell's equations (differential and integral forms) - Displacement current - Poynting theorem.

UNIT V **8 Hours**

ELECTROMAGNETIC WAVES

Electro Magnetic Wave equations - Wave parameters: velocity, intrinsic impedance, propagation constant - Waves in free space, lossy and lossless dielectrics, conductors - skin depth - Poynting vector.

FOR FURTHER READING

Transformation of coordinates, Electric field intensity due to co-axial cylinder, Scalar magnetic potential, Maxwell's equation for sinusoidal time varying quantity, Skin effect, Transmission line parameters,Transmission line equations, input impedance.

Total: 75 Hours

Reference(s)

1. William H. Hayt, Jr. John A. Buck, Engineering Electromagnetics, McGraw Hill Higher Education, 8th revised Edition, 2011.
2. K. A. Gangadhar, P.M. Ramanathan, Electromagnetic Field Theory, Khanna Publishers, Sixteenth Edition, 2011.
3. Bhag Sing Guru and Huseyin R. Hiziroglu, Electromagnetic Field Theory Fundamentals, Cambridge University Press, fourth Edition, 2010.
4. A.Joseph. Edminister and Vishnu Priye, Electromagnetics, Special Indian edition, Schaum's Outlines, Tata McGraw Hill, 2009.
5. Sadiku, Elements of Electromagnetics, Third Edition, Oxford University Press, 2010.
6. Kraus and Fleish, Electromagnetics with Applications, McGraw Hill International Editions, Fifth Edition, 2008.

Assessment Pattern

Unit/RBT	Remember				Understand				Apply				Analyse				Evaluate				Create				Total
	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	
1	2										6								12						20
2		2				4								6					8						20
3		2								6									12						20
4	2						12			6															20
5	4									8					8										20
Total																									100

Assessment Questions
Remember

1. State divergence theorem.
2. Reproduce vectors in Cartesian coordinate, cylindrical and spherical coordinate systems
3. State Coulomb's Law.
4. List the Boundary condition of electrostatics.
5. List the wave parameters for uniform plane waves.
6. Define skin depth.
7. Define Poynting vector.
8. List the various magnetic material used in practices.
9. State Faraday's law
10. State Lorentz Law of force.

Understand

1. Identify the relation between Cartesian and cylindrical coordinate systems.
2. Compare circuit theory and field theory.
3. Illustrate the boundary condition for dielectric to dielectric.
4. Illustrate the magnetic field due to straight conductor.
5. Identify the Maxwell's equation for time varying harmonic field
6. Exemplify the inductance of two conductors carrying current in same and opposite directions.
7. Interpret the magnetic force on two current carrying conductors.Â
8. Explain the Poisson and Laplace equations
9. Explain the relation between cylindrical and spherical coordinate systems.
10. Illustrate the torque equation for rectangular loop.

Apply

1. A vector field D=[5*r*r/4]Ir is given in spherical co-ordinates. Find both sides of divergence theorem for the volume enclosed between r=1&r=2.
2. Find the electric field intensity at the point (0, 0, 5) m due to Q1 =0.35 μC at (0,4,0) m and Q2 =-0.55 μC at (3,0,0) m.
3. Construct the expression for the electric field due to a straight and infinite uniformly charged wire of length 'L' meters and with a charge density of +λ c/m at a point P which lies along the perpendicular bisector of wire.
4. Compute an expression for field intensity at any point 'p' with distance h meter due to a straight, uniformly charged wire at a linear density of +1, coulombs per meter length. Also, find E , if the point 'p' is along the perpendicular bisector of wire and if the conductor is infinitely long.
5. Execute the boundary conditions of the normal and tangential components of electric field at the inter face of two media with different dielectrics.
6. A circular disc of 10 cm radius is charged uniformly with a total charge 10-10c.Find the electric field at a point 30 cm away from the disc along the axis.
7. An iron ring with a cross sectional area of 3cm square and mean circumference of 15 cm is wound with 250 turns wire carrying a current of 0.3A.The relative permeability of ring is 1500. Compute the flux established in the ring.
8. A uniform plane wave of 200 MHz, traveling in free space impinges normally on a large block of material having εr =4, μr =9 and σ =0. Find transmission and reflection co efficient of interface.
9. In a material for which σ=5 s/m and εr=1 and E=250sin10wt (V/m). Find the conduction and displacement current densities.
10. A circular disc of radius 'a' m is charged uniformly with a charge density of σ c/ square metre.Find the electric field at a point 'h' m from the disc along its axis.

Analyse

1. Conclude the relation between three variables E, V and D in electrostatic field.
2. Differentiate electric and magnetic circuits.
3. Conclude the potential at the centre of square, each side of square having charge density of λ c/m

Evaluate

1. Assume that E and H waves, traveling in free space, are normally incident on the interface with a perfect dielectric with εr=3. Determine the magnitudes of incident, reflected and transmitted E and H waves at the interface.
2. Determine the total current in a circular conductor of radius 4mm if the current density varies according to J=104/R A/square meter.
3. A solenoid 25cm long, 1cm mean diameter of the coil turns a uniformly distributed windings of 2000turns. The solenoid is placed in uniform field of 2 tesla flux density a current of 5A is passed through the winding. Determine the maximum torque on the solenoid, Maximum force on the solenoid and the magnetic moment on the solenoid.
4. Determine the attenuation constant and phase constant for theÂ uniform plane wave with the frequency of 10GHz in a medium for which μ=μ0, εr=2.3 and σ=2.54x10-4Ω/m
5. The capacitance of the conductor formed by the two parallel metal sheets, each 100 square cm,in area separated by a dielectric 2 mm thick is ,2x10-10 micro farad . A potential of 20kv is applied to it. Determine (i) Electric flux (ii) Potential gradient in kV/m (iii) The relative permittivity of materials (iv) Electric flux density.
6. The magnetic field intensity in free space is given as H=H0sinθ at t A/m. where θ=ωt-βz and β is a constant quantity. Determine the displacement current density.
7. A uniform plane wave of 200 MHz, traveling in free space impinges normally on a large block of material having εr =4, μr =9 and σ =0. Find transmission and reflection co efficient of interface.

Create

1. Create a parallel plate electrolytic capacitor having 2mm thick and 3 mm width εr= 1.2, d=2 m and calculate stress per m^2 .
2. Generate a solenoid used in process control system.

15EE305 DC MACHINES AND TRANSFORMERS

3 2 0 4

Course Objectives

- To understand the concepts of field energy, co energy, mechanical force and production of torque and EMF
- To explain the construction,operation and characteristics of various types of DC machines
- To understand different types of transformers and apply the testing methods on Transformers

Programme Outcomes (POs)

a. **Engineering Knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

b. **Problem Analysis:** Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

d. **Conduct Investigations of Complex Problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

e. **Modern Tool Usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

f. **The Engineer and Society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

Course Outcomes (COs)

1. Apply the electro mechanical energy conversion process in rotating electrical machines
2. Analyze various types and characteristics of DC generator
3. Examine the various types, characteristics and starters of DC motor
4. Compute the equivalent and analyze the performance of the different types of transformers
5. Apply the different types of testing methods for transformers

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3	2											3	
2	2	2											2	
3	2	2												3
4	1	2				1							3	
5	1			2	2								3	

UNIT I **9 Hours**

BASIC CONCEPTS IN ROTATING MACHINES

Energy in Magnetic systems-Field Energy and Co Energy-Determination of Mechanical Force- Singly and multiply excited systems -Laws of Electromagnetic induction - Torque and EMF production in rotating machines.

UNIT II **10 Hours**

DC GENERATOR

Construction - Principle of operation - EMF equation - Types - Characteristics - Armature reaction and commutation - Applications.

UNIT III **8 Hours**

DC MOTOR

Principle of operation - Back EMF and torque equations- Types - Characteristics - Necessity of starters - Losses and efficiency- Swinburne's test - Hopkinson's Test - Braking methods.

UNIT IV **10 Hours**

TRANSFORMERS

Construction - Principle of operation- EMF equation - Equivalent circuit - Voltage regulation- Losses- All day efficiency-Auto transformer - Saving of copper.

UNIT V **8 Hours**

TRANSFORMER TESTING AND POWER TRANSFORMERS

Testing of transformers - Polarity, open circuit, short circuit and Sumpner's test - Three phase transformers connections- Parallel operation-concept of tap changing, on-load and off-load tap changing.

FOR FURTHER READING

Speed control of DC motor-Conservator and breather-Instrument transformers-Cooling methods for transformer

Total: 75 Hours

Reference(s)

1. D. P. Kothari and I. J. Nagrath, Electric Machines, Tata McGraw Hill Publishing Company Ltd, 2010.

2. R.K. Rajput, Electrical Machines, Laxmi Publications (P) Ltd, New Delhi, 2011.
3. P. S. Bimbhra, Electrical Machinery, Khanna Publishers, Delhi, 2007.
4. E. Fitzgerald, Charles Kingsley, Stephen.D.Umans, Electric Machinery, Tata McGraw Hill publishing Company Ltd, New Delhi ,2003.
5. B. L. Theraja, A. K. Theraja, A Text Book of Electrical Technology, Volume II, S.Chand & Company Ltd, New Delhi, 2007.
6. Stephen J.Chapman, Electric Machinery Fundamentals, Tata McGraw Hill, New Delhi, 2010.

Assessment Pattern

Unit/RBT	Remember				Understand				Apply				Analyse				Evaluate				Create				Total
	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	
1	4					12							4												20
2		4				8				4				6											22
3		4				6				2									6						18
4	2					8					8			4											22
5		4				6													8						18
																								Total	100

Assessment Questions

Remember

1. State the function of carbon brush used in DC generator.
2. Reproduce the number of parallel paths in a lap and wave connected windings
3. Define back EMF in DC motors.
4. List any five applications of DC motor.
5. State the condition for maximum efficiency of DC motor.
6. List any four applications of a transformer.
7. Define voltage regulation of a transformer.
8. Define critical resistance of a DC shunt generator.
9. Recall the principle of operation of a transformer.
10. State the conditions to be fulfilled for a shunt generator to build up voltage?

Understand

1. With neat diagrams, explain the different types of DC generators.
2. Formulate the equation for torque developed in DC motor.
3. Illustrate the working principle of three point starter for DC shunt motor.
4. Indicate the main parts of a transformer.
5. Represent the two types of constructions used in transformer.
6. Identify the various losses that occur in DC machines.
7. Exemplify the construction and operation of DC generator.
8. Compare three point starter and four point starter.
9. Classify DC generators based on the connection of field winding.
10. Summarize the characteristics of DC motors.

Apply

1. A DC series motor having a resistance of 1 ohm drives a fan for which the torque varies as the square of the speed. At 220 V the set runs at 350 rpm and takes 25 A. The speed is to be raised to rpm by increasing the voltage. Find the necessary voltage and the corresponding current assuming the field to be unsaturated.
2. Two series motors run at the speed of 500 rpm and 550 rpm respectively when taking 50 A at 500 V. The terminal resistance of each motor is 0.5 ohm. Compute the speed of the combination when connected in series and coupled mechanically. The combination is taking 50A on 500V supply.
3. A 4 pole 240 V, wave connected shunt motor given 1119 kW when running at 1000 rpm and drawing armature and field current of 50 A and 0.1 AÂ respectively. It has 540 conductors. Its resistance is 0.1 ohm. Assuming a drop of 1 volt/brush, compute

(a) Total torque.
(b) Useful Torque.
(c) Useful flux/pole.
(d) Rotational Losses.
(e) Efficiency

4. Show the mechanical characteristics of DC shunt, series, compound motors.
5. Construct the equivalent circuit of single phase transformer.
6. A 15 kVA, 2000/200 V transformer has an iron loss of 250 W and full-load copper loss 350 W. During the day it is loaded as follows:

No of hours	Load	Power Factor
9	¼ load	0.6
7	Full load	0.8
6	¾ load	1
2	No load	-

   Find the all-day efficiency.
7. Show that for the same capacity and voltage ratio, an auto-transformer requires less copper than ordinary transformer.
8. A single phase transformer is connected to a 230 V, 50Hz supply. The net cross sectional area of the core is 60 cm2. The number of turns in the primary is 500 and in the secondary 100. Compute the transformation ratio, emf induced in the secondary winding, Maximum value of flux density in the core, Voltage/turn and Secondary current when it supplies a load of 200 kW at 0.8 power factor lagging.
9. A 1500 kW, 550 V, 16 pole generator run at 1500 rpm. What must be the useful flux per pole if there are 2500 conductor in the armature of the winding is lap connected and full load armature copper loss in 25 kW? Calculate the area of the pole shoe if the gap flex density has a uniform value of 0.9Wb/m2, Also find the no load terminal voltage. Neglect change in speed.
10. Demonstrate the Hopkinson's test on two identical DC machines to find their efficiency.

Analyse

1. Differentiate lap winding and wave winding used in dc machine.
2. The rating of a transformer is given in kVA. Justify
3. Conclude the relation between losses and efficiency of DC machines.
4. Differentiate long shunt compound generator and short shunt compound generator.
5. DC series motor should never be started without load. Justify
6. Efficiency of transformer is higher than that of other electrical machines. Justify.

Evaluate

1. A 1500 kW, 550 V,16 pole generator run at 1500 rpm.What must be the useful flux per pole if there are 2500 conductor in the armature of the winding is lap connected and full load armature copper loss in 25 kW? Determine the area of the pole shoe if the gap flex density has a uniform value of 0.9Wb/m2, Neglect change in speed.
2. A 6-pole lap wound DC generator has 600 conductors on it’s armature. The flux per pole is 0.02 Wb. Determine the speed at which the generator must be run to generate 300 V.
3. A 500 V shunt motor runs at it’s normal speed of 250 r.p.m. when the armature current is 200 A. The resistance of the armature is 0.12 ohms. Determine the speed when a resistance is inserted in the field reducing the shunt field to 80% of normal value and armature current is 100 A.
4. In a 50 kVA transformer, the iron loss is 500 W and full-load copper loss is 800 W. Determine the efficiency at full-load and half full-load at 0.8 power factor lagging.

Create

1. Create a model for simple DC motor.
2. Generate winding for single phase transformer.

15EE306 DATA STRUCTURES

2 0 2 3

Course Objectives

- To understand the basics of abstract data types.
- To learn the principles of linear and non linear data structures.
- To implement an application using sorting and searching.

Programme Outcomes (POs)

d. **Conduct Investigations of Complex Problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
f. **The Engineer and Society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
l. **Life-long Learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Course Outcomes (COs)

1. Analyze the algorithm with basics of data structures
2. Demonstrate the concept of linear data structures.
3. Design of algorithms for various searching and sorting techniques.
4. Demonstrate the concept of tree data structures.
5. Express the concept of graph data structures.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1				3									1	
2				3									2	
3						2							3	
4						2							3	
5												1	3	

UNIT I **5 Hours**

INTRODUCTION

Pseudo code -Abstract data types - ADT Implementations -Algorithm efficiency - Designing recursive algorithms - Recursive examples.

UNIT II **7 Hours**

STACKS, QUEUES AND LISTS

Arrays - Basic stack operation- Stack ADT - Applications of stack - Queues operations- Queue ADT - Queue applications -List ADT - Circular - Doubly linked list.

UNIT III **6 Hours**

SORTING AND SEARCHING TECHNIQUES

Sorting: Insertion Sort- Selection Sort - Bubble Sort - Merge sort - Quick sort -Heap sort-shell sort - External Sorts.Searching: Sequential search- Binary Search.

UNIT IV **6 Hours**

TREES.

Basic Tree concepts -Binary Trees -Tree Traversals -Expression tree -Binary Search Trees - AVL Search Trees - Heap concepts - Implementation - Heap ADT.

UNIT V **6 Hours**

GRAPHS

Definitions -Shortest Path Algorithms: Unweighted Shortest Paths - Dijkstra's Algorithm. Minimum Spanning Tree: Prim's Algorithm- Kruskal's Algorithm.

FOR FURTHER READING

Applications of list - Radix sort - B-Trees - Red-Black trees - Splay trees- Bucket hashing - Heap Applications: Priority Queue - Binomial Heaps - Topological sort - Introduction to NP Completeness

1 **4 Hours**

EXPERIMENT 1

Program to Solve Tower-of-Hanoi Problem using Recursion.

2 **4 Hours**

EXPERIMENT 2

Array Implementation of stack and queue.

3 **2 Hours**

EXPERIMENT 3

Linked List Implementation of stack and queue.

4 **4 Hours**

EXPERIMENT 4

Program to perform various operations such as creation, insertion, deletion, search of node and display on singly linked list.

5 **4 Hours**

EXPERIMENT 5

Program to perform various operations such as creation, insertion, deletion, search of node and display on doubly linked list.

6 **4 Hours**

EXPERIMENT 6

Program to sort the elements in ascending order using selection sort and bubble sort.

7 **2 Hours**

EXPERIMENT 7

Implementation of quick sort.

8 **2 Hours**

EXPERIMENT 8

Develop a program to perform linear and binary search.

9 **2 Hours**

EXPERIMENT 9

Program to construct an expression tree for a given expression and perform various tree traversal methods.

10 **2 Hours**

EXPERIMENT 10

Implement Prims algorithm for graph in minimum spanning tree.

Total: 60 Hours

Reference(s)

1. Richard F. Gilberg, and Behrouz A. Forouzan, Data Structures -A Pseudocode Approach with C, Thomson 2011.
2. M.A.Weiss, Data Structures and Algorithm Analysis in C, Pearson Education Asia, 2013.
3. Y.Langsam, M.J.Augenstein and A.M.Tenenbaum, Data Structures using C, PHI, 2007.
4. Aho, J.E.Hopcroft and J.D.Ullman, Data Structures and Algorithms, Pearson education, Asia, 2010.
5. Ellis Horowitz, Sartaj Sahni and Susan Anderson-Freed, Fundamentals of Data Structures in C, Silicon Press, 2009.

Assessment Pattern

Unit/RBT	Remember				Understand				Apply				Analyse				Evaluate				Create				Total
	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	
1	4	4			4	4																			16
2	2				2	4				6					2			2							18
3	2				2					6				2	3							6			21
4		2			2					6				2	3			2				6			23
5		2				2				6				6								6			22
																								Total	100

15EE307 DC MACHINES AND TRANSFORMERS LABORATORY **0 0 2 1**

Course Objectives

- To make the students understand the behavior of DC motor and generator under various loading conditions.
- To perform the tests required to know the performance and characteristics of the machines.

Programme Outcomes (POs)

c. **Design/ Development of Solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for thepublic health and safety, and the cultural, societal, and environmental considerations.

d. **Conduct Investigations of Complex Problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

Course Outcomes (COs)

1. Analyze the performance characteristics of different types of DC machines.
2. Compute the efficiency and regulation of a single phase transformer.
3. Assemble, test a single phase transformer.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1			2										2	
2			3										3	2
3				1									1	3

1 **4 Hours**

EXPERIMENT 1

Open Circuit and load characteristics of separately excited DC generator.

2 **2 Hours**

EXPERIMENT 2

Load characteristics of DC series motor.

3 **2 Hours**

EXPERIMENT 3

Speed control of DC shunt and DC Series motor.

4 **4 Hours**

EXPERIMENT 4

Predetermination of Efficiency of DC machine using Swinburnes Test.

5 **4 Hours**

EXPERIMENT 5

Estimation of efficiency of DC machine using Hopkinsons Test.

6 **4 Hours**

EXPERIMENT 6

Determination of performance parameters of transformer using Sumpners test.

7 **2 Hours**

EXPERIMENT 7

Demonstrate the different types of three phase transformer connections

2 Hours

8

EXPERIMENT 8

Study of various accessories of 3 phase power transformer.

9 **2 Hours**

EXPERIMENT 9

Phase relation and polarity test of a transformer.

10 **4 Hours**

EXPERIMENT 10

Assembling of Shell and Core type transformers.

Total: 30 Hours

15EE308 ELECTRON DEVICES AND CIRCUITS LABORATORY **0 0 2 1**

Course Objectives

- To obtain the VI characteristics of Diode, Zener diode and transistor.
- To construct an unregulated power supply using a transformer, a rectifier circuit and a capacitor filter. Study the load regulation of the power supply.
- To obtain the frequency response of amplifiers and oscillator circuits.

Programme Outcomes (POs)

a. **Engineering Knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

b. **Problem Analysis:** Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

c. **Design/ Development of Solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for thepublic health and safety, and the cultural, societal, and environmental considerations.

Course Outcomes (COs)

1. Analyze the Volt-Ampere characteristics of different types of electronic devices and compute its parameters.
2. Synthesize and evaluate the performance of Power supply circuits using rectifiers, filters and series voltage regulators.
3. Construct the CE amplifier and Class B Push Pull Amplifier and determine its gain.
4. Design and test Oscillator and Multivibrator circuits using BJT and FET to generate sine and square waveform.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	1	3											3	
2	1		3										3	2
3	2	3											3	3
4	1	2	3										3	3

4 Hours

1

EXPERIMENT 1

Volt-Ampere characteristics of diode and zener diode.

2 **4 Hours**

EXPERIMENT 2

Volt-Ampere characteristics of Transistor and MOSFET.

3 **2 Hours**

EXPERIMENT 3

Volt-Ampere characteristics of SCR.

4 **4 Hours**

EXPERIMENT 4

Experimental verification of half and full wave rectifiers with and without filters.

5 **2 Hours**

EXPERIMENT 5

Design and verification of series voltage regulator.

6 **2 Hours**

EXPERIMENT 6

Design and implementation of CE amplifier.

7 **2 Hours**

EXPERIMENT 7

Design and implementation of class B push pull amplifier.

8 **4 Hours**

EXPERIMENT 8

Design and implementation of RC Phase shift and wein bridge oscillator.

9 **4 Hours**

EXPERIMENT 9

Design and implementation of multivibrator circuits using transistor.

10 **2 Hours**

EXPERIMENT 10

Design of audio amplifier using any one type of power amplifier.

Total: 30 Hours

15EE309 MINI PROJECT I 0 0 2 1

Programme Outcomes (POs)

a**. Engineering Knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

b. **Problem Analysis**: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

c**. Design/ Development of Solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

d. **Conduct Investigations of Complex Problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

e. **Modern Tool Usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

f. **The Engineer and Society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

g**. Environment and Sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

h. **Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

i. **Individual and Team Work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

j. Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
k. **Project Management and Finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to oneÃ¢??s own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
l. **Life-long Learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.
m. **PSO1:** Modeling , design and Analysis of Electrical and Electronic Systems using design principles and software tools
n. **PSO2**: Develop electrical machineries/Appliances for various Domestic and industrial needs

Course Outcomes (COs)

1. Formulate a real world problem, identify the requirement and develop the design solutions.
2. Identify technical ideas, strategies and methodologies.
3. Utilize the new tools, algorithms, techniques that contribute to obtain the solution of the project.
4. Test and validate through conformance of the developed prototype and analysis the cost effectiveness
5. Prepare report and present oral demonstrations

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1		3	2			2	1						3	1
2	2	2	1	3		2					2	2	2	
3			3	2	2			2			2	2	3	
4		1		2	3	1	2	2					1	3
5									3	3		2		3

Total:15 Hours

15GE310 LIFE SKILLS: BUSINESS ENGLISH 0 0 2 0

Course Objectives

- To acquire command in both the receptive skills (Listening and Reading)and the productive skills(Writing and Speaking) of English language
- Employ various types of sentences in business correspondence
- To acquire language skills needed for B2 level of the CEFR/ Common European Framework of Reference for Languages

Course Outcomes (COs)

1. Listen to business conversations and understand specific information and overall idea
2. Read and understand business texts
3. Write coherent business letters, e-mails and reports using appropriate sentence structures and cohesive devices
4. Communicate orally in business situations using necessary verbal and non verbal devices
5. Appear for the Business English Certificate (BEC)Vantage level examination conducted by Cambridge Assessment English

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	1												1	
2	2												1	
3	1												1	
4	1												2	
5	2												1	

1 **15 Hours**

UNIT I LISTENING AND READING

Listening for writing short answers - filling gaps in Listening for writing short answers - filling gaps in sentences - identifying topic, context and function - identify different functions of language in business situations - identify prompts -identify paraphrases of required information
Scanning - reading for gist - understanding sentence structure - error identification - identify paraphrases - cohesive words and phrases - understand the importance of analysing the distractors - identify grammatical and semantic relationships

2 **15 Hours**

UNIT II WRITING AND SPEAKING

Business Emails - notes - memos to colleagues or friends - Giving instructions - explaining a development - asking for comments - requesting information - agreeing to requests - explaining - apologising - reassuring - complaining - describing - summarising - recommending - persuading
Turn-taking - sustaining interaction - initiating - responding - giving personal information - Talking about present circumstances, past experiences and future plans - expressing opinion - speculating - organising a larger unit of discourse - giving information - expressing and justifying opinions - speculating - comparing and contrasting - agreeing and disagreeing

Total: 30 Hours

Reference(s)

1. Whitehead, Russell and Michael Black. Pass Cambridge BEC Vantage Self-Study Practice Tests with Key, Heinle,a part of Cengage Learning, Delhi, 2003.

15MA401 NUMERICAL METHODS AND STATISTICS

2 2 0 3

Course Objectives

- By enrolling and studying this course the students will be able to understand the methods to solve polynomial equations and Implement the mathematical ideas for interpolation numerically
- Summarize and apply the methodologies involved in solving problems related to ordinary and partial differential equations
- Apply the concepts testing of hypothesis in their core areas
- Develop enough confidence to identify and model mathematical patterns in real world and offer appropriate solutions, using the skills learned in their interactive and supporting environment

Programme Outcomes (POs)

a. **Engineering Knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

Course Outcomes (COs)

1. Classify the equations into algebraic, transcendental or simultaneous and apply the techniques to solve them numerically
2. Demonstrate and obtain the differentiation and integration of functions using the numerical techniques
3. Obtain the solutions of all types of differential equations, numerically.
4. Apply basic statistical inference techniques, including confidence intervals, hypothesis testing to science/engineering problems.
5. Design an experiment for an appropriate situation using ANOVA technique.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	1												2	
2	2												1	
3	3												1	
4	3												2	
5	3												3	

UNIT I **6 Hours**

SOLUTION OF EQUATIONS

Solution of algebraic and transcendental equations: Newton- Raphson method - Solution of system of linear equations: Gauss elimination method - Inverse of a matrix: Gauss-Jordan method- Eigen values of a matrix by Power method.

UNIT II **5 Hours**

INTERPOLATION, DIFFERENTIATIONAND INTEGRATION

Interpolation: Newton's forward and backward interpolation formulae - Numerical differentiation: Newton's forward and backward interpolation formulae. Numerical integration: Trapezoidal rule- Simpson's rules for single integrals- Two point Gaussian quadrature formula.

UNIT III **7 Hours**

SOLUTIONS OF DIFFERENTIAL EQUATIONS

Solution of first order ordinary differential equations: Fourth order Runge- Kutta method - Solution of partial differential equations: Elliptic equations: PoissonÃ¢??s equation- Parabolic equations by Crank Nicholson method- Hyperbolic equations by explicit finite difference method.

UNIT IV **6 Hours**

TESTING OF HYPOTHESIS

Sampling distributions- Large sample test: Tests for mean- Small sample tests: Tests for mean (t test), F- test- Chi-square test for Goodness of fit and Independence of attributes

UNIT V **6 Hours**

DESIGN OF EXPERIMENTS

Completely randomized design - Randomized block design - Latin square design.

FOR FURTHER READING

Collection of data and use the testing of hypothesis to analyze the characteristics of the data.

Total: 60 Hours

Reference(s)

1. Grewal B. S, Numerical Methods in Engineering and Science with Programms in C & C++, Ninth Edition, Khanna Publications, 2010.
2. Sankara Rao. K, Numerical Methods for Scientists and Engineers, Third Edition, PHI Learning Private Limited, New Delhi, 2009.
3. Gerald C. F and Wheatley P.O, Applied Numerical Analysis, Seventh Edition, Pearson Education, New Delhi, 2004.
4. Johnson R.A, Miller and Freund's Probability and Statistics for Engineers, Seventh Edition, Prentice Hall of India, New Delhi, 2005.
5. Walpole R.E, Myers R.H, Myers R.S.L and Ye K, Probability and Statistics for Engineers and Scientists, Seventh Edition, Pearsons Education, Delhi, 2002.
6. Burden R. L and Douglas Faires J, Numerical Analysis Theory and Applications, CengageLearning, Ninth Edition, 2005.

Assessment Pattern

Unit/RBT	Remember				Understand				Apply				Analyse				Evaluate				Create				Total
	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	
1	2					6					8			4			2								22
2		2									12								6						20
3	2					2				4					4				6						18
4	2						4			6				4					6						22
5		2					4				6				6										18
																								Total	100

Assessment Questions

Remember

1. Define Algebraic and Transcendental equations. (F)
2. Recall the order of convergence of Newton-Raphson method. (F)
3. Recognize the derivatives of Newton's Forward and Backward Interpolation formula. (C)
4. List the conditions for applying Simpson's rule. (F)
5. Reproduce the formula of Fourth order Runge – Kutta method. (C)
6. Label the procedure used in Liebmann's process.(F)
7. State the axioms of probability. (F)
8. Define the probability density function. (C)
9. Recall the region of acceptance. (C)
10. Label the types of errors in the hypothesis testing. (C)

Understand

1. Indicate the order and condition of convergence of Newton's method. (C)
2. Infer the working rule in Gaussian elimination method.(C)
3. Interpret y' (2) from the following: (P)

X :	0	1	2	3	4
Y:	6.9897	7.4036	7.7815	8.1281	8.4510

4. Interpret the value of $\int_1^5 \log x \, dx$.(C)
5. Using Taylor's method find the solution of the initial value problem (C) $\frac{dy}{dt} = t + y$, $y(0) = 0$.
6. Exemplify the working rule for solving a boundary value problems using finite difference method. (P)
7. If A and B are events in S such that $P(A \cap B)=1/4$, $P(\bar{A})=2/3$ and $P(A \cup B)=3/4$. Identify $P(\bar{A}/B)$.(C)
8. Identify the MGF of the binomial distribution and hence find its mean and variance. (C)
9. Sample of 900 members is found to have a mean of 3.4 cms. Can it be regarded as a simple sample from a large population with mean 3.2 cms and SD 2.3 cms. (C)
10. Narrate the properties and the advantages of χ^2 *–test*. (C)

Apply

1. Find the inverse of the following matrix using Gauss Jordan method (P)

$$\begin{pmatrix} 1 & 0 & -2 \\ 3 & 4 & 8 \\ -1 & 0 & 5 \end{pmatrix}$$

2. Solve $x^3 - 5x^2 + 2x + 10 = 0$ using Graffe's root squaring method. (C)
3. The table given below reveals the velocity V of a body during the time 't' specified. Find its

t:	1.0	1.1	1.2	1.3	1.4
v:	43.1	47.7	52.1	56.4	60.8

acceleration at t = 1.1: (C)

4. Compute $dy/dx=y^2 - x^2 / y^2+x^2$ with y(0)=1 at x=0.2 find y by Taylor's series method. (C)
5. Use Runge-kutta method, find y(0.01) from dy/dx= -x, y(0)=1. (C)
6. A bag contains 7 red and 3 black marbles and another bag contains 4 red and 5 black marbles. One marble is selected at random and is transferred from the first bag into the second bag and then a marble is taken from the second bag. If this marble is happened to be red, find the probability that a black marble was transferred. (C)
7. In a distribution exactly normal, 7% of the items are under 35 and 89% are under 63. What are the mean and SD. (C)
8. In a sample of 1000 people in Tamilnadu 540 likes music and the rest like dance. Can we assume the both music and dance are equally popular in Tamilnadu. (C)
9. In 150 tosses of a coin, 90 heads were observed. Test the hypothesis that the coin is fair at 1% LOS. (C)

Analyze / Evaluate

1. Organize to find the solution by Gaussian elimination method: 6x + 3y +12z = 36; 8x -3y +2z = 20; 4x +11y –z =33. (P)
2. Determine the solution using Neton-Raphson method, $\cos x - x e^x = 0$. (C)
3. Use Newton's forward interpolation formula to find x when y = 20 (C)

X :	1	2	3	4
Y:	1	8	27	64.

4. From the following data, find y' at x = 43: (P)

X:	40	50	60	70	80	90
Y:	184	204	226	250	276	304

5. Using Euler's formula, to find the value of y when x = 0.4, given $\frac{dy}{dx} = \frac{xy}{2}$

Y (0) = 1, y (0.1) = 1.01, y (0.2) = 1.022 and y (0.3) = 1.023. (C)

Evaluate the first three steps of the initial value problem $\frac{dy}{dx} = \frac{x-y}{2}$ y(0)=1 by Taylor series method and next step by Runge- kutta method. (P)

7. The marks obtained by a number of students in a certain subject are approximately normally distributed with mean 65 and and SD 5. If 3 students are selected at random from this group, what is the probability that at least one of them would have scored above 75. (C)
8. Choose the calculation of finding the mean and variance of Poisson distribution. (P)

9 In a nationwide survey, 1200 persons selected at random were asked their opinion whether BJP should be limited to 5 years in the party. Out of this sample, 780 persons answered in the affirmative. Make a decision on this problem. (C)

9. Test whether the example having the values 63,63, 64, 65, 66, 69, 70, 70 and 71 has been chosen from a population with mean 65 at 5% LOS. (C)

15EE402 AC MACHINES

3 2 0 4

Course Objectives

- To understand the working principle, performance characteristics of alternator and Synchronous motor.
- To understand the different types of induction motor, working principle and their performance.
- To select the appropriate machine from the knowledge of starting and speed control of three-phase induction motors.

Programme Outcomes (POs)

a. **Engineering Knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

b. **Problem Analysis**: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

Course Outcomes (COs)

1. Analyze the performance of synchronous generator and compute EMF equation and voltage regulation by using different methods.
2. Explain the characteristics of synchronous motor and analyze its performance.
3. Analyze the characteristics, equivalent circuit and circle diagram of three phase induction motor and induction generator.
4. Apply suitable starting and speed control methods to enhance the performance of three phase induction motors.
5. Apply the double revolving field theory to develop equivalent circuit of single phase induction motor and examine the performance of special machines.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2	3											2	
2	3	3											2	1
3	2	3											3	
4	3	2												2
5	3	3											1	2

UNIT I **10 Hours**

SYNCHRONOUS GENERATOR

Types - Constructional details - Pitch factor and Distribution factor - EMF equation - Armature reaction - Voltage regulation - EMF, MMF ZPF and ASA methods Parallel operation.

UNIT II **8 Hours**

SYNCHRONOUS MOTOR

Principle of operation - Methods of starting - Synchronous machine on infinite busbar - Phasor diagram - V and inverted V curves - Power/power angle relations - Analysis of Synchronous condenser for load sharing and power factor improvement - Hunting and methods of suppression.

UNIT III **10 Hours**

THREE PHASE INDUCTION MACHINES

Constructional details - Principle and types - Torque equation - Torque- Speed Characteristics Equivalent circuit and Circle diagram - Losses and efficiency Induction generator and types.

UNIT IV **8 Hours**

STARTING AND SPEED CONTROL OF THREE PHASE INDUCTION MOTORS

Methods of starting - Direct on Line starter,autotransformer, Star-delta and Rotor resistance starters Speed control methods - Ward Leonard scheme - by Changing voltage, frequency, number of poles - Crawling and Cogging Braking methods.

UNIT V **9 Hours**

SINGLE PHASE INDUCTION MOTORS AND SPECIAL MACHINES

Construction - Principle and types - Double revolving field theory -Equivalent circuit -Permanent magnet brushless motors -Construction, principle of operation - Stepper motor, Universal motor.

FOR FURTHER READING

Three phase winding diagrams - Effect of change of excitation in alternator on infinite bus, Energy Efficient Induction motors - Servo motor.

Total: 75 Hours

Reference(s)

1. A. E. Fitzgerald, Charles Kingsley, Jr.Stephen D. Umans, Electric Machinery, Sixth Edition, Tata McGraw Hill Publishing Company Ltd., 2002.
2. M.G.Say, Performance and Design of Alternating Current Machines, 3rd Edition, CBS Publisher.
3. D. P. Kothari and I. J. Nagrath, Electric Machines, Tata McGraw Hill Publishing Company Ltd, Fourth Edition 2010.
4. Raj put R.K, Electric Machines, Lakshmi publication,fifth edition, reprinted at 2011.
5. P. S. Bhimbhra, Electrical Machinery, Khanna Publishers, Seventh Edition 2011.
6. Biller T.J.E. Brushless permanent Magnet and Reluctance Motor Drives, Clarendon Press.

Assessment Pattern

Unit/RBT	Remember				Understand				Apply				Analyse				Evaluate				Create				Total
	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	
1	2					4				4				4				4			2				20
2		2			4					4					4		4					2			20
3	2						4			4				4				4			2				20
4			2			4			4						4		4					2			20
5	2				4					4				4					4				2		20
																								Total	100

Assessment Questions

Remember

1. List any two types of 3-phase induction motor.
2. Recall the equation for emf induced in an alternator.
3. Define winding factor.
4. Recall the condition for maximum torque in 3-phase induction motor.
5. State double revolving field theory.
6. List out the applications of slip ring induction motor.
7. Define synchronous speed. How is it related to the frequency of generated emf.
8. Recognise the methods of speed control of cage type 3-phase induction motor.
9. Define cogging of induction motor.
10. List out the methods used for hunting.

Understand

1. Illustrate the slip-torque characteristics curve of three phase induction motor.
2. Explain the different types of induction motor.
3. Compare the open circuit & short circuit characteristics of an alternator.
4. Compare slip ring rotor and cage rotor of an induction motor.
5. Formulate the equation for torque developed in induction motor.
6. Interpret the emf equation of alternator.
7. Represent the equivalent circuit of single phase induction motor.
8. Summarize the salient features of synchronous motor.
9. Classify the different types of speed control of three phase induction motor.
10. Identify the necessity for predetermination of voltage regulation.

Apply

1. An Induction motor has 4 poles and it is energized from a 50 Hz supply. If the machine runs on full load at 2% slip; determine synchronous speed and running speed and frequency of rotor current.
2. Find (i) The total mechanical power developed and the rotor copper loss, when the slip is 4%, (ii) The output of the motor when the friction and windage losses are 1kW,(iii) Efficiency of the motor neglecting the iron losses.The power supplied to a three phase Induction motor is 50kW and the stator losses are 2kW.
3. Compute the rotor speed and rotor copper loss of a 3 phase, 50 Hz, 6 pole Induction motor with a slip of 0.04 per unit. When the output is 20kW, the frictional loss is 2500W.
4. A 415V, 11kW, 50 Hz, delta connected, three phase Induction motor gives the following test
   A.No load test: 415V, 5.8A, 488W
   B.Blocked Rotor Test: 40V, 18.4A, 510W
   Stator resistance per phase = 0.7?.
   Find (i) The line current (ii) Power Factor (iii) Input Power (iv) Slip (iv) Efficiency.
5. Select the suitable auto transformer ratio for starting an induction motor with a supply current not exceeding twice the full load current. Use the following data. Short circuit is 4 times of full load current. Full load slip is 2.5%. Estimate also the starting torque in terms of full load torque.

6. Design voltage regulation using MATLAB Simulation.
7. A permanent magnet brushless dc motor has a torque constant 0.12Nm / A referred to dc supply.Find no load speed when connected to 48V dc supply. Find stall current and stall torque if the armature resistance is 0.15 Ω per phase and the voltage drop in the controller is 2V.
8. Construct the no load and short circuit diagram of a 20 HP, 400V, 50 Hz, 3 phase star connected Induction motor have the following test results.No load test : 400V, 9 A, cos F = 0.2. Blocked Rotor Test: 200 V, 50A, P.F = 0.4. From the circle diagram, (i) The line current (ii) Power Factor at full load and (iii)Maximum Input Horse Power.
9. A variable reluctance stepper motor has 8 poles in the stator and they have five teeth in each pole. If the rotor has 30 teeth compute the step angle and resolution.
10. Show the relation between losses and efficiency of AC machines.

Analyse

1. Analyze the performance of given alternator and evaluate the voltage regulation of it by using MMF and ZPF methods.
2. “The alternators rated in kVA and not in kW” ,Justify the reason for this statement.
3. Outline the relation between losses and efficiency of AC machines.
4. Analyze the characteristics of shaded pole induction motor.
5. Contrast the operation of Permanent Magnet Synchronous Motor.
6. Contrast the methods of starting synchronous motor against high-torque loads.
7. Compare the different methods of electric braking.

Evaluate

1. A 3 hp Induction motor with full load efficiency and power factor of 0.83 and 0.8 respectively. As a short circuit current of 3.5 times full load current, Determine the line current at the time of starting from a 500V supply by means of a star-delta switch. Ignore the magnetising current
2. In a 8 pole, 50 Hz. 3 phases Induction motor, the rotor resistance per phase is 0.04 Ω and the maximum torque occurs at a speed of 645rpm. Assume air gap flux is constant at all loads. Determine the percentage of maximum torque (i) AT starting (ii) When the slip is 3%.
3. Determine the synchronous impedance and reactance of an alternator in which a given field current produces an armature current of 200 A on short circuit and a generated EMF of 50 V on open circuit. If Ra = 0.1 Ω. Find necessary induced voltage to deliver a load of 100A at a p.f. of 0.8 lagging with a terminal voltage of 200V.

Create

1. Derive the equation for torque developed by an induction motor .Draw a typical torque- slip curve and deduce the condition for maximum torque.
2. Derive the EMF equation of brushless permanent magnet sine wave motor.

15EE403 MEASUREMENTS AND INSTRUMENTATION 2 0 2 3

Course Objectives

- To learn the use of DC and AC bridges for measuring R, L and C.
- To learn the use of different types of analog meters for measuring electrical quantities such as current, voltage, power, energy, power factor and frequency.
- To learn the principle of working, applications of CRO and other electronic measuring devices.

Programme Outcomes (POs)

a. **Engineering Knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. **Problem Analysis:** Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

Course Outcomes (COs)

1. Analyze the static and dynamic behavior of a measurement system and compare with standard system
2. Apply the concept of Faradays Law in measuring instruments and determine the various types of errors associated with them.
3. Analyze AC and DC bridges, used for the measurement of resistance, Inductance and Capacitance.
4. Explain the operating principle of electrical transducers.
5. Apply the concept of transducers in the measurement of physical quantities.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3	2											1	
2	3	2											2	
3	2	3											2	
4	2	2											2	1
5	2	2											1	

UNIT I **6 Hours**

INTRODUCTION

Units and dimensions, Functional elements of an instruments, Static and dynamic characteristics,Errors in measurement, Statistical evaluation of measurement data,Standards and calibration.

UNIT II **7 Hours**

ELECTRICAL AND ELECTRONICS INSTRUMENTS

D Arsonval Galvanometer. Moving iron: attraction and repulsion type instruments, errors. Moving coil instruments, Permanent magnet moving coil instruments, Torque equations and errors.Single and Three phase watt meters and Energy meters.

UNIT III **6 Hours**

MEASUREMENTS, STORAGE AND DISPLAY DEVICES

Resistance measurement, Kelvin double bridge, Wheatstone bridge, Measurement of inductance and capacitance: Maxwell, Anderson, and Schering bridge-Digital CRO-Power quality analyzer, Megger.

UNIT IV **6 Hours**

TRANSDUCERS AND DATA ACQUISITION SYSTEMS

Classification of transducers: Resistive, capacitive & inductive transducers,Piezoelectric, optical and digital transducers,Data acquisition systems.

UNIT V **5 Hours**

MEASUREMENT OF PHYSICAL QUANTITIES

Measurement of Temperature: Thermocouples,Radiation and Optical pyrometer, pressure measurement,Flow measurement- hot wire and hot film anemometer, venturi and orifice meter, ultrasonic and electromagnetic flow meter, Level, viscosity and pH measurement.

FOR FURTHER READING

Importance and need for calibration- Extension of measurement range Digital meters.

1 **2 Hours**

EXPERIMENT 1

Characteristics of LVDT .

2 **2 Hours**

EXPERIMENT 2

Experimental verification of Schering bridge.

3 **4 Hours**

EXPERIMENT 3

Experimental verification of Maxwells inductance bridge.

4 **4 Hours**

EXPERIMENT 4

Experimental verification of Wheatstone bridge experiment.

5 **4 Hours**

EXPERIMENT 5

Experimental verification of Kelvin double bridge.

6 **4 Hours**

EXPERIMENT 6

Calibration of ammeter and voltmeter.

7 **2 Hours**

EXPERIMENT 7

Calibration of single phase energy meter.

8 **2 Hours**

EXPERIMENT 8

Calibration of three phase energy meter.

9 **4 Hours**

EXPERIMENT 9

Temperature measurement using RTD, thermistor and IC AD590.

10 **2 Hours**

EXPERIMENT 10

Measurements using cathode ray oscilloscope.

Total: 60 Hours

Reference(s)

1. A. K. Sawhney, A Course in Electrical & Electronic Measurements & Instrumentation, 19th edition Dhanpat Rai and Co, 2014.
2. E. O. Doebelin, Measurement Systems Application and Design, Tata McGraw Hill Publishing Company, 2007.
3. D. V. S. Murthy, Transducers and Instrumentation, Prentice Hall of India Pvt Ltd, 2004.

4. H. S. Kalsi, Electronic Instrumentation, Tata McGraw Hill, 3rd edition 2012.
5. Martin Reissland, Electrical Measurements, New Age International (P) Ltd., Delhi, 2006.
6. J. B. Gupta, A Course in Electronic and Electrical Measurements, S. K. Kataria & Sons, Delhi, 2008.

Assessment Pattern

Unit/RBT	Remember				Understand				Apply				Analyse				Evaluate				Create				Total
	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	
1	1	2				12				1			1	2			1								20
2	2	1							2	7	6			1				1							20
3		1				2			1	2			12	1				1							20
4	1	2				1			1					2				13							20
5					3	12								1			1	3							20
																								Total	100

Assessment Questions

Remember

1. Define error
2. Define sensitivity
3. Define tolerance
4. State true value
5. List the standard inputs used to obtain dynamic behaviour of an instrument
6. Define secondary instrument
7. Define limiting error
8. List the various elements of measuring system
9. Classify the instruments
10. Define sensitivity and zero drift
11. Define standard deviation
12. List the advantages of electronic voltmeter
13. Define transducer
14. Define standard deviation

Understand

1. Classify the types of errors
2. Illustrate the functional elements of measurement system with block diagram
3. Explain the static and dynamic characteristics of instruments
4. Illustrate the construction and working of PMMC instrument with neat diagram
5. Illustrate the construction and working of PMMC instrument with neat diagram
6. Explain the basic block diagram of DMM.
7. Illuatrate the digital frequency meter with neat diagram
8. Explain the working of X-Y recorders with neat sketch.
9. Explain the block diagram of digital storage oscilloscope
10. Compare various types of printers
11. Explain about the pressure measurement techniques
12. Explain about the pressure measurement techniques
13. Explain the temperature measurement techniques

Apply

1. A set of reading obtained in an experiment is, 49.7,50.1,50.,49.6,49.7. Find arithmetic mean, mean deviation, standard deviation and variance.A set of reading obtained in an experiment is, 49.7,50.1,50.,49.6,49.7. Find arithmetic mean, mean deviation, standard deviation and variance.

2. A moving coil voltmeter ha a uniform scale with 100 divisions, the full scale reading is 200V and 1/10 of scale division can be estimated with a fair degree of certainity. Find the resolution of instrument in volt.
3. A moving coil instrument has the following data: number of turns=100, width of coil=20mm,depth of coil=30 mm, flux density in air gap 0.1Wb/m2. Calculate the deflection torque when a carrying current of 10mA. Also Find the deflection if spring constant is 2*10-6 Nm/degrees.
4. A moing coil ballistic galvanometer of 200? resistance gives a throw of 70 divisions when the flux through a search coil to which it is connected is reversed. Find the flux density given that the galvanometer constant is 100µC per division and the search coil has 1200 turns, a mean area of 60cm2 and a resistance of 15 ?
5. Find the pH value for pure water and milk of magnesia
6. The digital input for a 4-bit DAC is 0110. Find the final output voltage
7. The digital input for a 4-bit DAC is 1111. Find the final output voltage
8. A moving coil instrument has the following data: number of turns=80, width of coil=30mm,depth of coil=20 mm, flux density in air gap 0.2Wb/m2. Calculate the deflection torque when a carrying current of 8mA. Also Find the deflection if spring constant is 2*10-6 Nm/degrees
9. The digital input for a 4-bit DAC is 0101. Find the final output voltage.
10. A moving coil voltmeter ha a uniform scale with 50 divisions, the full scale reading is 100V and 1/10 of scale division can be estimated with a fair degree of certainity. Find the resolution of instrument in volt.
11. Find arithmetic mean, mean deviation, standard deviation and variance for the following set of readings obtained in an experiment :50.7,50.1,50.,49.7,49.5.
12. Find arithmetic mean, mean deviation, standard deviation and variance for the following set of readings obtained in an experiment :50.7,50.1,50.,49.7,49.5.

Analyse
1. Differentiate error and uncertainity
2. Compare digital and analog Meters
3. Contrast RTD and copper
4. Justify the importance of Wheatstone bridge
5. Justify the importance of Schering Bridge
6. Justify the importance of Maxwell bridge
7. Compare schering bridge and wheatstone bridge
8. Compare schering bridge and wheatstone bridge
9. Compare the static and dynamic characteristics of instruments
10. Compare MI and MC instruments

Evaluate
1. Check the fault in cables by using Wheatstone bridge

Create
1. Derive the torque equation of moving iron instrument
2. Design a LVDT circuit
3. Design a temperature measurement circuit using RTD

15EE404 ELECTRIC POWER GENERATION

3 0 0 3

Course Objectives
- Construct load curve, mass curve for power plants and decide the type and size of the power plants
- Analyze the characteristics of steam turbine, turbo alternators and explain the layout and working of steam power station

- Explain the characteristics of turbine, generator used in hydro electric plant and tidal power plant
- Exemplify the location, layout and principle of working of Nuclear power station
- Analyse the different types of alternative sources of electrical energy

Programme Outcomes (POs)

a. **Engineering Knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. **Problem Analysis**: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
e. **Modern Tool Usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
g. **Environment and Sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

Course Outcomes (COs)

1. Analyze load curve, mass curve for power plants and decide the type and size of the power plants.
2. Analyze the characteristics of steam turbine, turbo alternators and explain the layout and working of steam power station
3. Explain the characteristics of turbine, generator used in hydro electric plant and tidal power plant.
4. Analyze the location, layout and principle of working of Nuclear power station.
5. Exemplify the alternative sources of electrical energy.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2	2			1		1						3	
2	2	2					1						2	1
3	2	2					1						2	1
4	2	2					1						2	1
5	2	2					2						2	1

UNIT I **10 Hours**

INTRODUCTION

Definition of connected load, maximum load, maximum demand, demand factor, load factor, diversity factor, plant capacity factor, plant utilization factor, load duration curve, mass curve. Choice of Power station and units: Types of power station, choice of type of generation, choice of size of generator units and number of units.

UNIT II **7 Hours**

STEAM POWER STATION

Main parts and working of a steam station, characteristics of steam turbines, characteristics of turbo alternators, steam station auxiliaries, steam station layout, super pressure steam stations.

UNIT III **8 Hours**

HYDRO POWER STATION

Hydrology, hydrographs, flow duration curve, mass curve, types of dam, principle of working of a hydro electric plant, tidal power plant, power to be developed, types of turbine and their characteristics, characteristics of generators, power station structure and layout.

UNIT IV **9 Hours**

NUCLEAR POWER STATIONS

Main parts of nuclear power station principle of nuclear energy, main parts of reactor, types of power reactor,location of nuclear power plant, layout of power station, reactor control, nuclear waste disposal.

UNIT V **11 Hours**

ALTERNATIVE SOURCES OF ENERGY

Solar radiation, Solar energy collectors, Conversion of solar energy into electric energy, Solar hydrogen energy cycle, Wind mills, Tidal power generation schemes, Tidal barrage, Environmental aspects of new and old electric energy generation. MHD generation: history of MHD generation, principle of MHD generation, advantage of MHD generation.

FOR FURTHER READING

Types of power station Main parts of a steam station, Types of dam,Types of power reactor Conversion of solar energy into electric energy

Total: 45 Hours

Reference(s)

1. B.R. Gupta Generation of Electrical Energy, S.Chand Publishers, New Delhi,2008.
2. Car, T.H., Electric Power Station, Chappman & Hall Publishers, 2006.
3. M.V. Deshpande ,Elements of Electric Power Station Design, Tata McGraw Hill, New Delhi ,2006.
4. Soni Gupta Bhatnagar , A Course in Electrical Power, Dhanpat Rai Publishers, New Delhi ,2009.
5. J.B.Gupta , A Course in Electrical Power, Kataria Publishers, New Delhi ,2007.
6. Gate Academy Publication, Electrical Power Generation, Third Edition, DURG, 2016.

Assessment Pattern

Unit/RBT	Remember				Understand				Apply				Analyse				Evaluate				Create				Total
	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	
1	2	2			2	6				4				2				2							20
2		2				2				2				2				6				6			20
3	2					2				2				2	6				6						20
4		2				6				2			2	6				2							20
5	2					6			2				2				2					6			20
																								Total	100

Assessment Questions

Remember

1. List the various designs of blades of VAWT
2. Define solar constant
3. State the principle of solar photovoltaic energy conversion
4. Define wind velocity
5. Define lift force, axial force and tangential force.
6. Define MHD power generator
7. List the classification of coals.
8. List out main parts of nuclear power plant
9. Define atomic number and mass mass number
10. Define isotope

Understand

1. Explain the importance of non conventional energy resources in context of global warming
2. Explain the mechanism of photoconduction in a PV cell
3. Â IllustrateÂ the operation of standalone and grid interactive SPV System with the help of block diagrams
4. Illustrate the concept of load mismatch in SPV- load system with diagram
5. Explain how variations of insolation and temperature affect the I-V characteristics of solar Cell.
6. Explain the variations of power output of a wind turbine with tip speed of the rotor
7. Explain the working of steam power station.
8. Explain the general arrangement and operation of hydroelectric plant
9. Â Explain the factors to be considered for the selection of site of a nuclear power station
10. Prepare a rough heat balance sheet for a stem power station consuming 0.5kg of coal per kWh output.Take calorific value of coal as 5000kcal per kg. Asuume boiler efficiency as 80% and electrical efficiency as 90%.
11. Justify the factors to be considered for selection of the site for a thermal power station

Apply

1. A PV system feeds a dc motor to produce 1hp power at the shaft. The motor efficiency isÂ 85%. Each module has 36 crystalline solar cell arranged in 9*4 matrix. The cell size is 125mm*125mm and the cell efficiency is 12%. Find the number of modules required in the PC array. Assume global radiation incident normally to the panel as 1kW/m2
2. A thermal power plant spends Rs. 25 lakhs in one year as coal consumption. The coal has heating value of 5000kcal/kg and costs Rs. 500 per ton. If the thermal efficiency is 35% and electrical efficiency is 90%, find the average load on the power plant.
3. A generating station has a maximum demand of 500 MW. The annual load factor is 50% and capacity factor is 40 %. Find the reserve capacity of the plant
4. A two blade HAWT is installed at a location with free wind velocity of 20m/s. The rotor diameter isÂ 30m. Find the rotational speed should be maintained to produce maximum output?
5. A generating station has an installed capacity of 50,000 KW and delivers 220 X 106 units per annum. If the annual fixed charges are Rs.160 per KW installed capacity and running charges are 4 paise per Kwh, Find the cost per energy generator.
6. A hydro power plant operates under an effective head of 100 m and a discharge of 200 cubic metre / sec. If the efficiency of turbine alternator set is 90 %, Find the power developed .

7. A generating stations as a maximum demand (MD) of 15 MW and the daily load curve on the station is as follows, 10 pm to 05 am 2500 KW, 01 pm to 04pm 10000KW, 05am to 07 am 3000KW, 04pm to 06pm 12000KW ,07pm to 11am 9000KW, 06 pm to 08pm 15000KW, 11am to 01pm 6000KW ,08pm to 10pm 5000KW, Find the size and the number of generator units, plant load factor, plant capacity factor, use factor and reserve capacity of plant
8. A generating station has a maximum demand of 1000 MW. The annual load factor is 60% and capacity factor is 30 %. Find the reserve capacity of the plant
9. A two blade HAWT is installed at a location with free wind velocity of 30m/s. The rotor diameter is 40m. Find the rotational speed should be maintained to produce maximum output?

Analyse

1. Justify the importance of MPPT in an SPV system
2. Compare various types of generators for wind power generations
3. Compare the types of drive schemes used in wind turbines
4. Justify the importance of load factor of the supply system interms of diversity
5. Compare the run - off river plant with steam plant in combined hydro-electric and steam station operation.
6. Justify the importacnce of greenhouse effect
7. Compare the types of fuels used in thermal power plants
8. Justify the importance of load factor on the cost of generation in a power system
9. Justify the importance of photoconduction in a PV cell

Create

1. Combine the solar and wind energy and design a hybrid power plant
2. Combine the run - off river plant with steam plant and expalin hydro-electric and steam station operation.

15EE405 TRANSMISSION AND DISTRIBUTION

3 2 0 4

Course Objectives

- To understand the various types of transmission system and develop the mathematical models for computation of fundamental parameters of lines.
- To categorize the transmission lines and develop equivalent circuits for these classes.
- To analyze the voltage distribution in insulator strings and cables and methods to improve the same.

Programme Outcomes (POs)

a**. Engineering Knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

b. **Problem Analysis:** Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

c. **Design/ Development of Solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for thepublic health and safety, and the cultural, societal, and environmental considerations.

Course Outcomes (COs)

1. Analyze the line parameters of overhead transmission lines.
2. Determine voltage regulation and transmission efficiency of short, medium and long transmission lines.
3. Analyze the effect of corona on transmission line and examine the operation of HVDC transmission system.
4. Classify the different types of cables and insulators and estimate the string efficiency of insulators.
5. Analyze the performance of single and three phase distribution system and classify the substations.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3	3											3	
2	3	3	1										3	
3	2	3	1										1	
4	2	3	1											1
5	1	2												1

UNIT I **10 Hours**

LINE PARAMETERS

Resistance, Inductance and capacitance of single phase and three phase line - Stranded and bundled conductor configurations - Hollow conductors - Symmetrical and unsymmetrical spacing - Transposition of line conductors - Double circuit lines - Skin and proximity effects.

UNIT II **10 Hours**

PERFORMANCE OF TRANSMISSION LINES

Reactive power flow in transmission lines - Regulations and Efficiency of short - Medium transmission lines by nominal T & Pi methods- Rigorous solutions for long line - ABCD constant- Ferranti effect

UNIT III **8 Hours**

HVDC AND CORONA

HVDC - Introduction - Types - Advantages and disadvantages - Phenomenon of corona - Corona loss - Radio interference on transmission lines.

UNIT IV **8 Hours**

CABLES AND INSULATORS

Types - Capacitance of cables - Grading of cables - current rating of a cable - Insulators - Types and comparison - Voltage distribution in insulator string - String efficiency - Methods of improving string efficiency.

UNIT V **9 Hours**

DISTRIBUTION SYSTEM

AC distribution - single phase and three phase 4-wire distribution- System comparison- Primary and Secondary distribution networks - voltage drop and power loss in distribution system- feeder system- Substation equipment and layouts

FOR FURTHER READING

Analysis of DC distribution system -Introduction to FACTS-Testing of insulators - Energy storage systems.

Total: 75 Hours

Reference(s)

1. C.L .Wadhwa, Electrical Power Systems, New Age International Edition, New Delhi 2010.
2. I.J.Nagrath, D.P.Kothari, Power System Engineering Tata McGraw Hill Ltd, New Delhi, 2014.
3. Mehta V K, Rohit Mehta, "Principles of Power Systems", S.Chand & Co., New Delhi, 2011.
4. A S PABLA, Electriv Power Distribution Tata McGraw Hill Ltd, New Delhi, 2012.
5. Luces M. Fualkenberry, Walter Coffer, Electrical Power Distribution and Transmission, Pearson Education, 3rd edition, 2008.
6. S.N. Singh, Electric Power Generation, Transmission and Distribution, Prentice Hall of India Pvt Ltd, New Delhi, 2002.

Assessment Pattern

Unit/RBT	Remember				Understand				Apply				Analyse				Evaluate				Create				Total
	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	
1	1	1			1	2			1				2					12							20
2	1	2			1	2			1					1				12							20
3					1	2			1	2				1	6		1		6						20
4	1	2			1	12				1			1					2							20
5	1	1			1	12				1			2				2								20
																								Total	100

Assessment Questions

Remember

1. State two advantages of bundled conductors.
2. Recall the units for generalized circuit constants A, B, C and D ?
3. Define voltage regulation of transmission lines.
4. State the reason that concept of self GMD is not applicable for capacitance?
5. Recognise the term stranded conductors? Why are they used?
6. Define Skin effect?
7. Suggest two methods for Reducing Corona Effect.
8. Define critical disruptive voltage
9. Recognise the uses of strain insulators?
10. Draw equivalent circuit and phasor diagram for short transmission line
11. List the constants of transmission line?

Understand

1. Illustrate the need of economizer in power plant
2. Identify factors to be considered while selecting a site for hydroelectric power plant?
3. Identify the cause for skin and proximity effect.
4. Compare Self GMD (GMR) and mutual – G.M.D.
5. How ash is handled in the power plant? Explain the ash handling system.
6. Elucidate the types of cables with neat diagrams and compare their advantages and disadvantages
7. Explain the DC Distribution systems.
8. Compare unsymmetrical spacing & symmetrical spacing.
9. Explicate the importance of resistance, inductance, and capacitance in transmission lines.
10. Explain the expression for the flux linkage in a single current carrying conductor.

Apply

1. A 3 Φ overhead transmission line has its conductors arranged at the corners of an equilateral triangle of 2m side. Calculate the capacitance of each line conductor per km. Given the diameter of each conductor is 1.25cm.
2. Execute the concept of GMR and GMD in the calculation of transmission line inductance
3. A string of 5 insulators is connected across a 100kv line. If the capacitance of each disc to earth is 0.1 times the capacitance of the insulator, calculate
   The distribution of voltage over the discs b. String efficiency.
4. The self capacitance of each unit of a string of three suspension insulators is ‘c’.The pin to earth capacitance is 0.15c while the pin to line capacitance is 0.1c. calculate
   The voltage across the insulators as a % of phase voltage
   String efficiency
5. A transmission line has a space of 275m between level supports. The conductor has an effective dia. of 1.96cm and weighs 0.865kg/m.Its ultimate strength is 8060kg.If the conductor has an ice coating of radial thickness 1.27cm and is subjected to a wind pressure of 3.9g/cm2 of projected area, calculate the sag for a safety factor of 2.Weight of 1cc of ice is 0.91g.
6. A 1 phaseAC distributor AB has a impedance of 0.1+j0.2.At far end B a current of 80A at 0.8pf lag and at midpoint C, a current of 100A at 0.6pf lag are tapped. If the voltage at far end is maintained at 200V, determine
   a] Supply end voltage
   b] Phase angle between VA &VB
7. In a 1 phase ring distributor ABC, The loads at B & C are 40A at 0.8Pf lag and 60A at 0.6 Pf lag .The total impedance of sections AB,BC,CA are 2+j1,2+j3 and 1+j2 Determine the current in each section.
8. Determine the efficiency and regulation of a 3phase, 100Km, 50 Hz transmission line delivering 20 MW at a power factor of 0.8 lagging and 66 kV to a balanced load. The conductors are of copper, each having resistance 0.1 Ω / Km, 1.5 cm outside dia, spaced equilaterally 2 metres between centres. Use nominal T method.
9. Find the capacitance between the conductors of a single-phase 10 km long line. The diameter of each conductor is 1.213cm. The spacing between conductors is 1.25m. Also find the capacitance of each conductor neutral.
10. Find the inductance per phase per km of double circuit 3 phase line shown in Figure. The line is completely transposed and operates at a frequency of 50 Hz.

Analyse

1. Determine the reason for presence of skin effect in AC transmission systems.
2. Analyze the various AC distribution systems
3. Manipulate and explain the types of insulators based on the voltage levels.
4. Compare and contrast overhead lines and underground cables.
5. Evaluate the design principles of substation grounding system.

Evaluate

1. Find the following for a single circuit transmission line delivering a load of 45 MVA at 132 kV and p.f.0.8 lagging:
   a.sending end voltage b.ending end current
2. Determine the efficiency and regulation of a 3 phase, 100 km, 50 Hz transmission line delivering 20 MW at a p.f.of 0.8 lagging and 66 kV to a balanced load. The conductors are of copper, each having resistance 0.1 /km, 1.5 cm outside dia, spaced equilaterally 2 m between centres. Neglect leakage reactance and use Nominal T (pi) method.
3. A 200km long 3 phase overhead line has a resistance of 48.7 ohms per phase, inductive reactance of 80.20 ohms perphaseand capacitance (line to neutral) 8.42 n F per km. It supplies a loadof 13.5 MW at a voltage of 88 k V and power factor 0.9 lagging. Using nominal T circuit, find the sending end voltage current, and regulation

Create

1. Design an AC distribution system for simple domestic applications.
2. Develop a circuit to generate high voltage for insulation testing applications.
3. Create a simulation model to study the transmission line parameters.
4. Develop an algorithm to compare the efficiency of various lines
5. Create a circuit to demonstrate the break down strength of air.

15EE406 LINEAR INTEGRATED CIRCUITS

3 0 0 3

Course Objectives

- To provide a strong foundation to linear circuits.
- To familiarize students with applications of various IC's.
- To have a broad coverage in the field that is relevant for engineers to design linear circuits using Op-amps.

Programme Outcomes (POs)

a. **Engineering Knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

b. **Problem Analysis:** Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

c. **Design/ Development of Solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for thepublic health and safety, and the cultural, societal, and environmental considerations.cultural, societal, and environmental considerations.

Course Outcomes (COs)

1. Analyze the DC and AC characteristics of op-amp and infer the effect of the characteristics on the output of an Op-Amp.
2. Design and analyze the Op-Amp for linear applications.
3. Design and analyze the Op-Amp for non linear applications.
4. Analyze the performance of different types of A/D and D/A converters and the effect of power supply on the operation of Op-Amp.
5. Design multivibrator circuits using 555 timer and compare the different types of voltage regulator based on its performance

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2	3											1	
2	2	2	3										3	2
3	2	2	3										3	2
4	1	3	2										3	2
5	1	2	3										3	3

UNIT I **8 Hours**

CHARACTERISTICS OF OPERATIONAL AMPLIFIER

Basic information of Operational Amplifier - Block diagram and internal circuits of Operational Amplifier - Circuit schematic of IC741-Ideal Operational Amplifier characteristics, transfer characteristics -DC characteristics-AC characteristics-Frequency Response, Stability - Frequency Compensation techniques- CMRR and Slew Rate.

UNIT II **10 Hours**

LINEAR APPLICATIONS OF OPERATIONAL AMPLIFIER

Inverting and Non-inverting Amplifiers, Voltage follower - Summing amplifier- differential amplifier - Instrumentation amplifier - Integrator and Differentiator - Voltage to Current and Current to Voltage converters, Oscillators-Sine Wave, Square Wave, triangular Wave and Saw tooth Wave Generation.

UNIT III **10 Hours**

NON-LINEAR APPLICATIONS OF OPERATIONAL AMPLIFIERS

Comparators -Zero-crossing detector, Schmitt Trigger, Window detector, - Multivibrators -Clippers, Clampers, Peak Detector-Sample and Hold circuit- Active filters -Design of first order low pass, high pass, wide band pass and Band stop Butterworth filters, Narrow band pass and notch filters.

UNIT IV **9 Hours**

A-D AND D-A CONVERTERS A-D AND D-A CONVERTERS

DAC/ADC performance characteristics -Digital to Analog Converters: Binary weighted and R-2R Ladder types - Analog to digital converters: Successive approximation and Flash Type.Single power supply operational amplifiers Need for single power supply operational amplifiers - LM324, AC Inverting and Non-Inverting amplifiers.

UNIT V **8 Hours**

SPECIAL ICS

555 Timer circuit -Functional block, Astable & monostable characteristics, applications; Voltage regulators - fixed voltage regulators, adjustable voltage regulators - switching regulators.

FOR FURTHER READING

566-voltage controlled oscillator circuit; 565- PLL Functional Block diagram -Principle of operation, Applications: Frequency synthesis, AM and FM detection, FSK demodulator.

Total: 45 Hours

Reference(s)

1. D.Roy Choudhary, Sheil B.Jani, 'Linear Integrated Circuits', II edition, New Age, 2014.
2. David A.Bell, 'Op-amp & Linear ICs', Oxford, 2013.
3. Ramakant A.Gayakward, 'Op-amps and Linear Integrated Circuits', IV edition, Pearson Education, 2015.
4. Jacob Millman, Christos C.Halkias, 'Integrated Electronics - Analog and Digital circuits system',Tata McGraw Hill, 2009.
5. Michael Jacob J, 'Applications and Design with Analog Integrated Circuits', Prentice Hall of India, New Delhi, 2010.
6. S. Salivahanan and V.S. Kanchana Bhaaskaran , Linear Integrated Circuits, First reprint, Tata McGraw Hill, 2015.

Assessment Pattern

Unit/RBT	Remember				Understand				Apply				Analyse				Evaluate				Create				Total
	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	
1	2					6				6				6											20
2		2					6				6												6		20
3			2								6								4			8			20

4						2				6				6										6	20
5		2					6			6			6												20
																								Total	100

Assessment Questions
Remember

1. State the important features of instrumentation amplifier.
2. List the basic types of differential amplifier configurations
3. Recall the DC characteristics of an op-amp.
4. Define magnitude plot and phase angle plot.
5. List out the ac characteristics of an op-amp.
6. Label the two types of external compensation techniques.
7. Label the two types of external compensation techniques.
8. Define slew rate. What causes the slew rate?
9. Recall Sample and Hold circuit.
10. Recognize some of the linear applications of op – amps
11. Recall Schmitt trigger.
12. List the two basic modes of operation of IC 555.
13. Recognize some applications of 555 timer.
14. Recall the advantages of IC voltage regulators.
15. Define switching regulator.
16. Recall the classification of voltage regulators.
17. Criticize the working of LM 380 power amplifier with neat diagrams

Understand

1. Infer the drawbacks of using large RC in differential amplifiers
2. In practical op-amps, infer the effect of high frequency on its performance?
3. Infer the need for frequency compensation in practical op-amps?
4. Interpret main drawback of a dual-slop ADC.
5. Indicate the advantage of active filters over passive filters.
6. Infer the use of reset pin in 555 timer.
7. Draw a block schematic of PLL IC NE/SE 565 and describe its functions
8. Explain the various types of digital to analog converters.
9. Draw the circuit diagram of op-amp differentiator, integrator and derive an expression for the output in terms of the input.
10. Draw the circuit of a first order and second order butter worth active low pass filter and derive its transfer functions.
11. Elucidate the working of R-2R ladder type D/A converter.
12. Illustrate the operation of Op-Amp based monostable multivibrator along with duty cycle expressions
13. Sketch the circuit of schmitt trigger using IC 555 timer and explain its operation.
14. Illustrate the working protective circuits in regulators.
15. Illustrate the operation of ICL 8038 function generator. Give its advantages.
16. A PLL has free running frequency of 500 kHz and bandwidth of the low pass filter is 10 kHz. Will the loop acquire lock for an input signal of 600 kHz? Justify your answer. Assume that the phase detector produces sum and difference frequency components.
17. Differentiate between 723 general purpose voltage regulator and 7840 switching regulator.

Apply

1. Compute the formula for CMRR.
2. Design an amplifier with a gain of -10. Calculate its output voltage if the input voltage is 10V.

3. For the non inverting operational amplifier with input resistance 100 K and feedback resistance 900 K find the effect on output voltage due to common mode voltage when the input voltage changes by 1 V. Assume CMRR as 70 dB.
4. For the inverting amplifier R1=470Ω and Rf=4.7KΩ. Assume that the opamp is a 741. Calculate the values of Af, Rif ,Rof,fF and VooT.
5. A dual slope ADC uses a 16 bit counter and a 4 MHz clock rate. The maximum input voltage is =10V. The maximum integrator output voltage should be -8V when the counter has cycled through 2n counts. The capacitor used in the integrator is 0.1µF. Find the value of the resistor R of the integrator. If the analog signal is = 4. 129 V, find the corresponding binary number.
6. Implement a square wave oscillator for fo=1KHz using 741 Op-amp and a DC supply voltage of +/- 12V.
7. Demonstrate how a comparator can be used as a zero crossing detector.
8. Compute an expression for the period of pulse generated when 555 timer is used as a Monostable Multivibrator.
9. Compute the derivation for Lock-in Range and Capture range of PLL with suitable Expressions
10. Compute an expression for the period of pulse generated when 555 timer is used as Astable Multivibrator
11. Compute the derivation for Lock-in Range and Capture range of PLL with suitable Expressions.
12. Construct an adjustable voltage regulator to satisfy the following specifications: output voltage VO=5 to 12V, output current Io = 1A.Voltage regulator is LM317.
13. Why is the capture range of PLL dependent upon low pass filter (LPF) characteristics?

Analyse

1. Attribute the internal block diagram of typical op-amp circuit.
2. Compare the working of non-inverter circuit and voltage follower circuit
3. Conclude about the Applications of slew rate
4. With a neat circuit diagram describe the operation of three amplifier configuration of an Instrumentation Amplifier and also derive the expression for output voltage.
5. Differentiate ideal integrator with practical Integrator circuit by using op-amps.
6. Compare Current to Voltage Converter and Voltage to Current converter by using op-amps in terms of their working.
7. Show how a comparator can be used as a zero crossing detector.
8. Conclude the purpose of having input and output capacitors in three terminal IC regulators
9. Compare open loop and closed loop configuration of op-Amp
10. Resolve how the current boosting is achieved in a 723 IC.
11. Criticize the working of ICL 8038 by using suitable examples.

Evaluate

1. Justify the frequency compensation techniques of op-amp circuits
2. Support a Practical differentiator circuit that will differentiate an input signal with maximum frequency of 150Hz.
3. Support a RC phase shift oscillator and a wein bridge oscillator of frequency 1 KHz. (assume C=0.01µF)
4. Defend the applications of analog multipliers in (i) frequency Doubling(ii) squarer circuit.
5. Support an adder circuits using operational amplifier to get the output expression as V0 = -10.1v +v2+ 5 v3.
6. Determine the capture range and lock in range of PLL IC565
7. Check the functional block diagram of IC 723 regulator.
8. Choose a best opamp circuit to generate a square wave output.

Create

1. Generalize the LED temperature indicator using the application of V/F converter and 555 timer.

2. Relate a fourth order butter worth LPF having a upper cut off frequency of 1 KHz with second order filter.
3. Plan a square wave oscillator for fo=1KHz using 741 Op-amp and a DC supply voltage of +/- 12V.
4. Design a RC phase shift oscillator and a wein bridge oscillator of frequency 1 KHz. (assume C=0.01µF)
5. Generate a adjustable voltage regulator using IC 723 to obtain positive low voltage and high voltage.

15EE407 AC MACHINES LABORATORY

0 0 2 1

Course Objectives

- To understand the performance characteristics of Synchronous motors, AC motors, single phase motors and three phase motors as well as how to troubleshoot motors.
- To find the regulations of various synchronous generators.
- To conduct performance tests on AC motors.

Programme Outcomes (POs)

a. **Engineering Knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

b. **Problem Analysis:** Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

c. **Design/ Development of Solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for thepublic health and safety, and the cultural, societal, and environmental considerations.

d. **Conduct Investigations of Complex Problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

g. **Environment and Sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

Course Outcomes (COs)

1. Analyze the performance characteristics and voltage regulation of synchronous generator
2. Demonstrate the effect of excitation on armature current and power factor of synchronous motor.
3. Analyze the load characteristics, circle diagram and braking methods of three phase induction motor.
4. Demonstrate the four different types of starters and analyze the speed control characteristics of three phase induction motor.
5. Demonstrate the load characteristics of self-excited induction generator and single phase induction motor

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1		3		1									3	2
2				3									3	2

3		3					1						3	2
4	2			3									2	3
5		3	1										2	2

1 **4 Hours**

EXPERIMENT 1

Voltage Regulation of an alternator by MMF and ZPF methods.

2 **4 Hours**

EXPERIMENT 2

V and inverted V curves of grid connected synchronous machine.

3 **2 Hours**

EXPERIMENT 3

Load test on single phase induction motor.

4 **2 Hours**

EXPERIMENT 4

Load test three phase induction motor.

5 **4 Hours**

EXPERIMENT 5

Equivalent circuit and circle diagram of three phase induction motor.

6 **4 Hours**

EXPERIMENT 6

Braking methods of three phase induction motor.

7 **2 Hours**

EXPERIMENT 7

Speed control of three phase induction motor.

8 **2 Hours**

EXPERIMENT 8

Study and experimental verification of different types of starters for three phase induction motors.

9 **4 Hours**

EXPERIMENT 9

No load characteristics and Load test on self excited induction generator.

10 **2 Hours**

EXPERIMENT 10

Load test on 3 phase alternator and determination of voltage regulation.

Total: 30 Hours

Reference(s)

1. A. E. Fitzgerald, Charles Kingsley, Jr.Stephen D. Umans, Electric Machinery, Sixth Edition, Tata McGraw Hill Publishing Company Ltd., 2002.
2. M.G.Say, Performance and Design of Alternating Current Machines, 3rd Edition, CBS Publisher.
3. D. P. Kothari and I. J. Nagrath, Electric Machines, Tata McGraw Hill Publishing Company Ltd, Fourth Edition 2010.
4. Raj put R.K, Electric Machines, Lakshmi publication,fifth edition, reprinted at 2011.
5. P. S. Bhimbhra, Electrical Machinery, Khanna Publishers, Seventh Edition 2011.
6. Biller T.J.E. Brushless permanent Magnet and Reluctance Motor Drives, Clarendon Press.

15EE408 ANALOG AND DIGITAL INTEGRATED CIRCUITS LABORATORY

0 0 2 1

Course Objectives

- To design and analyze the operation of basic digital circuits and understand their functionality.
- To understand the linear combinational circuit and operational amplifier.
- To illustrate the concept of filters, ADC, DAC and 555 Timer.

Programme Outcomes (POs)

a. **Engineering Knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

c. **Design/ Development of Solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for thepublic health and safety, and the cultural, societal, and environmental considerations.

i. **Individual and Team Work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

Course Outcomes (COs)

1. Design and implement combinational logic circuits using logic gates.
2. Demonstrate the operation of sequential logic circuits.
3. Design wave shaping circuits,ADC and DAC using op amp.
4. Construct astable and monostable multivibrator circuits using IC555 timer.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2		3						1				3	
2	2		3						1				3	
3	3		2						1				3	2
4	2		3						1				2	3

1 **4 Hours**

EXPERIMENT 1

Experimental verification of logic gates and design adder and subtractor circuits.

2 **2 Hours**

EXPERIMENT 2

Implementation of three variable Boolean Functions using logic gates.

3 **4 Hours**

EXPERIMENT 3

Design and implementation of decade counter with decoder/driver and seven segment LED display.

4 **4 Hours**

EXPERIMENT 4

Verification of RS and JK Flipflop and design the bidirectional shift registers.

5 **2 Hours**

EXPERIMENT 5

Design and implementation of Multiplexer and Demultiplexer using logic gates.

6 **4 Hours**

EXPERIMENT 6

Experimental verification of operational amplifier characteristics and design differentiator and integrator circuits.

7 **2 Hours**

EXPERIMENT 7

Design and Implementation of second order low pass active filter.

8 **4 Hours**

EXPERIMENT 8

Generation of square, triangular, sinusoidal and sawtooth waveforms using operational amplifiers.

9 **2 Hours**

EXPERIMENT 9

Design and implementation of analog to digital converter and digital to analog converter.

10 **2 Hours**

EXPERIMENT 10

Design and implementation of Astable and Monostable Multivibrators using IC 555 Timer.

Total: 30 Hours

15EE409 MINI PROJECT II 0 0 2 1

Programme Outcomes (POs)

a.**Engineering Knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. **Problem Analysis:** Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
c. **Design/ Development of Solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
d. **Conduct Investigations of Complex Problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
e. **Modern Tool Usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
f. **The Engineer and Society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
g. **Environment and Sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
h**. Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

i. **Individual and Team Work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
j. **Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
k. **Project Management and Finance**: Demonstrate knowledge and understanding of the engineering and management principles and apply these to oneÃ¢??s own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
l. **Life-long Learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Course Outcomes (COs)

1. Formulate a real world problem, identify the requirement and develop the design solutions.
2. Identify technical ideas, strategies and methodologies.
3. Utilize the new tools, algorithms, techniques that contribute to obtain the solution of the project.
4. Test and validate through conformance of the developed prototype and analysis the cost effectiveness.
5. Prepare report and present oral demonstrations

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	-	3	2			2	1						3	1
2	2	2	1	3		2					2	2	2	
3			3	2	2			2			2	2	3	
4		1		2	3	1	2	2					1	3
5									3	3	-	2		3

Total: 15 Hours

15EE501 MICROPROCESSORS AND MICROCONTROLLERS 3 0 0 3

Course Objectives

- To study the Architecture, addressing modes & instruction set of 8085 & 8051.
- To develop skill in simple program writing for 8085 & 8051 and its applications.
- To introduce commonly used peripheral / interfacing ICs.

Programme Outcomes (POs)

a. **Engineering Knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. **Problem Analysis:** Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
c. **Design/ Development of Solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for thepublic health and safety, and the cultural, societal, and environmental considerations.
h. **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

Course Outcomes (COs)

1. Explain the architecture of 8085 microprocessor and timing diagram of the instructions.
2. Classify the addressing modes &instruction set of 8085 microprocessor and compute simple programs.
3. Analyze the peripheral interfacing used in 8085 microprocessor.
4. Interpret the architecture of 8051 microcontroller and classify the addressing modes.
5. Execute the applications using 8051 microcontroller programming.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3	2											1	
2	3		2										2	
3	3	2	1										3	
4	3	2											2	
5	2	2	3					1						2

UNIT I **9 Hours**

8085 PROCESSOR

Hardware Architecture, pin outs-Functional building blocks of processor-Memory organization-I/O ports and data transfer concepts-Timing Diagram-Interrupt structure.

UNIT II **10 Hours**

PROGRAMMING OF 8085 PROCESSOR

Instruction format and Addressing modes-Assembly language format-Data transfer, data manipulation & control instructions-Programming: Loop structure with counting & Indexing-Look up table-Subroutine instructions-stack.

UNIT III **9 Hours**

PERIPHERAL INTERFACING

Study of Architecture and programming of ICs: 8255 PPI, 8259 PIC, 8251 USART, 8279 Key board display controller and 8253 Timer/Counter-Interfacing with 8085-A/D and D/A converter interfacing.

UNIT IV **7 Hours**

8051 MICROCONTROLLER

Hardware Architecture, pin outs-Functional block diagram- Instruction format and addressing modes-Interrupt structure- Timer-I/O ports-Serial communication.

UNIT V **10 Hours**

MICROCONTROLLER PROGRAMMING

Data Transfer, Manipulation, Control & I/O instructions -Simple programming exercises-key board and display interface -Closed loop control of servo motor- stepper motor control- Washing Machine Control.

FOR FURTHER READING

P16F877 Architecture and instruction set, PIC Microcontroller - Peripherals.

Total: 45 Hours

Reference(s)

1. Ramesh S. Gaonkar,Microprocessor Architecture Programming and Applications with the 8085, Penram International Publishing Pvt. Ltd., Mumbai, sixth edition, 2013.
2. Krishna Kant, Microprocessor and Microcontrollers, Prentice Hall of India, New Delhi, 2007.
3. Muhammad Ali Mazidi & Janice Gilli Mazidi, R.D.Kinely The 8051 Micro Controller and Embedded Systems, PHI Pearson Education, 2009.
4. N.Senthil Kumar, M.Saravanan, S.Jeevananthan, Microprocessors and Microcontrollers, Oxford, 2013.
5. Soumitra Kumar Mandal, 'Microprocessor & Microcontroller Architecture, Programming & Interfacing using 8085, 8086, 8051', McGraw Hill Edu, 2013.
6. J. B. Gupta, A Course in Electronic and Electrical Measurements, S. K. Kataria & Sons, Delhi, 2008

Assessment Pattern

Unit/RBT	Remember				Understand				Apply				Analyse				Evaluate				Create				Total
	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	
1	2					2					6				4				6						20
2	4					4				2				6					4						20
3	2				10					4					4										20
4	4					5				5					6										20
5	4					4				12															20
																								Total	100

Assessment Questions

Remember

1. Define microprocessor.
2. List the five addressing modes of 8085 microprocessors.
3. Recall the classifications of 8051 instruction set.
4. List the four types of memories used in microprocessor.
5. Recall registers organization of 8085.
6. Recall the number and names of various peripherals of 8085 microprocessor.
7. Define T state, machine cycle and instruction cycle.
8. List the three buses of a microprocessor.
9. State the significance of RESETIN & RESETOUT signals in 8085.
10. Recall the registers present in 8085. Recall the pins on the chip 8085 which can be grouped into 6 groups.
11. List any four arithmetic instructions of 8085.
12. Define maskable and non-maskable interrupts.
13. Define conditional and un-conditional branch instructions.
14. Define interrupt.
15. Recall various constituents in Interrupt vector table.

Understand

1. Indicate the five flag bits of 8085.
2. Compare memory mapped I/O devices and I/O mapped memory devices.
3. Identify the function of instruction queue in 8085.
4. Illustrate the block diagrams of 8085 microprocessor.
5. Explain the branch instructions in 8085
6. Explain Interrupt service routine of 8085.
7. Compare addressing modes of 8085 and 8051.

8. Formulate the process control instructions of microprocessor.
9. Explain various pin attributes of 8085
10. Compare POP and PUSH, Wait and Halt instructions.

Apply

1. Use timing diagram to calculate the time required to execute MOV A,B.
2. Use rotate instruction for multiplication operation.
3. Compute the timing states of SIM and RIM instructions.
4. Demonstrate the position of SP after the pop instruction.
5. Construct the 2 K memory with flip flops in 8085.
6. Use the read and write cycles to any given instruction.
7. Show the 5 types of interrupts in 8085 in terms of priority.
8. Demonstrate I/O read and I/O write cylices for a given instruction
9. Assess the conditional and unconditional jump instructions in 8085.
10. Use various addressing modes and write a program for addition of two numbers.
11. Multiply two given numbers without using MUL instruction.
12. Demonstrate the utility of external memory in microprocessors.
13. Show the various types of DMA transfer.
14. Use the processor to convert hex code to decimal code

Analyse

1. Compare Clock generation, Reset generation & synchronization,
2. Justify why PPI is required for interfacing of RAM and EPROM memories in 8085.
3. Contrast the PSW of 8085 and 8051 in terms of bit position.
4. Compare push and pop instruction in 8085.
5. Compare NOP and HALT instructions
6. Contrast the rotate instruction in 8085 and 8051.
7. Justify the importance of interrupts in 8085.
8. Compare memory mapped and I/O mapped memories.
9. Justify the importance of interrupts in 8085.

Create

1. Generate an algorithm for identifying repeated data in a sequence.

15EE502 CONTROL SYSTEMS

3 2 0 4

Course Objectives

- To understand the basic concepts of open loop and closed loop control systems.
- To analyse the system in time domain and frequency domain.
- To design the compensator for different systems.

Programme Outcomes (POs)

a. **Engineering Knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

b. **Problem Analysis:** Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

c. **Design/ Development of Solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for thepublic health and safety, and the cultural, societal, and environmental considerations.

d. **Conduct Investigations of Complex Problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

Course Outcomes (COs)

1. Develop a mathematical model of a physical system and compute the transfer function using Block diagram reduction technique and Signal flow graph.
2. Analyze the performance of first and second order system and compute the steady state error for different test signals.
3. Analyze the frequency response of an electrical system and determine the phase margin and gain margin using bode plot and polar plot.
4. Examine the stability of an electrical system using various techniques.
5. Design a lag lead and lag lead compensator for open loop system and examine a system using state variable techniques.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3	3											3	
2	3	3											3	
3	3	3		1									3	
4	3	3		1									3	
5	3	3	1	1									3	3

UNIT I **10 Hours**

MATHEMATICAL MODEL OF PHYSICAL SYSTEMS

Open loop and closed loop system - Elements of Control system - Transfer function of mechanical translational and rotational system, electrical system - Electrical analogy of mechanical system - Block diagram reduction technique - Signal flow graph.

UNIT II **8 Hours**

TIME DOMAIN ANALYSIS

Standard test signals - Time response of first order and second order systems for different standard test signals - Time domain specifications - Static error constants - Generalized error series - steady state error - Dominant poles of transfer functions.

UNIT III **10 Hours**

FREQUENCY DOMAIN ANALYSIS

Frequency response of systems - Frequency domain specifications - Correlation between frequency domain and time domain specifications - Bode plot , Polar plot, Constant M an N circles, Nichols chart.

UNIT IV **9 Hours**

STABILITY ANALYSIS OF CONTROL SYSTEM.

Concepts of stability - Characteristics equation - Location of roots in S plane for stability - Routh Hurwitz criterion - Root Locus technique - Nyquist stability criterion.

UNIT V **8 Hours**

COMPENSATOR DESIGN

Compensators, Deign of Lag compensator - Lead compensator - Lag-lead compensator (using Bode plot) - Concept of state variable, Controllability and Observability.

FOR FURTHER READING

Design of P, PI PD and PID controllers.

Total: 75 Hours

Reference(s)

1. M.Gopal, Control System Principles and Design,TataMcGraw-Hill,2012.
2. K.Ogatta, Modern Control Engineering, Pearson Education, NewDelhi, 2010.
3. S.Palani, Control System Engg, TataMcGraw-Hill, 2009.
4. I.J.Nagrath and M.Gopal, Control System Engineering, NewAge International Publisher,2007.
5. BenjaminC. Kuo, Automatic Control Systems, Prentice-Hall of India Pvt. Ltd.2003.
6. M.N.Bandyopadhyay, Control Engineering Theory and Practice, Prentice Hall of India,2005

Assessment Pattern

Unit/RBT	Remember				Understand				Apply				Analyse				Evaluate				Create				Total
	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	
1	2					2					6				4				6						20
2	4					4				2				6					4						20
3	2				4					10					4										20
4	4					4				6					6										20
5	4					4				12															20
																								Total	100

Assessment Questions

Remember

1. Define control system.
2. List the types of system.
3. Define the transferfunction of a system.
4. Define the transferfunction of a system.
5. State the rule for shifting the take off point a head of the block.
6. State the rule for shifting the summing point after the block.
7. State Mason's gain formula.
8. List the types of friction sen counter edin physicalsystem.
9. Define settlingtime of a second order system with relevant equation.
10. Define peakovershoot of a second order system.
11. Define risetime and delay time of a second order system

Understand

1. Show the block diagram and signal flow graph for armature controlled DC motor.
2. Show the block diagram and signal flow graph for field controlled DC motor.
3. Derive the response of critically damped second order system with unit step input.
4. Explain the different types of controllers.
5. Give the disadvantages of static error constants.
6. Explain the step by step procedure to obtain the bode plot.
7. Explain the magnitude plot and phase plot of the polar plot.
8. Compare routh Hurvitz and Root locus.
9. Classify the second order system depance on damping ratio.
10. Compare lag,lead and lag-lead compensators

Apply

1. A unity feedback control system has an open loop transfer function, G(s)=10/(s(s+2)) Find the rise time, peak time, peak overshoot and settling time for a step input of 12units
2. Calculate the generalized error coefficients and steady state error for G(s) =1/(s(s+1)(s+10)). &H(s)= s+2 with input r(t)= 6+t+t2
3. Calculate the time domain specifications for the damping ratio=0.6 and natural frequency = 5rad/sec
4. Sketch the polar plot of the transfer function and determine whether the plot crosses the real axis. If so, determine the frequency at which the plot cross the real axis and corresponding magnitude G(j). Determine the phase margin and gain margin for the same G(S)= 1/(s(1+s)(1+2s)) .
5. Sketch the bode plot of the transfer function and determine the system gain K for the gain cross over frequency to be 5rad/sec. G(s) = Ks/((1+0.2s)(1+0.02s))
6. Compute the transfer function of mechanical systems.
7. Compute the transfer function of electrical systems.
8. Compute the response of under damped and over damped second order system with unit step input.

Analyse

1. Compare the open loop system and closed loop system.
2. Compare the bode plot and polar plot
3. for the given block diagram how transfer function is obtained
4. for the given signal flow graph how transfer function is obtained.
5. Compare time domain and frequency domain specifications.
6. Compare P, PI and PID controllers

Create

1. Design and simulate the lag lead compensator using MATLAB.
2. Demonstrate one mechanical translational system and obtain the transfer function using signal flow graph.

15EE503 POWER SYSTEM ANALYSIS

3 2 0 4

Course Objectives

- To understand the concept of per unit systems and reactance diagrams
- To compare the methods of load flow solution.
- To understand power system stability.

Programme Outcomes (POs)

a. **Engineering Knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

e. **Modern Tool Usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

Course Outcomes (COs)

1. Apply the concept of per unit systems and reactance diagrams to load flow studies.
2. Evaluate the power flow and losses in a power system network using non-linear iterative solution methods.

3. Apply the concepts of Bus impedance matrix, reactance diagrams and symmetrical components to predict the short circuit behavior of power system network
4. Prepare a commitment and decommitment algorithm for the generating units in a network based on their operating cost
5. Evaluate the stability of the power system during steady and transient operations

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3												3	
2	3				2								3	
3	3				2								3	
4	3				2								3	
5	3												3	

UNIT I **9 Hours**

POWER SYSTEM MODELING

Single line diagrams -Per unit system -Per unit impedance/ reactance diagrams -Formation of network matrices - Y bus formation using inspection and singular transformation -Z bus formation using step-by-step building algorithm method.

UNIT II **8 Hours**

LOAD FLOW ANALYSIS

Load flow equations and methods of solution -Slack bus concept -Gauss Seidal, Newton Raphson, Fast decoupled methods for load flow studies.

UNIT III **11 Hours**

FAULT ANALYSIS

Types of faults -Balanced three phase fault -Circuit transients and short circuit capacity -Systematic fault analysis using bus impedance matrix.Fundamentals of symmetrical components -Sequence impedances -Sequence networks -Unbalanced faults - Single line to ground fault -Line fault-Double line to ground fault.

UNIT IV **8 Hours**

UNIT COMMITMENT

Statement of Unit Commitment (UC) problem; constraints in UC: spinning reserve, thermal unit constraints, hydro constraints, fuel constraints and other constraints; UC solution methods: Priority-list methods, forward dynamic programming approach, numerical problems only in priority-list method using full-load average production cost

UNIT V **9 Hours**

POWER SYSTEM STABILITY

Steady state and transient stability -Swing equation and its solution method (step by step) -Multimachine system-Equal area criterion -Factors affecting stability and methods of improving stability.

FOR FURTHER READING

Overview of Indian power scenario- Electricity Deregulation-Captive Power Plants

Total: 75 Hours

Reference(s)

1. I.J. Nagarath, D.P. Kothari, Modern Power System Analysis, Tata McGraw Hill Publishing Company, New Delhi,2013.
2. Abhijit Chakrabarti Sunita Halder Power System Analysis Operation and control, PHI Learning New delhi, 2015.
3. Hadi Saadat, Power System Analysis, PSA Publishers, New Delhi, 2013.
4. P.Kundur, Power System Stability and Control, Tata McGraw Hill Book Company, New Delhi, 2013.
5. John Grainger, William Stevenson JR, Power System Analysis, Mcgraw-Hill Series in Electrical and Computer Engineering, New Delhi, 2014.
6. Charles A. Gross, Power System Analysis, Wiley India Pvt Ltd, Second edition, 2010.

Assessment Pattern

Unit/RBT	**Remember**				**Understand**				**Apply**				**Analyse**				**Evaluate**				**Create**				**Total**
	F	**C**	**P**	**M**	**F**	**C**	**P**	**M**	**F**	**C**	**P**	**M**	**F**	**C**	**P**	**M**	**F**	**C**	**P**	**M**	**F**	**C**	**P**	**M**	
1		2			2						10											6			20
2	2					6					12														20
3						4					12				4										20
4		6				14																			20
5						4					12				4										20
																								Total	100

Assessment Questions

Remember

1. Define per unit values.
2. State the need for base values.
3. Recall the advantages of per unit computations.
4. List the two types of network matrices
5. List the types of buses.
6. List three types of unsymmetrical faults
7. Recall the equation for FAPC.
8. Define steady state stability limit
9. Define transient stability limit
10. Recall the load flow equations
11. Represent the economic operating point of a lossless system using the incremental cost.

Understand

1. Identify the differences between YBus and ZBus
2. Illustrate the zero sequence network of a synchronous machine.
3. Indicate the difference between half line charging admittance and line charging admittance.
4. Identify the reason for the statement “Ybus is a sparse matrix”.
5. Indicate the purpose of eliminating reference node.
6. Formulate an equation to compute off- diagonal elements of the Jacobian 1 in Newton Raphson method
7. Identify the magnitude of neutral current in an unbalanced system
8. Represent the power flow equation of a transmission line using voltage at two ends of the considered line.
9. "Delta windings of the transformers are trap for zero sequence components". Justify the above statement.
10. “In a floating system the zero sequence components will not flow”, Infer the reason behind this statement.

Apply

1. A three-phase generator with rating 1000kVA, 33kV has its armature resistance and synchronous reactance 20 ohm/phase and 70 ohm/ phase. Calculate p.u. impedance of the generator.
2. A three-phase, delta-star transformer with rating 100kVA, and 11kV/400V has its primary and secondary Leakage reactance as 12 ohm/phase and 0.05 ohm/phase respectively. Compute the p.u. reactance of transformer.
3. A 120 MVA, 19.5 kV generator has a synchronous reactance of 0.15 p.u. and it is connected to a transmission line through a transformer rated 150MVA, 230/18kV (star/delta) with X=0.1 p.u. Construct the reactance diagram by taking generator rating as base values.
4. A three-phase generator with rating 1000kVA, 33kV has its armature resistance and synchronous reactance as 20 ohm/phase and 70 ohm/ phase. Compute the p.u. impedanceÂ of the generator.
5. A 20 MVA, 11 kV generator has a synchronous reactance of 0.15 p.u. and it is connected to a transmission line through a transformer rated 25 MVA, 230/18kV (star/delta) with X=0.1 p.u. Compute the p.u reactance of the generator by taking transformer rating as base values.

6. A 120 MVA, 19.5 kV generator has a synchronous reactance of 0.15 p.u. and it is connected to a transmission line through a transformer rated 150MVA, 230/18kV (star/delta) with X=0.1 p.u. Compute the p.u. reactances for a base value of 100 mVA and 220 kV on HT sideÂ of transformer.
7. A synchronous generator of reactance 1.20 Pu is connected to an infinite bus bar (|V|=1.0pu) through transformers and a line of total reactance of 0.6 Pu. The generator no load voltage is 1.20pu and its inertia constant is H= 4MW-s/MVA. The resistance and machine damping may be assumed negligible. The system frequency is 50Hz. Calculate the frequency of natural oscillations if the generator is 50% loaded.
   A set of three unbalanced voltages and currents resolved in two symmetrical components gave the results below. Construct the complex power vector.
   Va0=30 at 30 Va1 =450 at 0 Va2=225 at 40
   Ia0 = 10 at 190 Ia1= 6 at 20 Ia2 = 5 at -200
8. Predict the reason for the simplicity of FDLF algorithm over Newton Raphson method for Load flow calculations
9. A synchronous generator of reactance 1.01 Pu is connected to an infinite bus barÂ (|V|=1.03 pu) through transformers and a line of total reactance of 0.5 Pu. The generator no load voltage is 1.25 pu and its inertia constant is H= 4MW-s/MVA.The resistance and machine damping may be assumed negligible. The system frequency is 50Hz. Compute the frequency of natural oscillations if the generator is loaded to 80% of its rated value.

Analyse

1. Compare the merits and demerits of the three load flow solution methods.
2. Bus admittance matrix is a sparse matrix.Justify the statement.
3. Justify the reason for zero neutral current in a balanced network
4. Analyze the causes for the various faults occurring in power systems.
5. Criticise the need for symmetrical components to compute fault currents in an unbalanced system.

Evaluate

1. A 20 MVA, 50 Hz generator delivers 18 MW over a double circuit line to an infinite bus. The generator has a kinetic energy of 2.52 MJ/MVA at rated speed. The generator transient reactance is Xd' =0.35 pu. Each transmission circuit has R= 0 and a reactance 0f 0.2 pu on a 20MVA base. |E'| =1.1 pu and infinite bus voltage V=1.0. A three-phase short circuit occurs at the mid point of one of the transmission lines. Plot swing curves and Judge the stability of the above system
2. A 20 MVA, 50 Hz generator delivers 18 MW over a double circuit line to an infinite bus. The generator has kinetic energy of 2.52 MJ/MVA at rated speed. The generator transient reactance is Xd' =0.35 pu. Each transmission circuit has R= 0 and a reactance 0f 0.2 pu on a 20MVA base. |E'| =1.1 pu and infinite bus voltage V=1.0. A three-phase short circuit occurs

at the mid point of one of the transmission lines. Plot swing curves assuming that the fault cleared bysimultaneous opening of breakers at both ends of the line at 2.5 cycles and 6.25 cycles after the occurrence of fault. Criticise the stability of the system.

3. Judge the necessity to compute neutral current magnitude in a system.
4. Choose a suitable method to compute economic load dispatch schedule in a small lossless system.
5. Defend the importance of Unit Commitment Schedule.

Create

1. Compose a commitment chart for a power system network with the following charecteristics H1= 510.0+7.2P1+0.00142P12 Mbtu/hr ; fuel cost = 1.1Rs/Mbtu Min=150MW ; Max=600 (Diesel Gen Set) H2 =310.0+7.85P2+0.00194P22Mbtu/hr; fuel cost = 1.0Rs/Mbtu Min =100; Max = 400MW (Waste to Energy Plant) H3 = 78.0+ 7.97P3+0.00482P32 Mbtu/hr; fuel cost = 1.2 Rs/Mbtu
   Min = 50MW;Max = 200MW (Thermal Plant)
2. Generate an algorithm to determine bus admitttance matrix of an n bus system.

15EE504 POWER ELECTRONICS

3 0 0 3

Course Objectives

- To analyze the static and switching characteristics of power semi-conductor devices.
- To evaluate the operation, characteristics and performance parameters of controlled rectifiers, Inverters and AC-AC converters.
- To apply different switching techniques to various topologies of DC-DC converters.

Programme Outcomes (POs)

a. **Engineering Knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. **Problem Analysis:** Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
c. **Design/ Development of Solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for thepublic health and safety, and the cultural, societal, and environmental considerations.
d. **Conduct Investigations of Complex Problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

Course Outcomes (COs)

1. Examine the static and dynamic characteristics of power semiconductor devices and its protection circuits.
2. Evaluate the input and output parameters of controlled rectifiers with R,RL and RLE Load.
3. Apply the various converter topologies to design and analyze the switched mode regulators
4. Analyze the operation of inverter topologies with different PWM schemes.
5. Analyze the performance parameters of AC- AC converters

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2			1									1	
2	2	3	2	1									3	
3	3	2	2	1									3	1
4	2	2	3	1									3	1
5	2	3	2	1									3	1

UNIT I **8 Hours**

POWER SEMI-CONDUCTOR DEVICES

Construction, Operation, Switching characteristics of Power semiconductor devices -Diode -transistor -SCR- DIAC - TRIAC -MOSFET - IGBT -Ratings of power switches -Protection of power switches-Heat sinks and mountings.

UNIT II **11 Hours**

CONTROLLED RECTIFIERS

Single Phase and Three phase half and fully controlled rectifier with R, RL, RLE Load -Analysis of input performance parameters-Power factor correction rectifiers- Dual converter- Triggering circuits for controlled rectifiers.

UNIT III **8 Hours**

CHOPPERS

Types -control strategies - buck, boost, buck boost, Cuk - SEPIC Converter - Performance analysis - PWM generation circuits for choppers- Switched mode regulators - Applications.

UNIT IV **10 Hours**

INVERTERS

Single phase and three phase voltage source inverters - Performance analysis -Sinusoidal PWM and Space vector PWM schemes -Single phase and three phase current source inverters - Multilevel inverters.

UNIT V **8 Hours**

AC-AC CONVERTERS

Performance analysis of Single phase and three phase AC voltage controllers - Single phase and three phase Cycloconverters - Matrix converters.

FOR FURTHER READING

IGCT, MCT, GTO- Boost Rectifiers- Z-Source inverter

Total: 45 Hours

Reference(s)

1. Muhammad H.Rashid,Power Electronics Circuits, Devices & Applications, Prentice Hall of India New Delhi,2013.
2. NedMohan, Tore.M.Undeland, William.P.Robbins, Power Electronics: Converters, Applications and Design, WileyIndia, NewDelhi, 2011.
3. M.D.Singh & K.BKhanchandani. Power Electronics Tata Mc Graw Hill Publishing Co.Ltd., New Delhi,2008.

4. http://nptel.iitm.ac.in/courses/Webcoursecontents/IIT%20Kharagpur/Power%20Electronics/New_index1.html
5. Daniel.W.Hart, Power Electronics, Indian Edition, McGraw Hill, 3rd Print 2013.
6. P.S.Bimbra Power Electronics, Khanna Publishers, third Edition, 2003.

Assessment Pattern

Unit/RBT	Remember				Understand				Apply				Analyse				Evaluate				Create				Total
	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	
1	2					2					6				4				6						20
2	4					4				2				6					4						20
3	2				4					10					4										20
4	4					4				6					6										20
5	4					4				12															20
																								Total	100

Assessment Questions

Remember

1. Define rectification and inversion.
2. Define commutation.
3. List the disadvantages of power converters.
4. Define firing angle of SCR
5. List the advantage and disadvantage of PWM control.
6. State the applications of UPS.
7. List the different types of PWM control.
8. Define Cycloconverter. Give its applications.
9. Define ac voltage regulator and give its applications.
10. List the classification of Cycloconverter.

Understand

1. Explain the switching characteristics of MOSFET.
2. Describe the structure of a TRIAC with relevant diagram and symbol .
3. Explain the need of series and parallel operation of SCRs. Also explain their operation with V-I Characteristics and string efficiency.
4. Explain the construction and operation of SCR. Also explain V-I characteristics.
5. Explain the construction and operation of IGBT and explain V-I characteristics.
6. Explain the operation of single phase dual converter.
7. Explain the operation of single phase semiconverter and derive expressions for its average and rms output voltages.
8. For a single phase uncontrolled rectifier feeding a resistive load, draw theÂ waveforms of source voltage and output voltage Describe the working withÂ reference to waveforms drawn.
9. Explain the operation of single phase half controlled rectifier with R load.
10. Explain the principle of basic chopper circuit with relevant voltage and Â current waveforms. Also explain the various control strategies used to get Â the variation in the output voltage.

Apply

1. Compute the Average output Voltage and RMS output voltage of Single phase fully controlled converter.
2. A single-phase fullconverter is supplied from 230V, 50Hz, The load consists of R=10 ohm and a large Inductances or enter the load current constant. For a firing angle delay300 compute the average output voltage
   (2) Average output current
   (3) Average and rms values of thyristor currents
   (4)The power factor.

3. A single-phase fullconverter is supplied from 230V, 50Hz, The load consists of R=10 ohm and a large Inductances or ender the load current constant. For a firing angle delay300 compute the average output voltage.
4. A single-phase fullconverter is supplied from 230V, 50Hz, The loadconsists of R=10ï¿½?ï¿½ and a large Inductances or ender the load current constant. For a firing angle delay300 determine the average output current.
5. A single phase half controlled thyristor converter is connected toa load of a 5ï¿½?ï¿½ resistance,1H inductance and 10V emf. Compute the average load voltage and average load current assuming continuous current operation.
6. The full wave controlled bridge rectifier has an ac input of 120V rms at 60Hz and a 20 ohm load resistor. The delay angle is 400 Determine the average current in the loads,the power absorbed by the load and the input powerfactor.
7. A resistive load of 10 ohm is connected through a halfwave SCR circuit to 220V, 50Hz, single phase source. Calculate the power delivered to the load for a firing angle of 600 and also the value of input power factor.
8. A dc chopper is turned on for30µsec and off 10µsec. Compute the value of dutycycle
9. A dc chopper is turned on for30µsec and off 10µsec .Compute the value of choppingfrequency.
10. A single-phase fullconverter is supplied from 230V, 50Hz, Theloadconsists of R=10ohm and a large Inductances or enter the load current constant. For a firing angle delay300 determine average and rms valuesof thyristor currents.

Analyse

1. Compare 120° and180° modes of VSI
2. Distinguish between halfcontrolled and fullycontrolled converter circuits.
3. Compare VSI and CSI.
4. Compare single PWM over multiple pulse width modulation technique.
5. Compare SPWM over MPWM technique.
6. Compare SPWM over SVPWM technique.
7. Compare SVPWM over MSVPWM technique.
8. Evaluate the ability of state space nodel to evaluate the stability of the power conversion circuits

Evaluate

1. Generation of firing pulse for single inverter and converter.
2. Criticise the procedure to select the power switches for particular application.

Create

1. Derive the necessary condition for triggering an SCR.
2. Derive the necessary condition for triggering an SCR.
3. Design a snubber circuit for power converter

15EE507 MICROPROCESSOR BASED SYSTEM DESIGN LABORATORY

0 0 2 1

Course Objectives

- To develop skill in simple program writing for 8085 & 8051.
- To interface the input/output devices to 8085 & 8051.
- To perform simulation circuit for 8051 microcontroller.

Programme Outcomes (POs)

a. **Engineering Knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

c. **Design/ Development of Solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for thepublic health and safety, and the cultural, societal, and environmental considerations.

e. **Modern Tool Usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

Course Outcomes (COs)

1. Able to write programs on 8085 & 8051 for different applications.
2. Interface the input/output devices with 8085 & 8051.
3. Design a circuit using simulation software for various applications.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3		3										1	
2			3		1								2	1
3					1								3	

1 **4 Hours**

EXPERIMENT 1

Simple arithmetic operations:Addition / subtraction.

2 **4 Hours**

EXPERIMENT 2

Simple arithmetic operations:Multiplication / division.

3 **4 Hours**

EXPERIMENT 3

Programming with 8085 instructions:Ascending / Descending order.

4 **4 Hours**

EXPERIMENT 4

Programming with 8085 instructions:Maximum / Minimum of numbers.

5 **4 Hours**

EXPERIMENT 5

Programming with 8085 instructions:Hex / ASCII / BCD code conversions.

6 **2 Hours**

EXPERIMENT 6

Interface Experiment with 8085:A/D Interfacing.

7 **2 Hours**

EXPERIMENT 7

Interface Experiment with 8085:D/A Interfacing.

8 **2 Hours**

EXPERIMENT 8

Interface Experiment with 8085:Traffic light controller.

9 **2 Hours**

EXPERIMENT 9

Interface Experiment with 8085:Keyboard and Display.

10 **2 Hours**

EXPERIMENT 10

Interface Experiment with 8085:Timer.

Total: 30 Hours

Reference(s)

1. Ramesh S. Gaonkar, "Microprocessor Architecture Programming and Applications with the 8085", Penram International Publishing Pvt. Ltd., Mumbai, sixth edition, 2013.
2. Krishna Kant, "Microprocessor and Microcontrollers", Prentice Hall of India, New Delhi, 2007.
3. Muhammad Ali Mazidi & Janice Gilli Mazidi, R.D.Kinely "The 8051 Micro Controller and Embedded Systems", PHI Pearson Education, 2009.
4. N.Senthil Kumar, M.Saravanan, S.Jeevananthan, "Microprocessors and Microcontrollers", Oxford, 2013.
5. Soumitra Kumar Mandal, "Microprocessor & Microcontroller Architecture, Programming & Interfacing using 8085, 8086, 8051", McGraw Hill Edu, 2013.

15EE508 CONTROL SYSTEMS LABORATORY

0 0 2 1

Course Objectives

- To acquire software development skills and experience in the usage of standard packages necessary for analysis.
- To knowledge about simulation of control system required for its planning, operation and control.

Programme Outcomes (POs)

c. **Design/ Development of Solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for thepublic health and safety, and the cultural, societal, and environmental considerations.

d. **Conduct Investigations of Complex Problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

e. **Modern Tool Usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

Course Outcomes (COs)

1. Determine transfer functions of DC and AC servo motors.
2. Analyse time and frequency response of linear and nonlinear systems.
3. Design and simulate the controllers and compensators.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1			2										3	2
2				1	1								2	
3			3										3	

1 **4 Hours**

EXPERIMENT 1

Analyse the first order system using step, ramp and impulse inputs.

2 **2 Hours**

EXPERIMENT 2

Study of poles and zeros in open loop system.

3 **4 Hours**

EXPERIMENT 3

Develop a transfer function of DC servo motor and analyze the stability using Polar plot.

4 **4 Hours**

EXPERIMENT 4

Develop a state model for given circuit and analyze the stability using Bode plot and Root locus

5 **2 Hours**

EXPERIMENT 5

Realization of transfer function using op-amp

6 **4 Hours**

EXPERIMENT 6

Compensator design and realize using op-amp

7 **4 Hours**

EXPERIMENT 7

Design and experimental verification of P, PI and PID controllers

8 **2 Hours**

EXPERIMENT 8

Experimental verification of inner current and outer speed feedback control systems for induction motor speed control

9 **2 Hours**

EXPERIMENT 9

Design and implementation of closed loop control system for speed control of PMDC motor

10 **2 Hours**

EXPERIMENT 10

Study and experimental verification of Programmable Logic Controller

Total: 30 Hours

Reference(s)

1. M.Gopal, "Control System Principles and Design", TataMcGraw-Hill,2012.
2. K.Ogatta, Modern Control Engineering, Pearson Education, NewDelhi, 2010.
3. S.Palani, Control System Engg, TataMcGraw-Hill, 2009.
4. I.J.Nagrath and M.Gopal, Control System Engineering, NewAge International Publisher,2007.

15EE510 MINI PROJECT III **0 0 2 1**

Programme Outcomes (POs)

a.**Engineering Knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

b. **Problem Analysis:** Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

c. **Design/ Development of Solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
d. **Conduct Investigations of Complex Problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
e. **Modern Tool Usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
f. **The Engineer and Society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
g. **Environment and Sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
h**. Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
i. **Individual and Team Work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
j. **Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
k. **Project Management and Finance**: Demonstrate knowledge and understanding of the engineering and management principles and apply these to oneÃ¢??s own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
l. **Life-long Learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Course Outcomes (COs)

1. Formulate a real world problem, identify the requirement and develop the design solutions.
2. Identify technical ideas, strategies and methodologies.
3. Utilize the new tools, algorithms, techniques that contribute to obtain the solution of the project.
4. Test and validate through conformance of the developed prototype and analysis the cost effectiveness.
5. Prepare report and present oral demonstrations

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	-	3	2			2	1						3	1
2	2	2	1	3		2					2	2	2	
3			3	2	2			2			2	2	3	
4		1		2	3	1	2	2					1	3
5									3	3	-	2		3

Total: 15 Hours

15GE511 LIFE SKILLS: APTITUDE I 0 0 2 0

Course Objectives

- To expose the undergraduate students to such methods and practices that help, develop and nurture qualities such as character, effective communication, aptitude and holding ethical values.

Programme Outcomes (POs)

a. **Engineering Knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems

Course Outcomes (COs)

1. Distinguish the pattern of coding and decoding.
2. Demonstrate various principles involved in solving mathematical problems and thereby reducing the time taken for performing job functions
3. Evaluate critically the real life situations by resorting and analyzing analytical reasoning of key issues and factors
4. Calculate the percentages and averages

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2												1	
2	2												2	
3	2												3	
4	2												2	

1 **3 Hours**

CODING AND DECODING

Introduction - Description of Coding method - Coding patterns - Concepts of Coding and Decoding - Problems involving Coding and Decoding methods

2 **3 Hours**

SEQUENCE AND SERIES

Introduction - Sequences of real numbers - Number and Alphabet series - Description of Number and Alphabet series - Analogy - Odd man out- Power series

3 **3 Hours**

DATA SUFFICIENCY

Introduction to Data Sufficiency - Overview of the wide variety of Data Sufficiency problems - Basic introduction on how to determine what information is sufficient to solve a given problem - Common pitfalls to avoid

4 **3 Hours**

DIRECTION

Introduction to Direction - sense test - Overview of the wide variety of Direction problems -Direction - Plotting diagrams

5 **3 Hours**

PROBLEM ON AGES

Introduction- basic concept - usage of percentage and averages- applications

6 **3 Hours**

ANALYTICAL REASONING

Introduction - basic concept - non verbal analytical reasoning - arrangements

7 **3 Hours**

BLOOD RELATION

Introduction - Basic concept - Kinds of relation - Tree diagram - Relations

8 **3 Hours**

BLOOD RELATION

Introduction -Basic concept - Kinds of relation - Tree diagram - Relations

9 **3 Hours**

VISUAL REASONING

Introduction - Basic concepts - Odd man out - Next series - Mirror image and water image

10 **3 Hours**

SIMPLIFICATIONS

Introduction - Basic concepts - Arithmetic operations -Equation solving methods - Puzzles

Total: 30 Hours

Reference(s)

1. Abhijit Guha, Quantitative Aptitude for Competitive Examinations, Fourth Edition, Tata McGraw-Hill Publishing Company Ltd, 2012
2. Arun Sharma, How to prepare for Data Interpretation for the CAT, First Edition, Tata McGraw-Hill Publishing Company Ltd, 2012.
3. Dr.R S Aggarwal, Quantitative Aptitude, Seventh Revised Edition, S.Chand Publishing Company Ltd, 2013.
4. Edgar Thorpe , Course In Mental Ability And Quantitative Aptitude For Competitive Examinations, Third Edition, Tata McGraw-Hill Publishing Company Ltd, 2013.
5. Arun Sharma, How to prepare for Quantitative Aptitude for the CAT, Fifth Edition, Tata McGraw-Hill Publishing Company Ltd, 2013

15GE701 ENGINEERING ECONOMICS

3 0 0 3

Course Objectives

- To introduce the concepts of micro, macro economic systems and business decisions in organizations.
- To acquire knowledge on laws of demand & supply and methods of forecasting the demand
- To emphasis the systematic evaluation of the costs, breakeven point for return on economics and diseconomies
- To acquaint in pricing methods, payback and competition in modern market structure
- To obtain knowledge on macro economics, various taxes and financial accounting procedures

Programme Outcomes (POs)

f. **The Engineer and Society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

g. **Environment and Sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

k. **Project Management and Finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplin

l. **Life-long Learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Course Outcomes (COs)

1. Explain the micro economic environment for creating a favourable business environment.
2. Make use of the major concepts and techniques of engineering economic analysis in real time applications.
3. Compare the cost of multiple projects by using the methods learned, and make a quantitative decision between alternate facilities and/or systems.
4. Apply the appropriate engineering economics analysis method(s) for problem solving: present worth, annual cost, rate-of-return, payback, break-even, benefit-cost ratio.
5. Examine and evaluate the issues in macro-economic analysis.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1						2	2						1	
2											3	2	2	1
3						2	2				2	2	3	
4						2	2				3	2	2	
5						2	2				2	2	1	

UNIT I **9 Hours**

INTRODUCTION

Introduction to Micro and Macro economics - Kinds of Economic Systems - Production Possibility Frontier - Opportunity Cost - Objective of Organizations - Kinds of Organization.

UNIT II **9 Hours**

DEMAND AND SUPPLY

Functions of Demand and Supply - Law of diminishing Marginal Utility - Law of Demand and Supply - Elasticity of Demand - Demand Forecasting Methods - Indifference curve.

UNIT III **9 Hours**

PRODUCTION AND COST

Production Function - Returns to Scale - Law of Variable Proportion - Cost and Revenue concepts and Cost Curves - Revenue curves - Economies and Dis-economies of scale - Break Even point.

UNIT IV **9 Hours**

MARKET STRUCTURE

Market Structure - Perfect Competition - Monopoly - Monopolistic - Oligopoly - Components of Pricing - Methods of Pricing - Capital Budgeting IRR - ARR - NPV - Return on Investment - Payback Period.

UNIT V **9 Hours**

INTRODUCTION TO MACRO ECONOMICS AND FINANCIAL ACCOUNTING

National Income - Calculation Methods - Problems - Inflation - Deflation - Business Cycle - Taxes - Direct and Indirect Taxes - Fiscal and monetary policies.

FOR FURTHER READING

Nature and characteristics of Indian Economy - Role and functions of Central bank - LPG - GATT - WTO.

Total: 45 Hours

Reference(s)

1. A Ramachandra Aryasri and V V Ramana Murthy, Engineering Economics and Financial Accounting, Tata McGraw Hill Publishing Company Limited, New Delhi, 2006.
2. V L Samuel Paul and G S Gupta,Managerial Economics Concepts and Cases, Tata McGraw Hill Publishing Company Limited, New Delhi, 1981.
3. R Kesavan, C Elanchezhian and T Sunder Selwyn, Engineering Economics and Financial Accounting, Laxmi Publication (P) Ltd, New Delhi, 2005.
4. S N Maheswari, Financial and Management Accounting, Sultan Chand
5. V L Samuel Paul and G S Gupta, Managerial Economics-Concepts and Cases

Assessment Pattern

Unit/RBT	Remember				Understand				Apply				Analyse				Evaluate				Create				Total
	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	
1	2					2					8			6											18
2		2					2			8					6				4						22
3			2			2				8								4							16
4	2						2		8						6				4						22
5		2				2				8				6				4							22
																								Total	100

Assessment Questions

Remember

1. Define Economics
2. What is opportunity cost?
3. List the types of Demand.
4. State the law of Demand.
5. Define Elasticity of Demand.
6. State the different degrees of elasticity of Demand?
7. List the factors determining Elasticity of Demand?
8. State the Law Of Diminishing Marginal Utility.
9. Define Replacement Cost and Historic Cost
10. Define Monopoly.
11. Define Oligopoly
12. Name the two types of Oligopoly.

13. List the objectives of Pricing?
14. Define Accounting
15. Define inflation

Understand

1. Explain the nature and scope of Economics.
2. List and explain the focus areas of Managerial economics.
3. Give reasons why mangers aim to maximize sales even at the cost of a lower profit.
4. Explain the nature of Demand.
5. What are the assumptions made when talking about the Law of Diminishing Marginal Utility?
6. Explain the characteristics of the Indifference Curve with examples
7. Can Demand Forecasting principles be applied to Services? Substantiate your answer with an example
8. What are the characteristic features of an oligopoly industry?
9. What causes Oligopoly?
10. Explain the types and features of Cost Based Pricing.
11. Explain the types and features of Demand Based Pricing.
12. Under what conditions does a company go in for Cross Subsidization pricing?
13. What is the role of the Central bank in controlling inflation?

Apply

1. Explain decisions based on the degree of certainty of the outcome with examples.
2. Give examples of products falling under the various kinds of competition, and the reasons they are able to survive in the market.
3. Give six examples of products that fall under Monopolistic Competitive pricing.
4. Give six examples of products that fall under Oligopolistic pricing
5. Pick any six Consumer Items and based on your knowledge of the markets, explain the pricing method that you think is most likely to have been followed for each of these items.

Analyse

1. Differentiate between Macro and Micro economics
2. Differentiate between Extension and Increase in Demand.
3. Distinguish between Cost and Price
4. Compare the merits and demerits of the Deductive Method and the Inductive Method of Investigation
5. The per-capita income of farmers in the country has to be raised by 20% this year to prevent their migration to cities. Discuss this statement from the point of view of Positive and Normative Economics.
6. Decision making improves with age and experience- Discuss.
7. Do a survey of the automotive (only cars) industry and analyze the reasons and timing for discounts offered from the point of view of elasticity of demand
8. How would you modify a sealed bid pricing system to take care of different technical approaches by different bidders for a project for which bids are called for, given that the cost varies depending on the technical approach?

Create

1. Create a matrix consolidating the definitions of the word ï¿½??Economics as defined by the leading Economists in the prescribed textbook. Using this define economics the way you understand it, in less than 50 words.
2. Study the price of a commodity over a period of one year and explain the possible reasons for the fluctuations from an economist‘s point of view

3. You are in a job which is paying you adequately. You are called for an interview for a job that double your salary. Unfortunately you miss the only train that will take you in time for the interview. How will you justify the cost of taking a flight considering the cost concepts you have learnt.?
4. Due to cancellation of an export order, you are stuck with a huge stock of jeans of International quality. Device a pricing strategy for disposing this stock without incurring a loss, considering that it is a very competitive market.

15EE602 SOLID STATE DRIVES

3 0 0 3

Course Objectives

- Analyze the motor load dynamics and stability condition for electrical drives
- Explain the steady state and transient performances of dc drives.
- Analyze different speed control techniques and power conversion topologies for induction motor drives
- Apply the control techniques for synchronous motor drives.
- Apply suitable drives and control schemes for various industrial applications

Programme Outcomes (POs)

a. **Engineering Knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. **Problem Analysis:** Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
d. **Conduct Investigations of Complex Problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

Course Outcomes (COs)

1. Analyze the dynamic and stability conditions for electrical drives.
2. Explain the steady state and transient performances of dc drives.
3. Analyze different solid state speed control schemes for induction motor drives.
4. Apply the control techniques for synchronous motor drives.
5. Apply suitable drives and control schemes for various industrial applications

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3	2											2	
2	2	3		1									2	1
3	2	3		1									2	1
4	2	3											2	
5	1	2											1	2

UNIT I
FUNDAMENTALS OF ELECTRIC DRIVES 9 Hours
History and Development of Electric Drives - Drive classifications - Advantage of Electric Drives - Equations governing motor load dynamics - Equilibrium operating point and its steady state stability - Mathematical condition for steady state stability and problems - Torque-speed characteristics of motor and load - Multiquadrant operation.

UNIT II 8 Hours
CONVERTER / CHOPPER FED DC MOTOR DRIVE
DC motor and their performance - Braking - Steady state and transient analysis of the single and three phase fully controlled converter fed separately excited D.C motor drive - Continuous and discontinuous conduction mode - Chopper -fed separately excited D.C drive - Four Quadrant operation - Effect of ripples in dc motor performance.

UNIT III 11 Hours
INDUCTION MOTOR DRIVES
Analysis and performance of three-phase induction motor - Stator voltage - stator frequency control - variable frequency operation - V/F control, controlled current and controlled slip operation - PWM inverter drives - Voltage Source Inverter, Current Source Inverter and cycloconverter fed induction motor drives - Rotor control - Rotor resistance control and slip power recovery schemes.

UNIT IV 9 Hours
SYNCHRONOUS MOTOR DRIVES
Adjustable frequency operation - Open loop v/f control - self controlled synchronous motor drive using load commutated thyristor inverter - self-control of CSI and VSI fed synchronous motor - Margin angle control and power factor control - Permanent magnet (PM) synchronous motor.

UNIT V 8 Hours
BLDC, STEPPER MOTOR DRIVES AND APPLICATIONS
Brushless DC motor drives and its applications - Variable reluctance and permanent magnet stepper motor Drives - Selection of drives and control schemes for steel rolling mills, paper mills,shipping - PLL, PID based control of drives.

FOR FURTHER READING
Modern trends in industrial drive, Microcomputer and PLC based control of drives - DC & AC servo drives - Hybrid drives.

Total: 45 Hours

Reference(s)

1. G.K.Dubey., Fundamental of Electrical Drives, Narosa publishing House, New Delhi 2002.
2. Vedam Subramanyan, Electric Drives: Concepts and Applications, Tata McGraw Hill Publishing Company, New Delhi, 2011.
3. J.M.D.Murphy and F.G. `Turnbull, Thyristor control of AC Motors, Pergamon Press, New Delhi 1988.
4. Krishan.R,'Permanent Magnet Synchronous and Brushless DC Motor Drives', CRC Press ,2010
5. Soumitra Kumar Mandal, "Microprocessor & Microcontroller Architecture, Programming & Interfacing using 8085, 8086, 8051", McGraw Hill Education, 2013.
6. P.S.Bimbra Power Electronics, Khanna Publishers, third Edition, 2003.

Assessment Pattern

Unit/RBT	Remember				Understand				Apply				Analyse				Evaluate				Create				Total
	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	
1	2					2					6				4				6						20
2	4					4				2				6					4						20
3	2				10					4					4										20
4	4					6				4					6										20
5	4					4				12															20
																								Total	100

Assessment Questions

Remember

1. Define electrical drives.
2. List the two types of control strategies in dc chopper?
3. Recall the conditions to be satisfied for the regenerative braking operation.
4. Label the 3 modes of region in the adjustable-frequency IM drives characteristics?
5. Recall the quadrants of induction motor operation in which plugging takes place.
6. List 2 advantages of load commutation over forced commutation of thyristor switches?
7. Define margin angle control of synchronous motor drive.
8. List any 2 application of brushless dc motor.
9. Define stepping angle.

Understand

1. Classify mechanical loads based on their speed torque characteristics
2. Illustrate the operation of a voltage source inverter fed synchronous motor in the true synchronous mode using a block diagram.
3. Explain the working of a wound field synchronous motor drive with brushless excitation.
4. Illustrate using suitable diagram , the static rotor resistance method of speed control of a three phase slip ring induction motor.
5. Explain with schematic diagram two methods of super synchronous speed control of slip ring induction motor under slip power recovery scheme.
6. Explain the operation of a single phase fully controlled converter fed separately excited DC motor with neat waveforms
7. Illustrate the motoring and regenerative braking operation in chopperÂ controlled separately excited dc motor using circuit diagram.
8. Compare DC drive and AC drive based on their characteristics.
9. Classify mechanical loads based on their classes of duty.
10. Explain the operation of the two quadrant chopper fed DC drive system
11. Summarize the working of a multi quadrant control of chopper fed DC series motor.

Apply

1. Construct the mathematical expression for steady state stability of equilibrium point for motor load dynamic system.
2. Differentiate constant and variable speed drives based on their performance.
3. Use the load hoisting mechanism to explain the multiquadrant operation of electric drive.
4. A 200V, 900rpm, 165A separately excited DC motor has an armature resistance of 0.06 Ω.It is fed from an single phase fully controlled converter with an AC source of 220V, 50HZ .Assuming continuous conduction, calculate Â a) firing angle for rated motor torque and 800rpm,b) Motor speed for α= 150º and rated torque.
5. The speed of a 125HP, 600V, 1500 rpm separately excited DC motor is fed by a three phase fully controlled converter. The converter is operated from a 3Φ, 415V and 50Hz supply. The

rated armature current of the motor is 150A and it is continuous. The motor parameters are: Ra= 0.044Ω, La=7.3mH,KaΦ=0.213V/rpm. Calculate the speed at firing angle α= 60º and also calculate the firing angle to obtain speed of 500 rpm at rated motor current.

6. Predict the causes forÂ poor input power factor in phase controlled DC drives?
7. A three phase 415V, 50Hz, 1440 rpm star connected wound rotor Â induction motor has the followingÂ Parameter 55 Ω, Xs=Xr'=1.8 Ω, Xm=42 Ω the motor is controlled by static rotor resistance control. Filter resistanceÂ Â is.04Ω and external resistance is chosen such that at 0.5, the break down torque is obtained at slip of a).Calculate the value of external resistance. b).Calculate the ∂ for speed of 960 rpm at 1.5 times the rated torque.c).calculate the speed for ∂=0.6 and 1.5 times the rated torque
8. A 440V, 50Hz,4pole ,star connected, 3Φ wound rotor induction motor has following parameters refered to the staor: Rs=0.25 Ω, R'r=.09Ω, Xs=0.45 Ω, Â X'r=0.47 Ω, stator to rotor turns ratio is 2. The motor speed is controlled by static scherbius drive for speed range of 15% below the synchronous speed.The maximum value firing angle is 165 º. Calculate transformer turns ratio,torque for a rotor current of 12A, speed of 800rpm and at α=140º,Rd=.01 Ω
9. Predict the control of speed when a current source inverter fed synchronous motor is controlled in its self controlled mode. Built a closed loop to regulate the speed in the above scheme.
10. Assess the performance of self control of synchronous motor fed from VSI and separately controlled synchronous motor fed from VSI.

Analyse

1. Check the breakdown torque of IM for variable frequency control when flux is maintained constant.
2. AnalyseÂ the electrical performance of the IM when frequency decreased or increased.
3. Compare the performance of CSI and VSI fed synchronousÂ motor drive.
4. Justify the reason that the three phase converter is better than single phase converter.
5. Justify theÂ need for power conversion in a drive.

Evaluate

1. Determine the Mathematical conditions for steady state stability and use the result to analyze the equilibrium points for different motor -load torque
2. Criticise the speed control of an induction motor by stator voltage control method using three phase voltage controller.
3. DetermineÂ the torque equation for wound field cylindrical rotor synchronous motor using an equivalent circuit.
4. A 3 phase 400 volt 50 Hz 6 pole star connected wound rotor synchronous motor has Zs=0+j2 ohms. Load torque proportional to speed2, is 340 NM at rated synchronous speed. The speed of the motor is lowered by keeping V/F constant maintain unity power factor by field control of the motor. For the motor operation at 600 rpm, determine
   i.Supply voltage
   ii.Armature current
   iii.Excitation angle
5. Judge the performance of induction motor when v/f method of speed control is employed.

Create

1. Design Time ratio and Current limit control strategy based chopper fed DC drives and obtain its steady state and transient response.
2. Generate the firing pulse to trigger the thyristor switches in voltage source inverter fedding induction motor.

15EE603 RENEWABLE ENERGY SOURCES

3 0 0 3

Course Objectives

- To understand the types and applications of various forms of renewable energy and its environmental impacts.
- To understand the technological basis for harnessing renewable energy sources.
- To study the environmental impacts of renewable energy sources.

Programme Outcomes (POs)

a. **Engineering Knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. **Problem Analysis:** Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
c. **Design/ Development of Solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for thepublic health and safety, and the cultural, societal, and environmental considerations.
f. **The Engineer and Society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
g. **Environment and Sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

Course Outcomes (COs)

1. Explain the Energy scenario and its impact on economic and social development.
2. Exemplify the solar energy system with the measurement techniques and factors affecting it.
3. Characterize the safety and environmental aspects of wind energy with its resource assessment and its types.
4. Classify the types of biomass energy systems and with its principle and conversion techniques.
5. Explain the benefits of hydropower, geothermal and fuel cell with its applications, principle and types.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	1	1				2	3						1	
2	1	2	2				1						2	
3	1	1	2			2	3						2	3
4	1	1				1	2						2	
5	1	1	2				3						1	3

8 Hours

UNIT I

INTRODUCTION

Worlds Energy Scenario - Global warming - Reserves of Energy Resources - Environmental Aspects of Energy Utilisation - Energy consumption in various sectors and its changing pattern - Renewable Energy Scenario in India and around the World - Role of energy in economic development and social transformation.

UNIT II **9 Hours**

SOLAR ENERGY

Solar Radiation - Measurements of Solar Radiation - Flat Plate and Concentrating Collectors - Solar heating and cooling techniques - Solar thermal plant - Solar Photo Voltaic - Solar Cells - factors affecting solar power generation - Solar PV Applications.

UNIT III **8 Hours**

WIND ENERGY

Wind Data and Energy Estimation - site selection - wind resource assessment - Types of Wind Energy Systems - factors influencing wind - wind shear - Safety and Environmental Aspects.

UNIT IV **10 Hours**

BIOMASS ENERGY

Biomass resources and their classification - biomass direct combustion-biomass gasifier - Biomass conversion processes - Biogas plants - Digesters - Ethanol production - Bio diesel - Cogeneration - Biomass Applications.

UNIT V **10 Hours**

OTHER RENEWABLE ENERGY SOURCES

Hydropower - site selection, construction, environmental issues - geothermal energy - site selection, and geothermal power plants. Hydrogen and Storage - Fuel cell - types - construction and applications.

FOR FURTHER READING

Ocean energy-tidal energy- hybrid system.

Total: 45 Hours

Reference(s)

1. Kothari, D.P., Singal, K. C., Ranjan, Rakesh,Renewable energy sources and emerging technologies, PHI Learning Pvt. Ltd 2011.
2. S.P. Sukhatme, J.K.Nayak, Solar Energy, Tata McGraw Hill Publishing Company Ltd., New Delhi, 2008.
3. G.N. Tiwari, Solar Energy - Fundamentals Design, Modelling and applications, Narosa Publishing House, New Delhi, 2002.
4. Solanki, Solar Photovoltaics: Fundamental Technologies and Applications, Prentice-Hall of India Pvt. Limited, 2009.
5. David Pimentel, Biofuels, Solar and Wind as Renewable Energy Systems, benefits and risks, Springer link,2008.

Assessment Pattern

Unit/RBT	Remember				Understand				Apply				Analyse				Evaluate				Create				Total
	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	
1	2	4			2	4				4				4											20

2	4	2	1		1	3				3	1			2	1			2							20
3	1	4			1	4	2		1	2				3	1			1							20
4		4			2	3				3	1		1	4			1	1							20
5	1	3			2	4	2		2	3				3											20
																								Total	100

Assessment Questions
Remember
1. List the three non–conventional energy sources utilized in India.
2. List three green house gases responsible for global warming.
3. List the three types of solar energy collectors.
4. Define solar constant.
5. List any four applications of solar PV system in rural area.
6. Define Tip speed ratio.
7. Define incident angle.
8. Define collector efficiency.
9. State the essential features of a probable site for a wind farm.
10. Recall the reneable energy scenario in India.

Understand
1. Indicate the prospects of renewable energy sources in India?
2. Explain with neat sketch the operation of a geothermal power plant.
3. Explain with a neat diagram the working of various types of wind generators.
4. Illustrate the solar heating system using water heating solar collectors.
5. Illustrate the main components of a flat plate solar collector.
6. Indicate what information of wind speed is best to estimate the average annual energy yield from the turbine?
7. Indicate the effect of temperature on the output of PV array?
8. Exemplify the process of producing ethanol from Biomass.
9. Exemplify the application of solar thermal principle in flat plate solar collector and also discuss its operation.
10. Expalin the need for generating electrical energy by non-conventional energy sources.

Apply
1. Demonstrate with a neat sketch, the working principle of standalone and grid connected solar system.
2. Construct the different types of solar energy collectors with neat diagram.
3. Predict the approximate amount of total power generation in India?
4. Construct the horizontal wind mill with neat sketch and explain?
5. Demonstrate the electrical layout of a typical wind farm by means of single line diagram.
6. Construct the various types of wind generators and explain its operation.
7. Demonstrate with a neat sketch, the operation of a geothermal power plant.
8. Construct and explain the working principle of a fuel cell.
9. Demonstrate the construction and working principle of hydro power plant with neat sketch.
10. A farmer has been paying an electricity bill of Rs. 500/- per month. If heinstalls a biogas plant which costs Rs.10,000/- in his house to meet all his electricity requirements,what will be the pay back period?

Analyse
1. Differentaite the difference between horizontal and vertical axis wind turbine.
2. Compare diffuse, beam and global radiations
3. Compare biomass and biogas.
4. Diferentiate the difference between a pyrheliometer and pyranometer
5. Compare the conventional and nonconventional energy sources.
6. Justify the increase in the contribution of renewable sources to the country total energy share.

7. Compare solar attitude angle and incident angle.
8. Justify why orientation is needed in concentrating type collectors?
9. Compare yaw and pitch control.
10. Organize the points to be considered for Solar Radiation measurement Data.

Evaluate

1. Choose the type of wind turbine for low power applications.
2. Justify why hydrogen is considered to be more versatile than fossil fuels?

Create

1. Estimate the size of the PV panels required to meet the total demand of the house if the appliances in the house are
   a.100 W lamps- 4 Nos
   b. 40 W lamps- 2 No.s
   b. 40W fans- 4 No.s
   c. 500W fridge -1 No
2. A householder uses Solar panels to generate electricity in his house. What should be the tilt angle of the fixed panels so as to receive maximum power from the sun.

15EE604 POWER SYSTEM PROTECTION AND SWITCH GEAR

3 0 0 3

Course Objectives

- To Study the different types of protection schemes and different types of faults in power system.
- To Understand the construction and operating principle of protective relays, transmission line and apparatus protection schemes.
- To analyze the construction and operating principle of circuit breakers and lightning arresters.

Programme Outcomes (POs)

a. **Engineering Knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. **Problem Analysis:** Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
f. **The Engineer and Society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

Course Outcomes (COs)

1. Classify the types of faults and zones of protection and analyze the fault using symmetrical components.
2. Explain the construction and operating principle of protective relays.
3. Apply suitable protective schemes for electrical apparatus.
4. Analyze the circuit interruptions schemes for power systems.
5. Explain the performance of different circuit breakers.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2	2											2	
2	1	2											3	1
3	2	3				1							2	2
4	2	3											2	1
5	1	2				1							1	2

UNIT I **9 Hours**

INTRODUCTION TO PROTECTION SCHEMES

Principles and need for protective schemes, Nature and causes of faults, Types of faults, Symmetrical components and its applications to fault analysis, Power system earthing, Step and Touch potential, Zones of protection, primary and backup protection.

UNIT II **10 Hours**

PROTECTIVE RELAY

Non directional and directional over current relays, Distance - Impedance, reactance and mho relays, Differential and pilot relaying schemes, Static and numerical over current relays, Wide area protection and measurement, Wide area phasor measurement technology.

UNIT III **8 Hours**

APPARATUS AND LINE PROTECTION

Alternator, transformer, induction motor, bus bar and feeder protection schemes, CTs and PTs and their applications in protection schemes, microprocessor based protective schemes.

UNIT IV **8 Hours**

THEORY OF CIRCUIT INTERRUPTION

Physics of arc phenomena and arc interruption, Restriking voltage, Recovery voltage, rate of rise of restriking voltage, resistance switching, current chopping and interruption of capacitive current.

UNIT V **10 Hours**

CIRCUIT BREAKERS

Introduction - Types of Circuit Breakers - Miniature, Earth leakage, Air blast, Air break, oil, SF6 and Vacuum circuit breakers, advantages and disadvantages - High voltage dc circuit breakers - Moduled Case Circuit Breaker (MCCB) - Residual Current Circuit Breaker (RCCB) - Testing of circuit breakers.

FOR FURTHER READING

Protection against transient and surges, lightning arresters and its types, Electrostatic discharge.

Total: 45 Hours

Reference(s)

1. Sunil S. Rao, "Switchgear Protection and Power Systems", Khanna publishers, New Delhi, 13th Edition, Reprint 2008.
2. Badri Ram, D.N.Viswakarma "Power system Protection and switchgear", Tata Mcgraw Hill Private Limited, New Delhi, 2013.
3. V.K.Metha and Rohit Metha "Principles of power system", S. Chand company Ltd, 2011.
4. Wadhwa C L, "Electrical Power Systems", New age International (P) Ltd., Sixth Edition, 2010.

5. Ravindranath B, and Chander N, "Power System Protection & Switchgear", New age International (P) Ltd., Reprint, 2009.
6. http://electrical-engineering-portal.com

Assessment Pattern

Unit/RBT	Remember				Understand				Apply				Analyse				Evaluate				Create				Total
	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	
1	4					12				2				2											20
2		4					12				2			2											20
3						2				12				6											20
4		2	6			6	2							4											20
5		4			2	6							2		6										20
																								Total	100

Assessment Questions
Remember
1. Define protected zone.
2. List the two types of over current relays.
3. Define operating time of a relay.
4. List the four basic requirements of protective relay?
5. List any two advantages of air blast circuit breaker over oil circuit breaker?
6. Define the term burden on CT.
7. State the term power system earthing.
8. Define positive sequence component.
9. Define restriking voltage.
10. List any two demerits of using oil as an arc quenching medium?

Understand
1. Indicate the consequences of short circuit.
2. Compare fuse and circuit breakers.
3. Identify the causes of over speed and how alternators are protected from it?
4. Compare positive, negative and zero sequence components.
5. Compare Static and Electromagnetic relay.
6. Explain non directional over current relay with neat diagram.
7. Illustrate impedance relay with neat diagram.
8. Illustrate the Transley protection scheme with neat diagram.
9. Explain the static relay with block diagram. Give the limitations of static relay.
10. Indicate the purpose of Buchholz's relay for transformer protection?

Apply
1. Construct the zones of protection for power system.
2. Predict how the relay coordination happens in power system protection?
3. Use the Merz Price voltage balance protection in parallel feeder and explain how to diagnose the fault.
4. Construct the Buchholz relay for transformer protection
5. Demonstrate the working of non-directional over current relay with the suitable diagram.
6. Construct the translay scheme for transmission line protection.
7. Find the suitable relay for transmission line protection and explain it with neat diagram.
8. Demonstrate the working of reverse power or directional relay with neat diagram.
9. Construct the block diagram of microprocessor based overcurrent current relay with necessary flowchart.
10. Compute the expression for rate of rise of recovery voltage.

Analyse

1. Justify why resistor is added between neutral and earth of an alternator?
2. Compare solid and resistance earthing.
3. Resolve the hazards imposed by oil when it is used as an arc quenching medium?
4. Justify why MOCB is superior to bulk oil circuit breaker?
5. Outline the disadvantages of MOCB over a bulk oil circuit breaker.
6. Compare electromagnetic relays and numerical relays.
7. Compare SF6 circuit breaker with vacuum circuit breaker.
8. Differentiate positive and negative sequence components.
9. Compare air circuit breaker and air blast circuit breaker.
10. Justify why is it necessary to protect the lines and other equipment of the power system against over voltages?

Create

1. For a 132 KV systems the reactance and capacitance upto the location of the circuit breaker is 3 ohm and 0.015 µF respectively. Calculate the frequency of transient oscillation, maximum value of restriking voltage across the contacts of circuit breaker and maximum value of RRRV.
2. In a 220 KV systems the reactance and capacitance upto the location of circuit breaker is 8 ohm and 0.025µF respectively. A resistance of 600 ohm is connected across the contacts of the circuit breaker. Determine natural frequency of oscillation, damped frequency of oscillation and critical value of resistance which will give no transient oscillation.

15EE607 POWER ELECTRONICS AND DRIVES LABORATORY **0 0 2 1**

Course Objectives

- To analyze the operation and performance of power converters
- To analyze and design the current and speed controllers for a closed loop solid state DC motor drive and induction motor drive.
- To perform various testing in AC motor drive.

Programme Outcomes (POs)

a. **Engineering Knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

c. **Design/ Development of Solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for thepublic health and safety, and the cultural, societal, and environmental considerations.

d. **Conduct Investigations of Complex Problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

i. **Individual and Team Work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

Course Outcomes (COs)

1. Demonstrate the speed control methods and techniques of dc and ac machines
2. Analyze the working of drives in generating and motoring modes
3. Understand the multiquadrant operation of drives.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2		3	1					2				3	3
2	3		3						2				2	3
3	2		3	1					2				1	2

1 **4 Hours**

EXPERIMENT 1

Verification of single phase half and fully controlled converters

2 **4 Hours**

EXPERIMENT 2

Simulation of dc-dc Converter Using Matlab for Electric Vehicle and Experimental verification of Boost regulator with TPS55340 and LM5122 ICs and Low-dropout Regulators with TPS7A4901 and TPS7A8300.

3 **2 Hours**

EXPERIMENT 3

Verification of TPS54160 buck regulator and LM3475 hysteretic buck regulator

4 **2 Hours**

EXPERIMENT 4

Verification of single phase AC voltage controller

5 **4 Hours**

EXPERIMENT 5

Experimental verification of multilevel inverter

6 **4 Hours**

EXPERIMENT 6

Verification of three phase voltage source inverter and V/f control of three phase VSI fed Induction motor drive

7 **2 Hours**

EXPERIMENT 7

Four quadrant operation of dc motor using chopper.

8 **2 Hours**

EXPERIMENT 8

Switched reluctance motor drive

9 **2 Hours**

EXPERIMENT 9

Simulation of Permanent magnet synchronous motor Using Maxwell Software for Electric Vehicle.

10 **4 Hours**

EXPERIMENT 10

Power quality measurement (Harmonics, THD and voltage sag) using power analyser

Total: 30 Hours

15EE608 POWER SYSTEM SIMULATION LABORATORY **0 0 2 1**

Course Objectives

- To acquire programming skills and experience in the usage of standard packages like Matlab, PSLF and E-Tap necessary for power system analysis.

- To acquire knowledge required for planning, operation and control of power system networks through simulation.

Programme Outcomes (POs)

b. **Problem Analysis:** Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

c. **Design/ Development of Solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for thepublic health and safety, and the cultural, societal, and environmental considerations.

e. **Modern Tool Usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

Course Outcomes (COs)

1. Apply the concepts of graph theory to determine the network incidence matrices.
2. Evaluate the power flow and losses in a power system network using non-linear iterative solution methods.
3. Analyse the short circuit current and rotor angle stability in a power system network following a fault, using simulation tools.
4. Create a program to determine the economic loading point of synchronized generating units under lossless condition.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1					3								3	
2			3		1								3	
3					2								3	
4		3											3	

1 **6 Hours**

EXPERIMENT 1

Formation of Bus Admittance Matrix and Bus Impedance Matrix

2 **4 Hours**

EXPERIMENT 2

Formation of Bus incidence matrix and loop incidence matrix.

3 **4 Hours**

EXPERIMENT 3

Formation of Branch path incidence matrix and Basic cutest matrix.

4 **2 Hours**

EXPERIMENT 4

Solution of Power Flow and Related Problems Using Gauss-Seidel method.

5 **4 Hours**

EXPERIMENT 5
Solution of Power Flow and Related Problems Using Newton-Raphson Method.

6 **4 Hours**
EXPERIMENT 6
Solution of Power Flow and Related Problems Using Fast-Decoupled Load Flow.

7 **2 Hours**
EXPERIMENT 7
Short Circuit analysis.

8 **2 Hours**
EXPERIMENT 8
Economic Dispatch in Power Systems.

2 Hours
9
EXPERIMENT 9
Transient Stability Analysis.

Total: 30 Hours

0 0 2 1

15EE610 MINI PROJECT IV

Programme Outcomes (POs)
a.**Engineering Knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. **Problem Analysis:** Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
c. **Design/ Development of Solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
d. **Conduct Investigations of Complex Problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
e. **Modern Tool Usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
f. **The Engineer and Society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
g. **Environment and Sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
h**. Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
i. **Individual and Team Work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
j. **Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

k. **Project Management and Finance**: Demonstrate knowledge and understanding of the engineering and management principles and apply these to oneÃ¢??s own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
l. **Life-long Learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Course Outcomes (COs)

1. Formulate a real world problem, identify the requirement and develop the design solutions.
2. Identify technical ideas, strategies and methodologies.
3. Utilize the new tools, algorithms, techniques that contribute to obtain the solution of the project.
4. Test and validate through conformance of the developed prototype and analysis the cost effectiveness.
5. Prepare report and present oral demonstrations

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	-	3	2			2	1						3	1
2	2	2	1	3		2					2	2	2	
3			3	2	2			2			2	2	3	
4		1		2	3	1	2	2					1	3
5									3	3	-	2		3

Total: 15 Hours

15GE611 LIFE SKILLS: APTITUDE II 0 0 2 0

Course Objectives

- The undergraduate students to such methods and practices that help, develop and nurture qualities such as character, effective communication, aptitude and holding ethical values

Programme Outcomes (POs)

a. **Engineering Knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems

Course Outcomes (COs)

1. Perform arithmetical operations with complex numbers
2. Explain the meanings of a relation defined on a set, an equivalent relation and a partition of a set
3. Calculate percentages in real life contexts , find any percentage of a given whole using their knowledge of fraction multiplication and increase / decrease a given whole by a percentage
4. Demonstrate the situations like motion in as straight line,Boats and Streams, Trains, Races and clocks
5. Evaluate the Counting techniques, Permutation and Combination, Recursion and generating functions

Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2												2	
2	1												2	
3	2												3	
4	2												2	1
5	2												2	

1 **3 Hours**

NUMBER SYSTEMS

Introduction - definition- classification on Numbers -power cycles and remainders - short cut process - concept of highest common factor - concept of least common multiple - divisibility - number of zeros in an expression

2 **3 Hours**

PERCENTAGES

Introduction - definition and Utility of percentage - importance of base/denominator for percentage calculations - concept of percentage values through additions - fraction to percentage conversion table

3 **3 Hours**

AVERAGES

Introduction - average of different groups - addition or removal of items and change in average-replacement of some of the items

4 **3 Hours**

RATIO, PROPORTIONS AND VARIATION

Introduction- Ratio- properties-dividing a given number in the given ratio - comparison of ratios - proportions - useful results on proportion- continued proportion - relation among the quantities more than two - variation

5 **3 Hours**

PROFIT AND LOSS

Gain/Loss and percentage gain or percentage loss-multiplying equivalents to find sale price - relation among cost price, sale price, gain/loss and percentage gain or percentage loss - an article sold at two different selling price - two different articles sold at same selling price - percentage gain or percentage loss on selling price - percentage gain or percentage loss on whole property

6 **3 Hours**

TIME AND WORK

Introduction - Basic concepts -Concepts on working with different efficiency - Pipes and Cisterns - Work Equivalence (Man Days) -Alternative approach

7 **3 Hours**

TIME, SPEED AND DISTANCE

Definition - Basics of Time, Speed and Distance - Relative speed - Problems based on Trains? Problems based on Boats and Streams -Problems based on Races - time taken with two difference modes of transport - time and distance between two moving bodies

8 **3 Hours**

PERMUTATION AND COMBINATION

Definition - Fundamental rules - Theorems on Permutation - Theorems on Combination

9 **3 Hours**

PROBABILITY

Concept and importance of probability - underlying factors for Real- Life estimation of probability - Basic facts about probability - some important consideration while defining event.

10 **3 Hours**

MIXTURES AND ALLIGATION

Definition - alligation rule - mean value (cost price) of the mixture - some typical situations where allegation can be used.

Total: 30 Hours

Reference(s)

1. Abhijit Guha, Quantitative Aptitude for Competitive Examinations, Fourth Edition, Tata McGraw-Hill Publishing Company Ltd, 2012
2. Arun Sharma, How to prepare for Data Interpretation for the CAT, First Edition, Tata McGraw-Hill Publishing Company Ltd, 2012
3. Dr.R S Aggarwal, Quantitative Aptitude, Seventh Revised Edition, S.Chand Publishing Company Ltd, 2013.
4. Edgar Thorpe , Course In Mental Ability And Quantitative Aptitude For Competitive Examinations, Third Edition, Tata McGraw-Hill Publishing Company Ltd, 2013
5. Arun Sharma, How to prepare for Quantitative Aptitude for the CAT, Fifth Edition, Tata McGraw-Hill Publishing Company Ltd, 2013.

15GE601 PROFESSIONAL ETHICS

2 0 0 2

Course Objectives

- To understand Human values, ethical theory, codes of ethics, work place responsibilities, rights, engineering experimentation, global issues and contemporary ethical issues
- To understand personal ethics, legal ethics, cultural associated ethics and engineer's responsibility

Programme Outcomes (POs)

h. **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

k. **Project Management and Finance**: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one’s own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

Course Outcomes (COs)

1. Articulate engineering ethics theory with sustained lifelong learning to strengthen autonomous engineering decisions
2. Be an example of faith, character and high professional ethics, and cherish the workplace responsibilities, rights of others, publicÃ¢??s welfare, health and safety
3. Contribute to shape a better world by taking responsible and ethical actions to improve the environment and the lives of world community
4. Fortify the competency with facts and evidences to responsibly confront moral issues raised by technological activities, and serve in responsible positions of leadership
5. Be Proficient in analytical abilities for moral problem solving in engineering situations through exploration and assessment of ethical problems supported by established experiments

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1								3			2			
2								2			2			
3											3			
4								2			2			
5								2			2			

UNIT I **6 Hours**

HUMAN VALUES

Morals and Ethics - Honesty - Integrity - Values - Work Ethic - Civic Virtue - Respect for Others - Living Peacefully - Caring and Sharing - Self-Confidence - Courage - Co-operation - Commitment - Empathy.

UNIT II **6 Hours**

ENGINEERING ETHICS AND PROFESSIONALISM

Scope of 'Engineering Ethics'- Variety of moral issues - Types of inquiry - Accepting and sharing responsibility - Ethical dilemmas - Moral autonomy - Kohlberg's and Gilligan's theory - Consensus and controversy - Profession and Professionalism - Models of Professional Roles - Right action theories - Senses of corporate responsibility - Codes of ethics: Importance - justification - limitation - Abuse - Sample codes NSPE - IEEE - Institution of Engineers (India).

UNIT III **6 Hours**

ENGINEERING AS SOCIAL EXPERIMENTATION

Engineering as experimentation - Engineers as responsible experimenters - Balanced outlook on law - Cautious optimism - Safety and risk - Assessing and reducing risk - Safe exits - The Challenger case study - Bhopal Gas Tragedy - The Three Mile Island and Chernobyl.

UNIT IV **6 Hours**

WORKPLACE RESPONSIBILITIES AND RIGHTS

Fundamental Rights - Responsibilities and Duties of Indian Citizens - Teamwork - Ethical corporate climate - Collegiality and loyalty - Managing conflict - Respect for authority - Collective bargaining - Confidentiality - Conflicts of interest - Occupational crime - Professional rights - Employee rights.

UNIT V **6 Hours**

GLOBAL ISSUES

Multinational corporations: Technology transfer and appropriate technology - International rights - promoting morally just measures - Environmental ethics: Engineering, ecology - economics - Human and sentient centred - and bio and eco centric ethics - Computer ethics and internet - Engineers as managers - Consulting engineers - Engineers as expert witnesses and advisors - Moral leadership.

FOR FURTHER READING

The Challenger case study - Bhopal Gas Tragedy - The Three Mile Island and Chernobyl case studies - Fundamental Rights, Responsibilities and Duties of Indian Citizens -Sample code of ethics like IETE, ASME, ASCE, IEEE, Institution of Engineers (India), Indian Institute of Materials Management.

Total: 30 Hours

Reference(s)

1. Mike W Martin and Roland Schinzinger, Ethics in Engineering, 4th edition, Tata McGraw Hill Publishing Company Pvt Ltd, New Delhi, 2014.

2. M Govindarajan, S Natarajan and V S Senthil Kumar, Engineering Ethics, PHI Learning Private Ltd, New Delhi, 2012.
3. R S Naagarazan, A text book on professional ethics and human values, New age international (P) limited, New Delhi,2006.
4. Charles D Fleddermann, Engineering Ethics, Pearson Education/ Prentice Hall of India, New Jersey, 2004.
5. Charles E Harris, Michael S Protchard and Michael J Rabins, Engineering Ethics - Concepts and Cases, Wadsworth Thompson Learning, United States, 2005.
6. http://www.slideworld.org/slidestag.aspx/human-values-and- Professional-ethics

Assessment Pattern

Unit/RBT	Remember				Understand				Apply				Analyse				Evaluate				Create				Total
	F	**C**	**P**	**M**	**F**	**C**	**P**	**M**	**F**	**C**	**P**	**M**	**F**	**C**	**P**	**M**	**F**	**C**	**P**	**M**	**F**	**C**	**P**	**M**	
1	5	5				5					5														20
2		5			5						5										5				20
3		5					10				5														20
4	5									5											5	5			20
5	5					5				5					5										20
																								Total	100

Assessment Questions

Remember

1. Define Human Values.
2. What are Morals and Values?
3. What do you mean by Civic virtue and Respect for others?
4. Write the various meanings of Spirituality.
5. List four different types of Virtues.
6. Mention different Human values.
7. What is meant by moral autonomy?
8. Classify the types of inquiry
9. What are the steps needed in confronting moral dilemmas?
10. List the levels of moral development suggested by Kohlberg
11. What do you understand by self-interest and ethical egoism?
12. What are the steps needed in confronting moral dilemmas?
13. What are the three virtues of religion?
14. What are the professional responsibilities?

Understand

1. Which are the practical skills that will help to produce effective independent thought about moral issues?
2. Why does engineering have to be viewed as an experimental process?
3. Why isn‘t engineering possible to follow a random selection in product design?
4. Why is the code of ethics important for engineers in their profession?
5. What does the Balanced Outlook on Law stress in directing engineering practice?
6. Are the engineers responsible to educate the public for safe operation of the equipment? How?
7. What kind of responsibility should the engineer have to avoid mistakes that may lead to accident due to the design of their product?
8. What is the use of knowledge of risk acceptance to engineers?
9. Why is Environmental Ethics so important to create environmental awareness to the general public?
10. Why do the engineers refuse to do war works sometimes?

Apply

1. How does the consideration of engineering as a social experimentation help to keep a sense of autonomous participation is a person's work?
2. How does the code of ethics provide discipline among the engineers?
3. Exemplify the space shuttle Challenger case accident?
4. How does the manufacturer understand the risk in a product catalog or manual?
5. How does the knowledge of uncertainties in design help the engineers to access the risk of a product?
6. How can the quantifiable losses in social welfare resulting from a fatality be estimated? Give some examples.
7. How does the engineer act to safeguard the public from risk?

15EE702 ELECTRICAL MACHINE DESIGN

3 2 0 4

Course Objectives

- To study the MMF calculation and thermal rating of various types of electrical machines.
- To design armature and field systems for D.C. machines.
- To design core, yoke, windings and cooling systems of transformers, stator and rotor of induction and synchronous machines.

Programme Outcomes (POs)

a. **Engineering Knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

b. **Problem Analysis:** Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

d. **Conduct Investigations of Complex Problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

Course Outcomes (COs)

1. Examine the mmf calculations for rotating machines
2. Analyze the design of armature, field system and commutator & brushes for the D.C. machines.
3. Apply the output equation of transformer and compute its design parameters
4. Apply the output equation of induction motor and find its design parameters
5. Apply the output equation of synchronous machine and compute its design parameters

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3	2											2	
2	2	3		1									3	
3	2	3											3	1
4	2	3		1									3	
5	2	3		1									3	1

UNIT I **10 Hours**

INTRODUCTION

Major considerations - Limitations in design - Concepts of magnetic circuit - B-H curves - MMF calculation of various types of electrical machines - Net length of iron - real and apparent flux density of rotating machines - Choice of specific loadings for various rotating machines. Basic concepts of computer aided design and its different approaches.

UNIT II **9 Hours**

DC MACHINES

Output equation - main dimensions - Selection of number of poles - Armature Design - Design of shunt field poles and shunt field coil - Design of Commutator and Brushes.

UNIT III **9 Hours**

TRANSFORMERS

KVA output rating for single and three phase transformers - Volt per turn - Optimum design of transformers - Window space factor - Overall dimensions - Temperature rise of Transformers - Design of Tank with & without cooling tubes - Cooling of Transformers.

UNIT IV **9 Hours**

INDUCTION MOTORS

Output equation of Induction Motor - Main dimensions - Relation between D & L for best Power Factor. Length of air gap - Rules for selecting rotor slots of Squirrel Cage Machines - Design of Rotor bars & slots - Design of End Rings - Design of Wound Rotor - Magnetic leakage calculations - Magnetizing Current.

UNIT V **8 Hours**

SYNCHRONOUS MACHINES

Runaway speed - Output equations - Design of salient pole machines - Short circuit ratio - Estimation of air gap length - Shape of pole face - Armature design - Armature parameters - Design of rotor - Design of damper winding.

FOR FURTHER READING

Indian standard specifications for copper conductors used in electrical machines and apparatus - International standard specifications.

Total: 75 Hours

Reference(s)

1. A. K. Sawhney, A Course in Electrical Machine Design, Dhanpat Rai & Sons, New Delhi, Sixth reprint, 2014.
2. S. K. Sen, Principles of Electrical Machine Designs with Computer Programmes, Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi, 2006.
3. A. Shanmugasundaram, G. Gangadharan and R. Palani, "Electrical Machine Design Data Book", New Age India Pvt. Ltd., New Delhi, 2007.
4. R. K. Agarwal, Principles of Electrical Machine Design, Kataria S K and Sons, New Delhi, 2010.
5. V. N. Mittle and Mittle A, Design of Electrical Machines, Standard Publishers Distributors, New Delhi, Fifth reprint, 2013.
6. M.V .Deshpande, Design & Testing of Electrical Machines, PHI Learning private Limited, New Delhi , Third Print 2013.

Assessment Pattern

Unit/RBT	Remember				Understand				Apply				Analyse				Evaluate				Create				Total
	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	
1	2					2			1	3					12										20
2		2								2	2								14						20
3		2				2					4												12		20
4		2							1	3									14						20
5	2					2			2	2									12						20
																								Total	100

Assessment Questions

Remember

1. Compare the similarities magnetic and electric circuits.
2. Define carter's coefficient
3. State three important features of turbo alternator rotors
4. Write down the expression for calculation of reluctance of air gap with slotted armature
5. Define gap contraction factor.
6. Recall the expression for gap contraction factor for ducts.
7. Define field form factor in magnetic circuit for a machine
8. Define stacking factor magnetic circuit for a machine

Understand

1. Differentiate magnetic and electric circuits
2. List the three methods used for estimating the mmf for tapered teeth
3. Relate the leakage flux with the performance of machine.
4. Justify how the length of commutator is affected by changing the number of poles.
5. List the different cooling methods of electrical machines
6. Indicate the need of circular coils in transformer design.
7. Indicate the effect of air gap length on power factor.
8. Reproduce the factors that influence the choice of specific electric loading
9. Generalize the procedure for the design of rotor bars and end rings of a squirrel cage induction motor.
10. Justify the criteria for selection of a suitable diameter of armature of a dc generator.
11. State the effects of SCR in synhcrounous machine.
12. Recall the output equation for induciton motor.
13. Determine the air gap length of a dc machine from the following particulars: gross length of core=0.12m,No.of ducts=1 and is 10mm wide, slot pitch=25mm,slot width=10mm, carter's co – efficient for slots and ducts= 0.32,gap density at pole centre =0.7 wb/m² ;field mmf/pole=3900 AT, mmf required for iron parts of magnetic circuit=800AT .
14. Compute the main dimensions of the core of a 5 KVA, 11000/400 transformer. Window space factor=0.2; The height of the window is 3 times the width; current density=1.4 A/mm²; Bmax=1 telsa; stacking factor =0.9;Net conductor area in window=0.6 times the net cross sectional area of iron in the core.
15. Compute the main dimensions including winding conductor area of the three phase, delta to star core type transformer rated at 300KVA, 6600/440V,50 HZ.A suitable core with three steps having a circumscribing circle of 0.25m diameter and a leg spacing of 0.4m available. Emf per turn is 8.5V, space factor is 0.9, winding factor is 0.28 and current density is 2.5 A/m.

Apply

1. Find out the apparent flux density in the teeth of a D.C. machine when the real flux density is 2.1 Wb/m2, slot pitch = 28 mm, slot width = 10 mm and the gross core length = 0.35 m. The number of ventilating ducts = 4, each 10 mm wide. The magnetizing force for a flux density of 2.15 Wb/m² is 55000 A/m. The iron stacking factor is 0.9.

2. Compute the mmf required for the air gap of a d.c machine with an axial length of 20cm(no ducts) and a pole arc of 18 cm, the slot pitch =27mm,slot opening=12mm,air gap=6mm and the useful flux/pole=25 mwb. Take carter's co – efficient for slot as 0.3.
3. Calculate the apparent flux density at a particular section of a tooth from the following data: Tooth width=12mm;slot width=10mm;gross core length=0.32m; nd=4 each 10mm wide;real flux density =2.2 wb/m2 ;permeability of teeth corresponding to real density =31.4 x 10-6 H/m; stacking factor =0.9
4. A 5 KW, 250 v, 4 pole, 1500rpm dc shunt generator is designed to have Bav=0.42 Telsa. Ampere conductors per meter=15000; Full load efficiency=87%; ratio of pole arc to pole pitch=0.66.Compute the main dimensions of the armature.
5. Compute main dimensions D and L of a 3.7KW, 400V, three phase, 4 pole, 50 HZ squirrel cage Induction Motor. Bav =0.45 Telsa; Electric loading=23000 amp-cond./m; efficiency=85%;Power factor=0.84; Winding factor=0.955; Stacking factor=0.9 .
6. Find the main dimensions, air gap length, stator slots, stator turns/phase and cross sectional area of stator and rotor conductors for a tree phase ,15 HP, 400V,6 pole ,50HZ,975 rpm, Induction motor. The motor is suitable for star delta starting. Bav =0.45 Telsa, pole arc/pole length =0.85, P.F.=0.85, efficiency=90%; Electric loading=20000 amp-cond./m.
7. Find out the approximate diameter and length of the stator core, the number of stator slots and the number of conductors for a 11 kW, 400 V, 3φ, 4 pole, 1425 rpm delta connected Induction motor. Adopt a specific magnetic loading of 0.45 Wb/m² and a specific electric loading of 23,000 A/m. Assume full load efficiency and power factor as 0.85 and 0.88 respectively. The ratio of core length to pole pitch is 1. The stator employs a double layer winding.

Analyse

1. Develop the expressions for leakage reactance of transformer
2. Obtain the expressions for leakage reactance of Induction motor
3. Derive the expressions for leakage reactance of synchronous machine
4. Derive the output equation of a dc generator and point out salient features of this
5. Obtain the output equation of the single phase transformer and point out the salient features of this equation

Evaluate

1. Determine the diameter and length of armature core for 55KW,110v,1000rpm,4 pole shunt generator, assuming specific electric and magnetic loadings of 26000amp.cond./m and 0.5wb/m².The pole arc should be about 70% of pole pitch and the length of core about 1.1 times the pole arc. Allow 10 Amp for the field current and assume a voltage drop of 4V for the armature circuit. Specify the winding used and also determine suitable values for the number of armature conductors and number of slots
2. Determine the terminal voltage of the machine. Find also the specific electric loading if the power factor is 0.85. If the mmf required for air gap is 80% of no load mmf, short circuit ratio 0.55, air gap contraction factor 1.1, determine the length of air gap
3. Estimate the stator core dimensions, number of stator slots and no. of stator conductor/slot for a 100KW, 3300V, 50 HZ, 12 pole, star connected slip ring induction motor. Bav =0.4 Telsa; Electric loading=25000 amp-cond./m; efficiency=90%;Power factor=0.9; Winding factor=0.96; Choose main dimensions to give best power factor. The slot loading should not exceed 500 amp.cond
4. Compute the D and L for a 3 – phase alternator whish is rated 1000 KVA, 50 Hz , 375 rpm, Avg. air gap flux density is 0.55 tesla, Ampere conductors per metre are 28000, The ratio of core length to pole pitch = 2, Winding factor KW = 0.955
5. Formulate the relationship between machine size and output power

15EE703 UTILIZATION OF ELECTRICAL ENERGY

3 0 0 3

Course Objectives

- To study Electrical energy heating welding and the concept of electroplating.
- To analyze Electric traction systems and their performance.
- To understand Industrial applications of electric drives.

Programme Outcomes (POs)

a. **Engineering Knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

b**. Problem Analysis:** Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

c. **Design/ Development of Solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for thepublic health and safety, and the cultural, societal, and environmental considerations.cultural, societal, and environmental considerations.

g**. Environment and Sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

Course Outcomes (COs)

1. Explain different parameters in illumination system and design of illumination system for various location.
2. Compare different methods of heating & welding methods by its various parameters.
3. Compute the mechanism of Electric Traction System.
4. Analyze the characteristics of electric drives and their speed control in industrial applications.
5. Analyze the working of electrical circuits used in refrigeration and air conditioning.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2		3										2	
2	3												2	1
3	1						3						3	2
4	1	2												3
5		3					2							3

9 Hours

UNIT I

ILLUMINATION

Nature of radiation - definition - laws -photometry - lighting calculations - design of illumination systems - residential, industrial, commercial, health care, street lightings, sports, administrative complexes - types of lamps - energy efficiency lamps.

UNIT II **11 Hours**

HEATING AND WELDING

Methods of heating, requirement of heating material - design of heating element - furnaces - welding generator - welding transformer and its characteristics. Electro-plating: Methods, estimation of power and current for depositing metals, Current and energy efficiency, Electro-deposition and electroforming, Power supply for electrolysis.

UNIT III **8 Hours**

ELECTRIC TRACTION

Introduction - requirements of ideal traction system - supply systems - mechanics of train movement - Traction motors and control - multiple units - braking - current collection systems - recent trends in electric traction.

UNIT IV **9 Hours**

DRIVES AND THEIR INDUSTRIAL APPLICATIONS

Introduction - motor selection and related factors - loads - types - characteristics - steady state and transient characteristics - load equalization - industrial applications - modern methods of speed control of industrial drives.

UNIT V **8 Hours**

ELECTRICAL CIRCUITS USED IN REFRIGERATION AND AIR CONDITIONING AND WATER COOLERS

Principle of air conditioning, vapour pressure, refrigeration cycle, eco-friendly refrigerants. Description of Electrical circuit used in Refrigerator, air-conditioner, and water cooler,BEE star rating.

FOR FURTHER READING

Characteristics of welding transformer, Applications of braking in traction, Application of speed control in industrial drives, Electric car.

Total: 45 Hours

Reference(s)

1. E. Openshaw Taylor, Utilization of Electrical Energy in SI Units, Orient Longman Pvt.Ltd, 2006.
2. B.R. Gupta, Generation of Electrical Energy, Eurasia Publishing House (P) Ltd, New Delhi, 2010.
3. H. Partab, Art and Science of Utilisation of Electrical Energy, Dhanpat Rai and Co, New Delhi, 2004.
4. Gopal.K.Dubey, Fundamentals of Electrical Drives, Narosa Publishing House, New Delhi, 2002.
5. C.L. Wadhwa, Generation, Distribution and Utilization of Electrical Energy, New Age International Pvt.Ltd, 2015.
6. J.B. Gupta, Utilization of Electric Power and Electric Traction, S.K.Kataria and Sons, 2012.

Assessment Pattern

Unit/RBT	Remember				Understand				Apply				Analyse				Evaluate				Create				Total
	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	
1	1	1			2	12			1				1									2			20
2	1	1			2	12			1				1									2			20
3	1	1			2	12			1				1									2			20
4	1	1			2				1				1					12				2			20
5	1	1			2	12			1				1									2			20
																								Total	100

Assessment Questions

Remember

1. Define turbine and its function
2. Classify the two types of hydro electric systems
3. State any two functions of the economiser
4. List the two advantages of the moderator
5. State the functions of the control rod in nuclear power plant
6. Compare nuclear plant and thermal power plant
7. Mention the functions of super heater.
8. State the typical rated voltages of electrical sub systems used in air – craft
9. Differentiate nuclear fission and fusion
10. State the principle of working gas turbine

Understand

1. List any three applications of diesel electric plant
2. Compare demand charge and penalty
3. Define load duration curve
4. List any three types of equipment that can cause power quality problems
5. List any two drawbacks of harmonics
6. Differentiate sag and swell
7. Define Diversity factor for electrical loads
8. Recall the procedure involved in installation solar plant
9. Interpret the requirements for ideal traction system.
10. classify braking techniques in traction system

Apply

1. State and explain the laws of photometry.
2. Discuss the types of illumination systems.
3. Exemplify the concept of energy efficiency lamps.
4. categorize different types of lamps in illumination engneering.
5. recall various steps used in lighining calculations
6. Exemplify different types of electroplating in metals.
7. compute power consumption and steps associated in electroplating.
8. Elobroate principle and working of welding generator.
9. With neat sketch , exemplify the different electrical characteristics of welding transformer
10. Outline the preocedure involved in selections of drives in traction systems

Analyse

1. classify different types of braking and also explain any one type.
2. compare the differences in air coinditioning and refrigeration systems
3. outline the power supply requirement for electrolysis process
4. elobrate arc furnace and its characteristics.

Evaluate

1. A lamp of 300 candle power. is placed 1.5 m below a reflecting plane mirror surface, which reflects 70% of the light falling on it. Find the illumination at a point 4m
2. A 105 KVA of tin is to be melt during an hour in a melting furnace. Determine a suitable rating of the furnace if melting temperature of tin is 240^0 C. Take initial temperature of metal 35^0 C. Specific heat = 0.055 Kcal/kg ^{0} C Latent heat of liquid = 13.3 Kcal/kg
3. Design a VFD drive for various spinning mill applications
4. Design a shunt active filter to eliminate 7th order harmonic

Create

1. Design a suitable illumination for a cricket stadium
2. Create a simulation model to demonstrate the application of traction motors

15EE704 EMBEDDED SYSTEMS

3 0 0 3

Course Objectives

- To understand the embedded system architecture and memory organization
- To interface between processors & peripheral devices related to embedded processing.
- To develop efficient programs on any dedicated processor.

Programme Outcomes (POs)

a. **Engineering Knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

b. **Problem Analysis:** Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

c. **Design/ Development of Solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for thepublic health and safety, and the cultural, societal, and environmental considerations.

e. **Modern Tool Usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

f. **The Engineer and Society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

g. **Environment and Sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

Course Outcomes (COs)

1. Explain the architecture of PIC16F877A micro controller
2. Interpret the functions of structural units and input output blocks of processors
3. Analyze the RTOS concepts in embedded system design
4. Apply the interrupts and task scheduling concepts in real time system design
5. Asses the various supporting devices used to design an embedded system

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3	1	2										2	
2	1		3		2								1	
3			3		1	2	2						2	
4	2	1	1		3	2							2	
5			3		2	1								3

UNIT I **9 Hours**

EMBEDDED SYSTEM

Evolution, Issues and challenges, Introduction to functional building blocks of embedded systems PIC16F877A - Register, memory devices, ports, timer, interrupt, Instruction Set and Addressing Modes.

UNIT II **8 Hours**

PROCESSOR AND MEMORY ORGANIZATION

Structural units in a processor; selection of processor & memory devices; shared memory; DMA; interfacing processor, memory and I/O units, memory management

UNIT III **8 Hours**

PROGRAMMING EMBEDDED SYSTEMS

Introduction to basic concepts of RTOS, Basics of real time & embedded system operating systems, RTOS -Interrupt handling, task scheduling; embedded system design issues in system development process.

UNIT IV **11 Hours**

I/O PROGRAMMING SCHEDULE MECHANISM

Transfer rate, latency; interrupt driven I/O - Non-maskable interrupts; software interrupts, writing interrupt service routine in C & assembly languages; preventing interrupt overrun; disability interrupts. Multi threaded programming- Context switching, premature & non-premature multitasking, semaphores. Scheduling -Thread states, pending threads, context switching, round robin scheduling, priority based scheduling, assigning priorities, deadlock, watch dog timers

UNIT V **9 Hours**

DEVICES

I/O devices; serial communication using I2C, CAN, USB buses; parallel communication using ISA, PCI, PCI/X buses, arm bus; interfacing with devices/ports, device drivers in a system -Serial port & parallel port, Testing of Embedded Systems, System Design Example

FOR FURTHER READING

Integrated Embedded System development environment -IDE, Types of file generated on cross compilation, disassembler / decompiler, simulator, emulator and debugging, embedded product development life-cycle, trends in embedded industry, Arduino Processor Architecture.

Total: 45 Hours

Reference(s)

1. Wayne Wolf, Computers as Components: Principles of Embedded Computer System Design, Elsevier, 2006.
2. Michael J. Pont, Embedded C, Pearson Education , 2007.
3. Steve Heath,Embedded System Design, Elsevier, 2005.
4. Muhammed Ali Mazidi, Janice Gillispie Mazidi and Rolin D. McKinlay, The 8051 Microcontroller and Embedded Systems, Pearson Education, Second edition, 2007.

Assessment Pattern

Unit/RBT	Remember				Understand				Apply				Analyse				Evaluate				Create				Total
	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	
1	2	4				4				10															20
2		2					2			2				12					2						20
3		4					12			2				2											20
4			2			4					10				2			2							20
5	2				2							6			10										20
																								Total	100

Assessment Questions

Remember

1. Define Embedded System
2. List the memory Organization.
3. List the registers.
4. List the external interrupts.
5. Define compare mode.
6. Define capture mode.
7. Define CAN Bus
8. List the names of any 4 types of commercial RTOS.
9. Define the role of on chip Debugging.

Understand

1. Define data memory.
2. Compare Program memory and data memory.
3. Differentiate internal interrupt and external interrupt.
4. State the Difference between timer0, timer1 , timer2.
5. Understand the difference between capture and compare mode.
6. Compare linker and locator.
7. Difference between Serial Peripheral Interface and PSP.
8. List design technique that supports Multiple Interrupt handling in Embedded processor.
9. Differentiate compiler & a cross compiler
10. Define non-premptive Scheduling in RTOS
11. List Bus supporting of Master-Slave Configuration in Bus topology

Apply

1. Compute real time issues.
2. Construct time loading measurement
3. Demonstrate Universal Asynchronous Receiver/Transmitter
4. Relate response time and time loading.
5. Construct logic analyzers.
6. Illustrate compare and capture mode.
7. Compute reducing memory loading.
8. Explain the role of on chip Debugging
9. Illustrate with neat diagrams on how the speed of a processor is improved by the DMA services.

Analyse

1. Analysis the memory requirement
2. Application of microcontroller PIC16 series.
3. Analysis the memory requirement of Real-time operating system.
4. Analysis the input and output performance of Real-time operating system.
5. Outline the techniques used for debugging
6. Describe briefly on the memory management & mapping techniques that enhance the efficiency of the Processor
7. Analyse the Functional Blocks of a typical embedded processor
8. Analyse the multitasking RTOS with involving priority level switching & the co-operative scheduling mechanism.

Evaluate

1. Characterize the need of embedded system.
2. Application of microcontroller in elevator controller.
3. Evaluate the real time specifications.
4. Write a program using Bit- Parallel Logic Operators

Create

1. Write a program to control the speed of a fan.

15EE707 EMBEDDED SYSTEMS LABORATORY

0 0 2 1

Course Objectives

- To understand the architecture of embedded Systems
- To learn the concept of memory map and memory interface
- To write programs to interface memory, I/Os with processor

Programme Outcomes (POs)

c. **Design/ Development of Solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for thepublic health and safety, and the cultural, societal, and environmental considerations.

e. **Modern Tool Usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

f. **The Engineer and Society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

Course Outcomes (COs)

1. Interface memory and write programs related to memory operations
2. Construct various control circuits for different applications using PIC controller
3. Develop programs to interface memory, I/Os with processor

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1			1										3	
2					3								2	3
3						2							2	3

1 **4 Hours**

EXPERIMENT 1
Write the PIC programs for simple arithmetic operations

2 **2 Hours**

EXPERIMENT 2
Design a suitable circuit for USART with PIC controller

3 **2 Hours**

EXPERIMENT 3
Design a temperature controller using LM 37 with PIC controller

4 **2 Hours**

EXPERIMENT 4
Design a decrement counter using PIC controller

5 **4 Hours**

EXPERIMENT 5
Design a suitable circuit to display the Character Embedded System in LCD Display with PIC

6 **4 Hours**

EXPERIMENT 6

Design a suitable circuit to control stepper motor in half and full step Configuration using PIC controller

7 **2 Hours**

EXPERIMENT 7

Design a suitable circuit to control servo motor for various position angles using PIC controller

8 **4 Hours**

EXPERIMENT 8

Design a suitable circuit for countdown timer using PIC controller

9 **4 Hours**

EXPERIMENT 9

Design a suitable circuit for parallel in serial out using shift register with PIC controller.

10 **2 Hours**

EXPERIMENT 10

Develop the LCD menu program with PIC controller

Total: 30 Hours

15EE708 RENEWABLE ENERGY LABORATORY **0 0 2 1**

Course Objectives

- To understand the non conventional energy resources.
- To learn the Renewable energy conversion techniques.
- To understand the characteristics of solar, wind and Hybrid energy systems.

Programme Outcomes (POs)

b. **Problem Analysis:** Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

e. **Modern Tool Usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

f. **The Engineer and Society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

g. **Environment and Sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

Course Outcomes (COs)

1. Explain the methods of environmental parameters measurements and the characteristics of PV panel
2. Evaluate the function of maximum power point tracker and solar lighting system
3. Analyze the characteristics of solar dryer/solar heater and hybrid power plant with battery
4. Evaluate the characteristics of various wind generators and design the SPV-wind hybrid system.
5. Analyze the operation of charge controller and biomass Gasifier

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1					1								2	
2							3						2	3
3		2											2	3
4							3							3
5						2							2	

1 **4 Hours**

EXPERIMENT 1

Solar Radiation and wind velocity measurement

2 **2 Hours**

EXPERIMENT 2

Determine I-V and P-V Curves for given solar PV module.

3 **4 Hours**

EXPERIMENT 3

Design and study of Maximum Power Point Tracker in solar PV applications.

4 **2 Hours**

EXPERIMENT 4

Design and study of solar lighting system.

5 **4 Hours**

EXPERIMENT 5

Design a hybrid power plant using SPV-FCC-Battery Bank-DG.

6 **4 Hours**

EXPERIMENT 6

Study of solar dryer and solar heater characteristics.

7 **2 Hours**

EXPERIMENT 7

Performance characteristics of induction generator for wind turbine application.

8 **2 Hours**

EXPERIMENT 8

Design and study of SPV-wind hybrid system.

9 **2 Hours**

EXPERIMENT 9

Design and study of charge controller for battery.

10 **4 Hours**

EXPERIMENT 10

Operation and Efficiency of a biomass Gasifier in updraught/downdraught mode.

Total: 30 Hours

0 0 2 1

15EE709 MINI PROJECT V

Programme Outcomes (POs)

a.**Engineering Knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

b. **Problem Analysis:** Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

c. **Design/ Development of Solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

d. **Conduct Investigations of Complex Problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

e. **Modern Tool Usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

f. **The Engineer and Society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

g. **Environment and Sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

h**. Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

i. **Individual and Team Work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

j. **Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

k. **Project Management and Finance**: Demonstrate knowledge and understanding of the engineering and management principles and apply these to oneÃ¢??s own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

l. **Life-long Learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Course Outcomes (COs)

1. Formulate a real world problem, identify the requirement and develop the design solutions.
2. Identify technical ideas, strategies and methodologies.
3. Utilize the new tools, algorithms, techniques that contribute to obtain the solution of the project.
4. Test and validate through conformance of the developed prototype and analysis the cost effectiveness.
5. Prepare report and present oral demonstrations

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	-	3	2			2	1						3	1
2	2	2	1	3		2					2	2	2	
3			3	2	2			2			2	2	3	
4		1		2	3	1	2	2					1	3
5									3	3	-	2		3

Total: 15 Hours

1. V. B. Bhandari, Design of Machine Elements, Tata McGraw-Hill Publishing Company Pvt. Ltd., New Delhi, 2010.
2. Beer, Johnston, Mazurek, Cornwells and Sanghi, Vector Mechanics for Engineers: Statics, Dynamics, 10th Edition, Tata McGraw Hill - Noida, Uttar Pradesh, 2013

15EE804 PROJECT WORK 0 0 18 9

Programme Outcomes (POs)

a.**Engineering Knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

b. **Problem Analysis:** Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

c. **Design/ Development of Solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

d. **Conduct Investigations of Complex Problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

e. **Modern Tool Usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

f. **The Engineer and Society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

g. **Environment and Sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

h**. Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

i. **Individual and Team Work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

j. **Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

k. **Project Management and Finance**: Demonstrate knowledge and understanding of the engineering and management principles and apply these to ones own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

l. **Life-long Learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Course Outcomes (COs)

1. Formulate a real world problem, identify the requirement and develop the design solutions.
2. Identify technical ideas, strategies and methodologies.
3. Utilize the new tools, algorithms, techniques that contribute to obtain the solution of the project.
4. Test and validate through conformance of the developed prototype and analysis the cost effectiveness.
5. Prepare report and present oral demonstrations

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	-	3	2			2	1						3	1
2	2	2	1	3		2					2	2	2	
3			3	2	2			2			2	2	3	
4		1		2	3	1	2	2					1	3
5									3	3	-	2		3

15LE101 BASIC ENGLISH I 3 0 0 3

Course Objectives:

- To teach students basic English vocabulary and tenses
- To offer practice on various conversation patterns
- To improve spelling and pronunciation by offering rigorous practice and exercises

Programme Outcomes (POs)

j. **Communication**: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

Course Outcomes (COs)

1. Form sentences using basic grammar and vocabulary in English
2. Converse in basic day-to-day situations
3. Speak on topics of general interest
4. Listen and comprehend Indian English audio clippings
5. Read passages and answer related questions

Program Outcomes (POs) Mapping

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1										1			1	
2										3			1	
3										3			1	
4										2			1	
5										2			1	

UNIT I **7 hours**

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Module	Vocabulary/ Grammar	Skills Sets	Skill Sets
1	Basic words- 12 most used words in English, usage and pronunciation	Starting a conversation and talking about what one does	Sentence construction bolstered by mother tongue
2	Basic words- 20 often used	Analyzing an action	Creating and

	words, usage and pronunciation	plan	presenting one's own action plan
3	Basic words with a focus on spelling	Discriminative listening	Informal conversation
4	Basic words- 10 often used words, usage and pronunciation	Content listening and Intonation	Reading comprehension
5	Unit Test I		

UNIT II **8 hours**

Module	Vocabulary/ Grammar	Skills Sets	Skill Sets
6	Basic words + greetings to be used at different times of the day	Formal conversation	Intonation to be used in formal address
7	Last 28 of the 100 most used words	Informal conversation between equals	Reading practice and peer learning
8	Using the 14 target words to form bigger words	Informal dialogues using contracted forms	Guided speaking- talking to peers using contracted forms
9	Palindromes, greetings- good luck, festivals	Placing a word within its context- culling out meaning	Offering congratulations
10	Unit Test II		

UNIT III **7 hours**

Module	Vocabulary/ Grammar	Skills Sets	Skill Sets
11	Homophones	Formal and informal methods of self- introduction	Let's Talk is a group activity that gives them some important pointers of speech
12	Homophone partners, matching words with their meanings	Contracted forms of the – be verbs, 've and 's	Translating English sentences to Tamil
13	Briefcase words- finding smaller words from a big word	Formal and informal ways of introducing others	Team work- speaking activity involving

			group work, soft skills
14	Compound words and pronunciation pointers	Giving personal details about oneself	Using the lexicon
15	Unit Test III		

UNIT IV **8 hours**

Module	Vocabulary/ Grammar	Skills Sets	Skill Sets
16	Proper and common nouns	Asking for personal information and details	Pronunciation pointers- an informal introduction to the IPA
17	Pronouns	Telephone skills and etiquette	Reading aloud and comprehension
18	Abstract and common nouns	Dealing with a wrong number	Reading practice and comprehension
19	Group names of animals, adjectives	Taking and leaving messages on the telephone	Pronunciation pointers
20	Unit Test IV		

UNIT V **8 hours**

Module	Vocabulary/ Grammar	Skills Sets	Skill Sets
21	Determiners	Interrupting a conversation politely- formal and informal	Pair work reading comprehension
22	Conjugation of the verb ‘to be’- positive and negative forms	Thanking and responding to thanks	Comprehension questions that test scanning, skimming and deep reading
23	Am/is/are questions	Giving instructions and seeking clarifications	Small group activity that develops dialogue writing
24	Present continuous tense- form and usage	Making inquiries on the telephone	Finishing sentences with appropriate verbs
25	Unit Test V		

UNIT VI

7 hours

Module	Vocabulary/ Grammar	Skills Sets	Skill Sets
26	Words with silent ‘b’ Present continuous questions	Calling for help in an emergency	Dialogue writing
27	Words with silent ‘c’ Simple present tense- form and usage	Making requests and responding to them politely	Identifying elements of grammar in text extract
28	Simple present tense- rules	Describing people	Guided writing
29	Words with silent ‘g’ Questions in the simple present tense	Describing places	Filling in the blanks with correct markers of tense
30	Unit Test VI		

Total: 45 hours

Source:

1. Basic English Module, L&L Education Resources, Chennai, 2011.

15LE102 COMMUNICATIVE ENGLISH I 3 0 0 3

Course Objectives

- To communicate effectively in social scenario
- To enhance the ability of reading, summarising and paraphrasing information
- To develop the techniques of writing through appropriate use of grammar and vocabulary

Programme Outcomes (POs)

j. **Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

Course Outcomes (COs)

1. Listen and comprehend different spoken discourses
2. Communicate ideas in English fluently during personal / official conversations
3. Apply grammar and vocabulary required at CEFR B1 level in spoken and written discourses
4. Read and comprehend general & technical text
5. Apply appropriate mechanics of writing in formal written communication

Program Outcomes (POs) Mapping

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1										2			1	
2										3			1	
3										1			1	
4										2			1	
5										3			1	

UNIT I: GRAMMAR AND VOCABULARY

9 hours

Content words and Structural words - Verbs and verb phrase - Subject - Verb agreement - Tenses - Active voice and passive voice - Sentence types (declarative, imperative, exclamatory & interrogative) - Framing questions - Comparative adjective

UNIT II: LISTENING

9 hours

Listening for specific information: Short conversations / monologues - Impersonal passive - Gap filling - Telephone conversations - Note-taking - Listening for gist / interviews - Listening to songs and completing the lyrics - Clear individual sounds - Telephone etiquette

UNIT III: READING

9 hours

Prediction - Skimming for gist - Scanning for specific information - Understanding text and sentence structure - Note Making

UNIT IV: WRITING

9 hours

Letter Writing: Formal letters / Job application - E-mail writing – Report & Proposal writing- Advertisement - Principles of writing a good paragraph: Unity, cohesion and coherence - Paragraph writing (descriptive, narrative, expository & persuasive)

UNIT V: SPEAKING

9 hours

Self-introduction (Elevator Pitch) - Giving personal and factual information - Talking about present circumstances, past experiences and future plans - Mini-presentation - Expressing opinions and justifying opinions - Likes and dislikes - Tongue twisters

FOR FURTHER READING

Short stories:
"The Astrologer's Day" by R. K Narayan "How Much Land does a Man Need?" by Leo Tolstoy

Total: 45 hours

References:

1. Murphy, Raymond. English Grammar in Use - A Self-Study Reference and Practice Book for Intermediate Learners of English. IV edition. United Kingdom: Cambridge University Press. 2012.
2. Seely, John. Oxford Guide to Effective Writing and Speaking. Indian edition. New Delhi: Oxford University Press. 2005.
3. Anderson, Kenneth. Study Speaking: A Course in Spoken English for Academic Purposes. United Kingdom: Cambridge University Press. 2004.

15LE201 BASIC ENGLISH II 3 0 0 3

Course Objectives:

- To focus on natural acquisition of rudimentary structures in English language through ample listening, reading and writing inputs
- To concentrate on speaking and conversation skills with a view to increase fluency in speaking
- Toenhance the ability of correct pronunciation and spelling

Programme Outcomes (POs)

j. **Communication**: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

Course Outcomes (COs)

1. Speak clearly in English to individuals / groups without hesitation
2. Comprehend simple day-to-day formal/ informal conversations
3. Apply appropriate tenses and verbs in writing
4. Read and comprehend paragraphs on simple topics
5. Write coherent paragraphs / reports / letters on familiar topics

Program Outcomes (POs) Mapping

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1										3			1	
2										2			1	
3										1			1	
4										2			1	
5										3			1	

UNIT I **7 hours**

Module	Vocabulary/ Grammar	Skills Sets	Skill Sets
31	Difference between Present Continuous and Simple Present tense	Calling for help in an emergency	Reporting an event- journalistic style
32	Verbs 'have' and 'have got'	Describing animals	Asking for and giving directions
33	Simple Past Tense	Inviting people, accepting and declining invitations	Self- enquiry and offering one's opinion on a given topic
34	Spelling rules & table of Irregular Verbs	Refusing an invitation	Reading and practicing pre- written dialogues
35	Unit Test I		

UNIT II **8 hours**

Module	Vocabulary/ Grammar	Skills Sets	Skill Sets
36	Questions and the negative form of	Apologizing and responding to an apology	(Reading) conversation practice

	the simple past tense		
37	Asking questions in the simple past tense	Reading comprehension	Seeking, granting and refusing permission
38	Past continuous tense	Paying compliments and responding to them	Pair work: writing dialogues and presenting them
39	Difference between simple past and past continuous- when and where to use each	Describing daily routines	Reading and comprehension skills
40	Unit Test II		

UNIT III **7 hours**

Module	Vocabulary/ Grammar	Skills Sets	Skill Sets
41	Simple future tense	Talking about the weather	Making plans- applying grammar theory to written work
42	Simple future tense- more aspects,	Talking about possessions	Opening up and expressing one's emotions
43	Future continuous tense	Talking about current activities	Listening comprehension
44	Revision of future tense- simple and continuous forms, prepositions used with time and date	Asking for the time and date	Discussion- analyzing and debating a given topic
45	Unit Test III		

UNIT IV **8 hours**

Module	Vocabulary/ Grammar	Skills Sets	Skill Sets
46	Articles a/an	Writing, speaking and presentation skills	Transcribing dictation
47	Singular- Plural (usage of a/an)	Reading practice- independent and shared reading	Comprehension –logical analysis, process analysis and subjective expression

48	Countable and uncountable nouns- a/an and some	Listening comprehension	Vocabulary: using context tools to decipher meaning
49	Articles- the	Sequencing sentences in a paragraph	Listening to a poem being recited, answer questions on it and practice reciting the same
50	Unit Test IV		

UNIT V **7 hours**

Module	Vocabulary/ Grammar	Skills Sets	Skill Sets
51	Articles- the: usage and avoidance	Speaking: sharing stories about family, village/town, childhood, etc. 10 students	Listening: comprehend and follow multiple step instructions read out by the teacher
52	Articles- the: usage and avoidance with like and hate	Speaking: sharing stories about family, village/town, childhood, etc. 10 students	Reading: Make inferences from the story about the plot, setting and characters
53	Articles- the: usage and avoidance with names of places	Speaking: sharing stories about family, village/town, childhood, etc. 10 students	Comprehension passage
54	This/ that/ these and those	Writing a notice-announcement	Speaking: Debate
55	Unit Test V		

UNIT VI **8 hours**

Module	Vocabulary/ Grammar	Skills Sets	Skill Sets
56	One and ones	Collaborative learning- problem solving	Writing short answers to questions based on reading
57	Capitalizatio n and	Controlled writing	Listen to a story and respond to its

	punctuation		main elements
58	Syntax and sentence construction-rearrange jumbled sentences	Guided writing	Listen to a poem and discuss its elements
59	Cloze Test	Free writing	Frame simple yet purposeful questions about a given passage
60	Unit Test VI		

Total: 45 hours

Resource:

1. Basic English Module, L&L Education Resources, Chennai, 2011.

15LE202 COMMUNICATIVE ENGLISH II 3 0 0 3

Course Objectives

- To acquire skills for using English language effectively in workplace
- To prepare students for taking BEC Vantage level examination
- To enhance the communicative ability from Intermediate to Upper Intermediate level
- To enhance the communicative ability from Intermediate to Upper Intermediate level

Programme Outcomes (POs)

j. **Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

Course Outcomes (COs)

1. Apply language structures and vocabulary required at CEFR B2 level in spoken and written discourses
2. Listen and comprehend different business conversations
3. Read and comprehend general & technical text
4. Apply appropriate mechanics of writing in formal written communication
5. Communicate effectively through formal and informal spoken and written business correspondences

Program Outcomes (POs) Mapping

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1										3			1	
2										2			1	
3										2			1	
4										1			1	
5										3			1	

UNIT I: GRAMMAR AND VOCABULARY **9 hours**

Simple, Compound and Complex sentences - Direct and Indirect speech - Conditionals - Business vocabulary - Collocations - Discourse markers

UNIT II: LISTENING **9 hours**

Listening to specific information - short notes - Listening to identify topic, content, function - Sentence stress - Rhythm - Intonation

UNIT III: READING **9 hours**

Reading graphs and charts - Skimming and scanning texts - Gap Filling - Read business articles for specific information - Understanding the structure of a text - Error identification

UNIT IV: WRITING **9 hours**

Formal and Informal English - Business Correspondence, Short Documents: e-mail, memo, message, - Longer Documents: Reports and Proposals - Transcoding

UNIT V: SPEAKING **9 hours**

Collaborative task - Turn taking (initiating and responding appropriately) - Negotiating - Exchanging information - Language Functions: suggesting - comparing and contrasting - expressing - Finding out facts, attitudes and opinions - Commonly mispronounced words

FOR FURTHER READING

Newspaper and Magazine reading (The Hindu / The New Indian Express / Times of India, India Today / Readers' Digest) - Reading Novels (The Monk Who Sold His Ferrari by Robin Sharma; Three Mistakes by Chetan Bhagat; The Fountain head by Ayn Rand)

Total: 45 hours

References:

1. Guy Book- Hart, BEC Vantage Cambridge Business Benchmark, Upper-Intermediate Cambridge University Press, 2006.

2. Eric H. Glendinning and Beverly Holmstrom, Study Reading: A Course in Reading for Academic Purposes. United Kingdom: Cambridge University Press, 2004.

15LC203 CHINESE 3 0 0 3

Course Objectives

- To help students acquire the basics of Chinese language
- To teach the student show to converse in Chinese in various situations
- To teach Chinese cultural facets and social etiquettes to the students

Programme Outcomes (POs)

j. **Communication**: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

Course Outcomes (COs)

1. Identify Initials and Finals of Chinese Alphabet
2. Recognise four different tones in a spoken Chinese sentence
3. Read Mandarin Chinese through Pinyin
4. Form sentences using basic Chinese vocabulary
5. Listen and comprehend basic Chinese conversation

Program Outcomes (POs) Mapping

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1										1			1	
2										2			1	
3										2			1	
4										3			1	
5										2			1	

UNIT I **9 hours**

Nǐhǎo-你好

Xuéhuìwènhòu de jīběnbiǎodáyòngyǔ - 学会问候的基本表达用语 ; Xuéhuìjièshàozìjǐ de xìngmíng, guójí - 学会介绍自己的姓名，国际 ; Xuéhuìhànyǔpīnyīn de shèngmǔ - 学会汉语拼音的圣母 ; yùnmǔhéshēngdiào - 韵母和声调 ; Pīndúhéshēngdiàoliànxí - 拼读和声调练习

UNIT II **9 hours**

Xiànzàijǐdiǎn-现在几点

Xuéhuìshíjiān, rìqí de biǎodá - 学会时间，日期的表达 ; Rèshēn - 热身 ; Shēngcí - 生词 ; Jùzi - 句子 ; Huìhuà - 会话 ;Huódòng - 活动 ; Kàntúwánchénghuìhuà - 看图完成会话 ; Xuécíyǔshuōshíjiān ; Tìhuànliànxí - 替换练习Dúyīdúránhòuliánxiàn - 读一读然后连线 ; Bǎxiàmiàn de cíànzhèngquè de shùnxùpáilièchéngjù - 把下面的词按正确的顺序排列成句

UNIT III **9 hours**

Nàjiànmáoyīzěnmemài? -那件毛衣怎么卖?

Xúnwènjiàqiánjíqián de biǎodá - 询问价钱及钱的表达 ; Tǎojiàhuánjià - 讨价还价 ; Tíchūduìsuǒmǎidōngxīdàxiǎo,yánsèděngděngjùtǐyāoqiú - 出对所买东西大小，颜色等等具体要求 ; ShēngcíHuódòng - 活动 ;Kàntúwánchénghuìhuà - 看图完成会话 ; Xuécíyǔshuōshíjiān ;Dúyīdúránhòuliánxiàn - 读一读然后连线 ;Tīnglùyīnxuǎnzézhèngquèdá'àn - 听录音选择正确答案 ; Bǔchōngcíyǔbiǎo - 补充词语表

UNIT IV **9 hours**

Xuéhuìxúnwènjiātíngqíngkuàng, zhíyèhéniánlíng - 学会询问家庭情况，职业和年龄

Xuéhuìdiǎncàitíyāoqiújiézhàng - 学会点菜提要求结账 ; Shēngcí - 生词 ; Jùzi - 句子 ;Huìhuà - 会话 ;Huódòng - 活动 ; Kàntúwánchénghuìhuà - 看图完成会话 ; Xuécíyǔshuōshíjiān ;Dúyīdúránhòuliánxiàn - 读一读然后连线 ;Tīnglùyīnxuǎnzézhèngquèdá'àn - 听录音选择正确答案 ; Bǔchōngcíyǔbiǎo - 补充词语表Juésèbànyǎn - 角色扮演; Tīnglùyīnpànduànduìcuò - 听录音判断对错

UNIT V **9 hours**

Nǐzàinǎ'ergōngzuò -在哪儿工作

Xuéhuìxúnwènjiātíngqíngkuàng, zhíyèhéniánlíng- 学会询问家庭情况，职业和年龄Shēngcí- 生词 ; Jùzi - 句子 ; Huìhuà - 会话 ; Huódòng - 活动 ; Kàntúwánchénghuìhuà - 看图完成会话 ;Tīnglùyīnxuǎnzézhèngquèdá'àn - 听录音选择正确答案 ; Bǔchōngcíyǔbiǎo - 补充词语表 - Tīnglùyīnxuǎnzézhèngquèdá'àn - 听录音选择正确答案; Bǔchōngcíyǔbiǎo - 补充词语表

Total: 45 hours

References:

1. David J. White. My Chinese Classroom, 2005 2. Tiyan Hanyu Shenghuo Pian, Experiencing Chinese, Ying Yu Ban Di 1 Ban. Beijing: Higher Education Press: Gaodengjiaohuchu ban she. 2011.

Software:

1.Hancel, Don. Mandarine Day. Chinese learning Software

Websites:

1. www.chinesexp.com.cn
2. www.yiwen.com.cn

15LF203 FRENCH 3 0 0 3

Course Objectives

- To help students acquire familiarity in the French alphabet & basic vocabulary
- To teach the students to use French in simple day-to-day conversations
- To prepare the students for French examination (level A1)

Programme Outcomes (POs)

j. **Communication**: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

Course Outcomes (COs)

1. Listen and comprehend individual sounds of French and simple day-to- day conversations
2. Apply basic sounds and words in simple sentences for communication
3. Read and comprehend short passages on familiar topics
4. Frame basic sentence structures while writing
5. Recognize and apply basic grammar and appropriate vocabulary in completing language tasks

Program Outcomes (POs) Mapping

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1										2			1	
2										3			1	
3										2			1	
4										3			1	
5										1			1	

Unit I 6 Hours

Alphabet Français et Les Accents Français - Les articles définis, indéfinis Genre - Singulier et pluriel – Salutations

Unit II **8 Hours**

Verbes - Conjugaison : Présent (Avoir / Être / ER, IR, RE : Régulier et Irrégulier) - Adjectifs - Nationalités - Professions - Formuler les questions **LIRE**

Unit III **8 Hours**

Les jours de la semaine - Les mois de l'année - Les saisons - Numéros - Quelle heure est - il ? - Famille - Articles Contractés - Préposition - Adjectifs Possessifs **PARLER :** Se présenter **; LIRE**

UNIT IV **9 Hours**

Verbes - Conjugaison : Impératif, Futur proche, Passé-récent (ER / IR / RE : Régulier et Irrégulier) - Articles Partitifs - Adjectifs Démonstratifs - La Gastronomie Française. **PARLER ; LIRE**

UNIT V **14 Hours**

Verbe Conjugaison : Passé-composé, Imparfait, Futur simple, Conditionnel (ER / IR / RE : Régulier et Irrégulier) - Carte Postale - Courriel **PARLER :** Jeu de Rôle**; ÉCOUTER** Compréhension Orale

Total : 45 Hours

References :

1. Grammaire Progressive du Français, CLÉ International, 2010.
2. Collins Easy Learning French Verbs & Practice, Harper Collins, 2012.
3. Barron's Learn French, 3rd Edition, Elizabeth Bourquin, Language Institute, 2012.
4. Cours de Langue et de Civilisation Françaises, G. Mauger, Hachette, 2014.
5. Saison 1, Marie-Noëlle Cocton et al, Didier, 2014.

Softwares :

1. Français Linguaphone : Linguaphone Institute Ltd., London, 2000.
2. Français Harrisonburg : The Rosetta Stone : Fairfield Language Technologies, 2001.

15LG203 GERMAN 3 0 0 3

Course Objectives

- To help students acquire the basics of German language
- To teach them how to converse in German in day-to-day situations

Programme Outcomes (POs)

J. **Communication**: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

Course Outcomes (COs)

1. Listen and identify individual sounds of German and simple day-to-day conversations
2. Speak simple sentences using basic sounds and words
3. Read and understand short passages on familiar topics
4. Apply basic sentence structures while writing
5. Apply basic grammar and appropriate vocabulary in completing language tasks

Program Outcomes (POs) mapping

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1										2			1	
2										3			1	
3										2			1	
4										3			1	
5										1			1	

UNIT I **7 Hours**
Introduction to German language: Alphabets - Numbers - Greetings - country - nationalities - Working with Dictionary.

UNIT II **7 Hours**
Nouns – Pronouns - definite and indefinite article - Speaking about oneself - Listening to CD supplied with the books, paying special atonunciation.
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UNIT III **7 Hours**
Regular verbs - Conjugation - Irregular verbs - Time - Negation - adjectives - family - profession - Introduction to types of sentences

UNIT IV **12 Hours**
Question words - Types of Questions - Nominative - Accusative and dative case - framing basic questions and answers - Writing short notes and letter- reading the news boards, directions

UNIT V **10 Hours**
Imperative case - Possessive articles - propositions - modal auxiliaries - Basic dialogue and group conversation - ordering in restaurants.

Total: 45 Hours

References

1. Continuum International Publishing Group Ltd. London / New York, 1992. Eckhard, Christine. Whittle, Black & Ruth. Cassel Language Guides - German.
2. Rusch, Paul. Netzwerk A1. Deutsch AlsFremdsprache. Goyal Publishers & Distributers Pvt. Ltd. New Delhi, 2015.
3. Langenscheidt Universal German Dictionary: German-English, English-German. Goyal Publishers & Distributers Pvt. Ltd., New Delhi, 2009.
4. Grundkurs Deutsch A Short Modern German Grammar Workbook and Glossary. Verlag Fur Deutsch.Munichen, 2007.
5. Grundkurs. Deutsch Lehrbuch. Hueber. Munichen, 2007.

15LH203 HINDI 3 0 0 3

Course Objectives

- To help students acquire the basics of Hindi language
- To teach them how to converse in Hindi in day-to-day situations
- To help students acquire the ability to understand a simple technical text in Hindi

Programme Outcomes (POs)

j. **Communication**: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

Course Outcomes (COs)

1. Read and identify Hindi letters, words and simple sentences
2. Construct simple sentences and use appropriate vocabulary during day-to-day oral communication
3. Identify basic sounds of Hindi language and understand simple conversations on familiar topics
4. Write common words and sentences
5. Comprehend elementary level grammar of Hindi

Program Outcomes (POs) Mapping

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1										2			1	
2										3			1	
3										2			1	
4										3			1	
5										1			1	

Unit I **9 Hours**

Hindi Alphabet: Introduction - Vowels - Consonants - Plosives - Fricatives - Nasal sounds - Vowel Signs - Chandra Bindu & Visarg -Table of Alphabet -Vocabulary.

Unit II **9 Hours**

Nouns: Genders (Masculine & Feminine Nouns ending in - ā,i,ī, u,ū)- Masculine & Feminine – Reading Exercises.

Unit III **9 Hours**

Pronouns and Tenses: Categories of Pronouns - Personal Pronouns - Second person (you & honorific) - Definite & Indefinite pronouns - Relative pronouns - Present tense - Past tense - Future tense - Assertive & Negative Sentences - Interrogative Sentences.

Unit IV **9 Hours**

Classified Vocabulary: Parts of body - Relatives - Spices - Eatables - Fruit & Vegetables - Clothes - Directions - Seasons - Professions.

Unit V **9 Hours**

Speaking: Model Sentences and Rhymes - Speaking practice for various occasions.

Total: 45 Hours

References:

1. Kishore B.R., Self Hindi Teacher for Non-Hindi Speaking People, Vee Kumar

2. Dakshin. Dakshin Bharath Hindi Prachar Sabha, Chennai. 2016.
3. Videos, Stories, Rhymes and Songs.

15LJ203 JAPANESE 3 0 0 3

Course Objectives

- To help students learn Japanese alphabet
- To teach students how to use the basic Japanese sentences in day-to-day conversation
- To make students familiar with the Japanese cultural facets and social etiquettes

Programme Outcomes (POs)

j. **Communication**: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

Course Outcomes (COs)

1. Recognise and write Japanese alphabet
2. Speak using basic sounds of the Japanese language
3. Apply appropriate vocabulary needed for simple conversation in Japanese language
4. Apply appropriate grammar to write and speak in Japanese language
5. Comprehend the conversation and give correct meaning

Program Outcomes (POs) Mapping

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1										3			1	
2										1			1	
3										3			1	
4										1			1	
5										2			1	

UNIT I 9 hours

Introduction to Japanese - Japanese script - Pronunciation of Japanese (Hiragana) - Long vowels - Pronunciation of in,tsu,ga - Letters combined with ya,yu,yo - Daily Greetings and Expressions - Numerals. N1 wa N2 des - N1 wa N2 ja arimasen - S ka - N1mo - N1 no N2- …….san - Kanji - Technical Japanese Vocabulary (25 Numbers) - Phonetic and semantic resemblances between Tamil and Japanese

UNIT II 9 hours

Introduction - Kore - Sore - are - Kono N1 - Sono N1 - ano N1 - so des - so ja arimasen - S1 ka - S2 ka - N1 no N1 - so des ka - koko - soko - asoko - kochira - sochira - achira - N1 wa N2 (Place) des - dhoko-N1 no N2 - Kanji-10 - ima….ji…fun des - Introduction of verb - V mas - V masen - V mashitha - V masen deshitha - N1(Time) ne V - N1 kara N2 des - N1 tho N2 / S ne Kanji-10 - Technical Japanese Vocabulary (25 Numbers) - Dictionary Usage.

UNIT III 9 hours

- N1(Place) ye ikimas - ki mas - kayerimasu - Dhoko ye mo ikimasen - ikimasendheshitha -

N1(vehicle) de ikimasu - kimasu - kayerimasu - N1(Personal or Animal) tho V ithsu - S yo.- N1 wo V (Transitive) - N1 wo shimus - Nani wo shimasu ka - Nan & Nani - N1(Place) de V - V masen ka - V masho - Oo……. Kanji-10 , N1(tool - means) de V - " Word / Sentence " wa …go nan des ka - N1(Person) ne agemus - N1(Person) ne moraimus - mo V shimashitha - , Kanji-10 – Japanese Typewriting using JWPCE Software, Technical Japanese Vocabulary (25 Numbers)

UNIT IV

9 hours

Introduction to Adjectives - N1wanaadj des. N1 wa ii adj des - naadjna N1 - ii adj ii N1 - Thothemo - amari - N1 wadho des ka - N1 wadhonna N2 des ka - S1 ka S2 - dore - N1 gaarimasu - wakarimasu - N1 ga suki masu - N1 gakiraimasu - jozu des - hetha des - donna N1 - Usages of yoku - dhaithai - thakusan - sukoshi - amari - zenzen - S1 kara S2 - doshithe, N1 gaarimasu - imasu - N1(Place) ne N2 gaarimasu - iimasu - N1 wa N2(Place) ne arimasu - iimasu - N1(Person,Place,or Thing) no N2 (Position) - N1 ya N2, Kanji-10 - Japanese Dictionary usage using JWPCE Software, Technical Japanese Vocabulary (25 Numbers)

UNIT V **9 hours**

Saying Numbers , Counter Suffixes - Usages of Quantifiers -Interrogatives - Dhonokurai - gurai – Quantifier - (Period) ne ….kai V - Quantifier dhake / N1 dhake Kanji - Past tense of Noun sentences and na Adjective sentences - Past tense of ii-adj sentences - N1 wa N2 yoriadj des - N1 tho N2 thoDhochiragaadj des ka and its answering method - N1 [no naka] de {nani/dhoko/dhare/ithsu} ga ichiban adj des ka - answering -N1 gahoshi des - V1 masform dhake mas - N1 (Place) ye V masu form ne ikimasu/kimasu/kayerimasu - N1 ne V/N1 wo V - Dhokoka - Nanika – gojumo - Technical Japanese Vocabulary (25 Numbers)

Total: 45 hours

References:

1. Japanese for Everyone: Elementary Main Textbook1-1, Goyal Publishers and Distributors Pvt. Ltd., Delhi, 2007.
2. Japanese for Everyone: Elementary Main Textbook 1-2, Goyal Publishers and Distributors Pvt. Ltd., Delhi, 2007.

Software:

1. Nihongo Shoho-1
2. Nihongo Shoho-2
3. JWPCE Software

Websites:

1. www.japaneselifestyle.com
2. www.learn-japanese.info/
3. www.kanjisite.com/
4. www.learn-hiragana-katakana.com/typing-hiragana-characters/

15PH201 PHYSICS OF MATERIALS

3 0 2 4

Course Objectives

- To understand the physical properties of conductors, semiconductors and superconductors
- To recognize the basic principles of interaction of light with matter and working of optical devices
- To classify the types of dielectric, magnetic materials and polarization mechanisms with their properties

Programme Outcomes (POs)

a. **Engineering Knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

b. **Problem Analysis**: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

i. **Individual and Team Work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

Course Outcomes (COs)

1. Analyze the properties of conductors and superconductors for different applications
2. Apply the concepts and types of semiconductors for solar cell applications
3. Discuss the types, properties and applications of dielectric materials
4. Explain the properties of optical materials, working mechanism of LEDs and LCDs
5. Classify the magnetic materials with their properties and apply in the data storage devices

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2	1							2				2	
2	2	1							2				2	1
3	2	1											2	
4	2	1											3	1
5	2	1							2				1	2

UNIT I **9 Hours**

CONDUCTING AND SUPERCONDUCTING MATERIALS

Electrical and thermal conductivity of metals - Wiedemann Franz law - band theory of metals - density of states. Superconductors: properties - types - High Tc superconductors- applications.

UNIT II **10 Hours**

SEMICONDUCTORS

Elemental and compound semiconductors - intrinsic semiconductors: carrier concentration - electrical conductivity- band gap. Extrinsic semiconductors: carrier concentration - variation of Fermi level. Hall effect: theory and experimental determination -applications:Solar cells

UNIT III **9 Hours**

DIELECTRIC MATERIALS

Types of polarization: electronic, ionic, orientation and space charge polarization mechanisms - Langevin-Debye equation - frequency and temperature effects on polarization - dielectric strength and loss -dielectric breakdown mechanisms - active dielectric materials: pizo, pyro and ferroelectricity - applications.

UNIT IV **9 Hours**

OPTICAL MATERIALS

Interaction of light with materials - optical absorption - transmission - Luminescence in solids - Fluorescence and Phosphorescence - Optical band gap - LED ,LCD.

UNIT V **8 Hours**

MAGNETIC MATERIALS

Classification and properties - domain theory - hard and soft magnetic materials - anti-ferro and ferri magnetic materials - applications: magnetic recording and memories.

FOR FURTHER READING

Photonic crystals - LIFI

1 **2 Hours**

INTRODUCTION

Exposure to Engineering Physics Laboratory and precautionary measures

2 **4 Hours**

EXPERIMENT 1

Using Lees disc apparatus, determine the coefficient of thermal conductivity of a bad conductor.

3 **4 Hours**

EXPERIMENT 2

Find the band gap value of the given semiconductor diode. Based on the band gap value, identify the given semiconductor.

4 **4 Hours**

EXPERIMENT 3

With the aid of travelling microscope, find the refractive index of a transparent solid and liquid material.

5 **4 Hours**

EXPERIMENT 4

Determine the wavelength of polychromatic source in the visible region using spectrometer.

6 **4 Hours**

EXPERIMENT 5

Based on Hall effect, calculate the charge carrier density of a given semiconductor and identify the nature of the semiconductor.

7 **4 Hours**

EXPERIMENT 6

Draw the B-H curve of a ferromagnetic material subjected to external magnetic field and hence identify the nature of the material.

8 **4 Hours**

EXPERIMENT 7

Determine the V-I characteristics of a solar cell.

Total: 75 Hours

Reference(s)

1. Saxena, Gupta, Saxena, Mandal, Solid State Physics, Pragati Prakashan Educational Publishers, 13th revised edition, Meerut, India, 2013.
2. M.N. Avadhanulu and P.G. Kshirsagar, A Text Book of Engineering Physics, S. Chand & Company Ltd., New Delhi, 2011.
3. S. O. Pillai, Solid State Physics, New Age International Publications, New Delhi, 2010.

4. M.A. Wahab, N.K. Mehta, Solid state physics-structure and properties of materials, Narosa publishing house Pvt. Ltd, 6th edition, 2010.
5. Semiconductor Physics and Devices, Donald A. Neamen , Mc Graw-Hill, 2011.
6. P.K. Palanisamy, Materials Science, Scitech Publications India Pvt. Ltd, 2014.

Assessment Pattern

Unit/RBT	Remember				Understand				Apply				Analyse				Evaluate				Create				Total
	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	
1	2	4	2		1	4	2		1	2			1	1											20
2	2		2		2		4		5	3			4												22
3	1	2	1		3	4			3	4			2												20
4	2	2			2	5			2	5			2												20
5	1	3			3	2	3		3	1			2												18
																								Total	100

Assessment Questions

Remember

1. State Meissner effect
2. List six properties of superconducting materials
3. Define photovoltaic effect
4. List the six common applications of dielectric materials
5. Retrieve optical absorption in metals
6. Reproduce the principle of LCD in display devices
7. Recall the term hysteresis in ferromagnetic materials
8. List four applications of magnetic materials
9. Recognize the need of optical band gap in differentiating the materials
10. Reproduce five applications of hard magnetic materials in day to day life

Understand

1. Explain the principle, construction and working of LED
2. Classify the three types of materials based on band gap energy
3. Interpret the working mechanism and characteristics of a solar cell
4. Illustrate Hall effect experiment used to find the concentration of charge carriers in n- type semiconductors and hence explain the necessary theory
5. Summarize the various dielectric breakdown mechanisms observed in dielectric materials
6. Infer the principle involved in working of magnetic levitation
7. Classify the two types of luminescence in solids with appropriate energy level diagrams
8. Subsume the four types of polarization mechanisms involved in dielectric materials
9. Illustrate the V-I characteristics of a solar cell
10. Extrapolate the Clausius Mosotti equation for the dielectric material which is subjected to external electric field

Apply

1. Free electron density of aluminum is 18.10x1028 m-3. Calculate its Fermi energy at 0K. Planck's constant and mass of free electron are 6.62x10-34 Js and 9.1x10-31 Kg
2. Compute the relation between Remanence and Coercivity
3. Demonstrate the domain theory of ferromagnetism
4. Derive the expressions for electrical and thermal conductivity of metals and hence compute the Wiedemann Frantz law
5. Compute the carrier concentration in intrinsic and extrinsic semiconductors
6. Calculate the number of free electrons per unit volume in a metal in terms of Fermi energy
7. Assess the Magnetic levitation and SQUIDS in day to day life
8. Show the importance of dielectric breakdown mechanisms in dielectrics
9. Implement the applications of dielectric materials in real world problems
10. Compute the relation between polarization vector (P) and electric field (E)

Analyse

1. Differentiate Phosphorescence and Fluorescence
2. Can we increase the orientation polarization with increase in temperature? Justify
3. Justify the principle, construction, working, advantages and disadvantages of LCD
4. Compare hard and soft magnetic materials
5. Differentiate the ferromagnetic and anti-ferromagnetic materials with examples
6. Compare dia, para and ferromagnetic materials
7. Distinguish between polarization and polarizability
8. Differentiate elemental and compound semiconductors
9. Compare type I and type II superconductors
10. Compare LED and LCD

15PH202 APPLIED PHYSICS

3 0 2 4

Course Objectives

- To understand conducting, semiconducting, dielectric and magnetic properties of materials and exemplify their applications
- To analyze the basic concepts of thermodynamics and heat transfer with illustrations
- To gain knowledge about acoustical standards of buildings

Programme Outcomes (POs)

a. **Engineering Knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

b. **Problem Analysis:** Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

i. **Individual and Team Work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

Course Outcomes (COs)

1. Analyze the physical properties of conducting and semiconducting materials
2. Discuss the physical properties of dielectric and magnetic materials with their applications
3. Apply the thermodynamic processes and laws to compute the efficiency of heat engines
4. Compare the different heat transfer modes with real time applications of conduction
5. Explain the characteristics of music and select proper sound absorbing materials for good acoustic of buildings

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2	1							2				2	
2	2	1							2				2	
3	2	1											1	2
4	2	1											1	2
5	2	1							2				2	1

UNIT I **11 Hours**

CONDUCTORS AND SEMICONDUCTORS

Conductors: Classical free electron theory - electrical and thermal conductivity- Wiedemann - Franz law - merits and demerits of classical free electron theory - band theory - density of states. Semiconductors: Elemental and compound semiconductors - intrinsic semiconductors -Fermi level and electrical conductivity - band gap energy - extrinsic semiconductors - n-type and p-type semiconductors: variation of Fermi level with temperature (qualitative) - Hall effect - applications.

UNIT II **9 Hours**

DIELECTRIC AND MAGNETIC MATERIALS

Dielectrics: Fundamental terminologies - electronic and ionic polarizations - orientation polarization mechanism (qualitative) - space charge polarization - Langevin -Debye equation - dielectric loss - applications of dielectric and insulating materials.Magnetic Materials: Properties of dia, para and ferromagnetic materials - domain theory of ferromagnetism - hysteresis curve - hard and soft magnetic materials - applications

UNIT III **9 Hours**

THERMODYNAMICS

Zeroth law of thermodynamics - Heat - equilibrium and quasistatic process - path functions - comparison between heat and work - internal energy - first law of thermodynamics - isothermal and adiabatic process - work done - reversible and irreversible process - second law of thermodynamics - entropy - enthalpy - Carnot ideal engine and its efficiency - Carnot's theorem-actual heat engine: Diesel engine and its efficiency

UNIT IV **9 Hours**

HEAT TRANSFER

Modes of heat transfer - thermal conductivity - heat capacity and diffusivity - rectilinear flow of heat - conduction through bodies in series and parallel - determination of thermal conductivity: good conductor: Searle's method - bad conductor: Lee's disc method - applications of heat transfer: formation of ice in ponds - conductivity of earth's crust and age of earth - practical applications

UNIT V **7 Hours**

ACOUSTICS

Classification of sound based on frequency - characteristics of audible sound - reverberation time: Sabine's formula - determination of absorption coefficient - Erying's formula (qualitative). Sound insulation - sound absorbing materials - factors affecting the acoustics of building – remedies

FOR FURTHER READING

Nanomaterials and its applications

1 **2 Hours**

INTRODUCTION

Exposure to Engineering Physics Laboratory and precautionary measures

2 **4 Hours**

EXPERIMENT 1

Using Lees disc apparatus, determine the coefficient of thermal conductivity of a bad conductor.

3 **4 Hours**

EXPERIMENT 2

Find the band gap value of the given semiconductor diode. Based on the band gap value, identify the given semiconductor.

4 **4 Hours**

EXPERIMENT 3

With the aid of traveling microscope, find the refractive index of a transparent solid and liquid material

5 **4 Hours**

EXPERIMENT 4

Determine the wavelength of polychromatic source in the visible region using spectrometer

6 **4 Hours**

EXPERIMENT 5

Based on Hall effect, calculate the charge carrier density of a given semiconductor and identify the nature of the semiconductor.

7 **4 Hours**

EXPERIMENT 6

Draw the B-H curve of a ferromagnetic material subjected to external magnetic field and hence identify the nature of the material.

8 **4 Hours**

EXPERIMENT 7

Determine the V-I characteristics of a solar cell.

Total: 75 Hours

Reference(s)

1. William D. Callister, Materials Science and Engineering an Introduction, John Wiley and Sons,Inc, 2010
2. BrijLal, N. Subrahmanyam and P. S. Hemne, Heat, Thermodynamics & Statistical Physics, S. Chand & Company Ltd., New Delhi, 2012
3. Saxena, Gupta, Saxena, Mandal, Solid State Physics, Pragati Prakashan Educational Publishers, 13threvised edition, Meerut, India, 2013
4. P.K. Mittal, Applied Physics, I.K. International Publishing House Pvt. Ltd, 2008
5. Donald A. Neamen, Semiconductor Physics and Devices,McGraw-Hill, 2011

Assessment Pattern

Unit/RBT	Remember				Understand				Apply				Analyse				Evaluate				Create				Total
	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	
1	3	4				3				4	4			2					4						24
2	2	2				4	2			2	4			4											20
3	2	4				4	2			4	2			2											20
4	2	2				4	2			2	4			4											20
5	2	2				2	2			4					4										16
																								Total	100

Assessment Questions

Remember

1. State Ohm's law.
2. Define drift velocity.
3. List the two drawbacks of classical free electron theory.
4. State Wiedemann-Franz law.
5. Mention the practical unit used for electron's magnetic moment.
6. Recall the term hysteresis in ferromagnetic materials.
7. List the four uses of magnetic materials.
8. State Zeroth law of thermodynamics.
9. State the Kelvin's statement of second law of thermodynamics.
10. Name the three modes of heat transfer.
11. State Echelon effect.

Understand

1. Illustrate the significance of Fermi energy.
2. Why indirect gap semiconductors are preferred in fabricating transistors?
3. Classify the types of magnetic materials.
4. Outline the term retentivity and coercivity.
5. Compare dia, para and ferro magnetic materials.
6. Point out the ideal conditions required for diesel cycle.
7. Sketch the isothermal and adiabatic processes in P-V diagram.
8. Is it possible for a practical engine to have 100% efficiency? Justify.
9. Ice kept in saw dust or wrapper in a blanket will not melt. Why?
10. Classify the types of sound waves.
11. Explain the three characteristics of musical sound.

Apply

1. The average energy of a conduction electron in copper at 300 K is 4.23 eV. Calculate the Fermi energy of copper at 300 K.
2. Determine the carrier concentration of *p*-type semiconductor whose hall coefficient is 3.6610-4 m3/C.
3. Compute the efficiency of Carnot's engine operating between the temperatures 3270C and 270C.
4. Point out practical applications of heat conduction.
5. Compute the efficiency of Carnot's engine working the steam point and the ice point.
6. Assess the reason for the formation ice on pond surface.
7. The intensity of sound produced by thunder is 0.1 $Wm^{-2.}$Calculate the intensity level in decibels.
8. Calculate Sabine's mathematical relation for reverberation time of the hall.
9. Compute the minimum wavelength of audible sound at zero degree centigrade.

Analyse

1. Distinguish between relaxation time and collision time.
2. Differentiate between electrical and thermal conductivity.
3. List the various applications of soft and hard magnetic materials for day to day life.
4. Analysis the six properties of hard and soft magnetic materials.
5. If the system and surrounding are in thermal equilibrium, is it necessary they are in same state? Comment the statement.
6. Differentiate isothermal and adiabatic process.
7. Entropy remains constant in an adiabatic process. Justify the statement.
8. Compare Carnot's cycle and diesel cycle.

9. Distinguish between loudness and intensity of sound.
10. Compare reverberation and echo.
11. How do you maintain optimum reverberation in a hall? Justify.

Evaluate

1. The mean free collision time of copper at 300 K is equal to 2X 10^{-14} s. Determine its electrical conductivity.
2. A silicon plate of thickness 1mm, breadth 10 mm and length 100mm is placed in a magnetic field of 0.5 wb/m^2 acting perpendicular to its thickness. If 10^{-2} A current flows along its length, determine the Hall voltage developed if the Hall coefficient is 3.66 X 10^{-4} m^3 / Coulomb.

15PH203 MATERIALS SCIENCE 3 0 2 4

Course Objectives

- To explain the properties of conducting, semiconducting and dielectric materials
- To impart fundamental knowledge in optical materials
- To understand the nature and applications of different magnetic materials

Programme Outcomes (POs)

a. **Engineering Knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

Course Outcomes (COs)

1. Distinguish electrical properties of different kinds of conducting materials
2. Identify the different types of semiconductors and its applications
3. Categorize the various polarization mechanisms in dielectrics
4. Choose the suitable material for the construction of display devices
5. Select appropriate magnetic materials for magnetic storage devices

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3												2	
2	2												3	
3	1												2	
4	1												2	3
5	1												2	3

UNIT I **8 Hours**

ELECTRICAL PROPERTIES OF METALS

Quantum free electron theory: Fermi-Dirac distribution function - Fermi energy and its variation with temperature - density of energy states - calculation of density of electrons and fermi energy at 0K - mean energy of electrons at 0K - problems.

UNIT II **10 Hours**

SEMICONDUCTING MATERIALS

Introduction - elemental and compound semiconductors - intrinsic semiconductors: expressions for number of electrons and holes - determination of carrier concentration and position of Fermi energy -

electrical conductivity - band gap energy determination - carrier concentration in extrinsic semiconductors. Hall effect: theory and experimental determination - uses - problems.

UNIT III **9 Hours**

DIELECTRICS

Introduction - fundamental definitions in dielectrics - expressions for electronic and ionic polarizations - orientation polarization (qualitative) - space charge polarization - Langevin - Debye equation - frequency and temperature effects on polarization - internal field - expression for internal field (cubic structure) - Clausius-Mosotti equation and its importance - applications of dielectric materials - problems.

UNIT IV **9 Hours**

OPTICAL MATERIALS

Introduction - optical absorption in metals, semiconductors and insulators. Fluorescence and phosphorescence. Light emitting diode: principle, construction, working and applications. Liquid crystal display: general properties - dynamic scattering display - twisted nematic display - applications - comparison between LED and LCD. Blue ray disc - principle - working.

UNIT V **9 Hours**

MAGNETIC MATERIALS

Introduction - orbital and spin magnetic moments - Bohr magneton - basic definitions - classification of magnetic materials - domain theory of ferromagnetism - process of domain magnetization - explanation of hysteresis curve based on domain theory - hard and soft magnetic materials.

FOR FURTHER READING

Optical data storage and Giant magnetoresistance

1 **2 Hours**

INTRODUCTION

Exposure to Engineering Physics Laboratory and precautionary measures

2 **4 Hours**

EXPERIMENT 1

Using Lees disc apparatus, determine the coefficient of thermal conductivity of a bad conductor.

3 **4 Hours**

EXPERIMENT 2

Find the band gap value of the given semiconductor diode. Based on the band gap value, identify the given semiconductor.

4 **4 Hours**

EXPERIMENT 3

With the aid of traveling microscope, find the refractive index of a transparent solid and liquid material.

5 **4 Hours**

EXPERIMENT 4

Determine the wavelength of polychromatic source in the visible region using spectrometer.

6 **4 Hours**

EXPERIMENT 5

Based on Hall effect, calculate the charge carrier density of a given semiconductor and identify the nature of the semiconductor.

7 **4 Hours**

EXPERIMENT 6

Draw the B-H curve of a ferromagnetic material subjected to external magnetic field and hence identify the nature of the material.

4 Hours

8

EXPERIMENT 7

Determine the V-I characteristics of a solar cell.

Total: 75 Hours

Reference(s)

1. William D. Callister, Materials Science and Engineering an Introduction, John Wiley and Sons, Inc, 2010.
2. S.O. Pillai, Solid State Physics, New Age International Publications, New Delhi, 2014.
3. M.N. Avadhanulu and P.G. Kshirsagar, A Text Book of Engineering Physics, S. Chand & Company Ltd., New Delhi, 2011.
4. P.K. Palanisamy, Physics For Engineers, Scitech Publications (India) Pvt. Ltd., Chennai, 2010.
5. V. Raghavan, Materials Science and Engineering, Prentice Hall of India, New Delhi, 2010.
6. R.K.Gaur and S.L.Gupta, Engineering Physics, Dhanpat Rai publications, New Delhi, 2010.

Assessment Pattern

Unit/RBT	Remember				Understand				Apply				Analyse				Evaluate				Create				Total
	F	**C**	**P**	**M**	**F**	**C**	**P**	**M**	**F**	**C**	**P**	**M**	**F**	**C**	**P**	**M**	**F**	**C**	**P**	**M**	**F**	**C**	**P**	**M**	
1	2	5	2		1	5	2		1																18
2	2		2		2	3	2		5		2		4												22
3	1	2	1		3	3			3	5			2												20
4	2	3			3	3			2	5			2												20
5	1	3			3	2	5		3	1			2												20
																								Total	100

Assessment Questions

Remember

1. Define density of electron energy states in metals.
2. Recall Fermi energy.
3. State Hall Effect.
4. List out the four advantages of semiconductors.
5. Define dielectric constant
6. Recall electric polarization.
7. Define Fluorescence.
8. Recognize hard and soft magnetic materials.
9. State the working principle of LED.
10. Define Bohr magnetron.

Understand

1. Classify three types of free electron theory
2. Represent the variation of Fermi level with temperature
3. Explain Clausius-Mosotti relation.
4. Compare element and compound type semiconductors.
5. Illustrate the variation of Fermi level with temperature in n-type semiconductors.
6. Distinguish between a dielectric and insulator.
7. Mention the technique to increase the emission time in phosphorescence.
8. Exemplify hysteresis on the basis of domain theory of ferromagnetism.
9. Identify four examples for hard magnetic materials.
10. Identify four properties of ferromagnetic materials.

Apply

1. Compute the Fermi direc function for energy kT above the Fermi energy.
2. Asses the Fermi-Dirac distribution function.
3. Energy level of p-type and n-type semiconductors and justify the results
4. Compute the carrier concentration of intrinsic semiconductors
5. Explain the principle, construction and working of Hall Effect
6. Show that electronic and ionic polarizabilities are independent of temperature.
7. Calculate the polarization of an atom above value five.
8. Differentiate the dia, para and ferromagnetic materials.
9. Compute the B-H Hysteresis curve on the basis of domain theory.

Analyse

1. Discriminate drift velocity and thermal velocity of an electron
2. Difference between p-type and n-type semiconductors.
3. Obtain the expression for concentration of charge carriers in p-type semiconductor.
4. In practical dielectrics, the current does not exactly lead the voltage by 90?. Justify.
5. Local field is the space and time average of the electric field acting on a particular molecule Justify the result.
6. Justify the special features of magnetic blue ray disks.
7. Analyze the role of energies in the domain growth.
8. Explain the roll of activators in optical materials
9. Describe the working of twisted pneumatic display device.
10. Compare LED and LCD.

15PH204 PHYSICS OF ENGINEERING MATERIALS 3 0 2 4

Course Objectives

- To familiarize with the physical properties of materials
- To gain practical applications of modern spectroscopy and microscopy techniques
- To understand the preparation of bio and nanomaterials

Programme Outcomes (POs)

a. **Engineering Knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

Course Outcomes (COs)

1. Identify the electrical and thermal properties of conducting and semiconducting materials
2. Analyze the various polarization mechanisms in dielectrics

3. Choose specific materials for optical and magnetic data storage devices
4. Investigate the specimen with the aid of suitable spectroscopic techniques
5. Realize the methods adopted for preparing nano materials

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3												2	
2	2												3	
3	1												2	3
4	3												2	
5	2												2	

UNIT I **10 Hours**

CONDUCTING AND SEMICONDUCTING PROPERTIES

Quantum free electron theory - Fermi-Dirac distribution function - effect of temperature on Fermi function - density of energy states - calculation of density of electrons and Fermi energy at 0 K. Intrinsic semiconductors: expressions for density of electrons and holes - intrinsic carrier concentration - band gap energy. Extrinsic semiconductors: carrier concentration in n-type and p-type semiconductors - variation of Fermi level with temperature and impurity concentration - problems.

UNIT II **9 Hours**

DIELECTRIC PROPERTIES

Introduction: fundamental definitions in dielectrics - types of polarization - expressions for electronic and ionic polarization mechanisms - orientation polarization (qualitative) - Langevin-Debye equation - frequency and temperature effects on polarization - dielectric loss - dielectric breakdown mechanisms - active dielectric materials - applications of dielectric materials - problems.

UNIT III **10 Hours**

OPTICAL AND MAGNETIC PROPERTIES

Optical properties: introduction - light interaction with solids - atomic and electronic interactions - optical properties of metals, semiconductors and insulators - reflection - refraction - absorption - transmission - luminescence and photoconductivity. Magnetic properties: introduction - origin of magnetic moment - properties of dia, para and ferro magnetic materials - domain theory and hysteresis effect - hard and soft magnetic materials - problems.

UNIT IV **8 Hours**

SPECTROSCOPY AND MICROSCOPY TECHNIQUES

Introduction: different types of spectroscopy techniques - basic principle of FTIR spectroscopy and X-ray Photoelectron Spectroscopy (XPS). Basic principle and working mechanisms of Scanning Electron Microscope (SEM) - Transmission Electron Microscope (TEM) - Atomic Force Microscope (AFM).

UNIT V **8 Hours**

BIO AND NANO MATERIALS

Biomaterials: classification of biomaterials - development of biomaterials - applications. Nanomaterials: properties - synthesis of nanomaterials - top-down approach: ball milling technique - bottom-up approach: Chemical Vapour Deposition (CVD) - uses of nanomaterials. Carbon nanotubes: properties and applications.

FOR FURTHER READING

Health and environmental impacts

1 **2 Hours**

INTRODUCTION

Exposure to Engineering Physics Laboratory and precautionary measures

2 **4 Hours**

EXPERIMENT 1

Using Lees disc apparatus, determine the coefficient of thermal conductivity of a bad conductor.

3 **4 Hours**

EXPERIMENT 2

Find the band gap value of the given semiconductor diode. Based on the band gap value, identify the given semiconductor.

4 **4 Hours**

EXPERIMENT 3

With the aid of traveling microscope, find the refractive index of a transparent solid and liquid material.

5 **4 Hours**

EXPERIMENT 4

Determine the wavelength of polychromatic source in the visible region using spectrometer.

6 **4 Hours**

EXPERIMENT 5

Based on Hall effect, calculate the charge carrier density of a given semiconductor and identify the nature of the semiconductor.

7 **4 Hours**

EXPERIMENT 6

Draw the B-H curve of a ferromagnetic material subjected to external magnetic field and hence identify the nature of the material.

8 **4 Hours**

EXPERIMENT 7

Determine the V-I characteristics of a solar cell.

Total: 75 Hours

Reference(s)

1. William D. Callister, Materials Science and Engineering An Introduction, John Wiley and Sons, Inc, 2010.
2. Halliday and Resnick, Fundamentals of Physics, John Wiley and Sons, Inc, 2011.
3. Jacob Milliman, Christos Halkias, Satyabrata JIT, Electronic Devices and Circuits, McGraw Hill Education (India) Private Limited, New Delhi, 2014.
4. S. O. Pillai, Solid State Physics, New Age International Publications, New Delhi, 2010.
5. Subbiah Pillai, Nanobiotechnology, MJP Publishers, 2010.
6. Yang Leng, Materials Characterization: Introduction to Microscopic and Spectroscopic Methods, Wiley-VCH, 2013.

Assessment Pattern

Unit/RBT	Remember				Understand				Apply				Analyse				Evaluate				Create				Total
	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	
1	1	4	2		2	5	2		2	2			1	1											22
2	2		2		2		2		5	3			4												20
3	2		2		3	3	2		3	3			2	2											22
4	1	2	1		3	3			3	3			2												18
5	2	2			3	2	3		2				2	2											18
																								Total	100

Assessment Questions

Remember

1. Recall the merits of quantum free electron theory over classical free electron theory
2. Define carrier concentration
3. Recall Fermi energy
4. List the four types of polarization mechanisms.
5. Recognize polar and non-polar molecules
6. Define Bohr magneton
7. Recall coercivity and retentivity
8. Point out the four salient features of biomaterials
9. Define bioactive materials
10. State the working principle of FTIR spectroscopy

Understand

1. Classify three types of materials based on bandgap energy
2. Explain fermi-distribution function and effect of temperature on Fermi function
3. Represent the variation of Fermi level with temperature
4. Explain intrinsic and thermal breakdown mechanisms
5. Infer the importance of Fermi level in a semiconductor
6. Illustrate the phenomenon of B-H hysteresis on the basis of domain theory
7. Classify four types of biomaterials
8. Represent the scanning electron microscope to determine the grain size of the nanomaterials
9. Explain the principle, construction and working of Scanning electron microscope
10. Explain the principle and working mechanism of X – ray photoelectron spectroscopy (XPS)

Apply

1. Find the variation of Fermi level with temperature and impurity concentration in n-type semiconductors
2. Show that electronic and ionic polarizabilities are independent of temperature
3. Show that the position of Fermi level is exactly at the midpoint of forbidden energy gap in intrinsic semiconductor
4. Compute the relationship between polarizability and electric flux density.
5. Assess the properties of dia, para and ferromagnetic materials
6. Show that top down method is inferior to bottom up method
7. Construct B-H Hysteresis curve on the basis of domain theory
8. Design the principle, construction and working of chemical vapour deposition.
9. Show that the electronic polarizability is directly propotional to the volume of an atom
10. Compute the expression for carrier concentration in intrinsic semiconductors

Analyse

1. Extrinsic semiconductors possess high electrical conductivity than intrinsic semiconductors. Justify
2. Silver is the best conductor of electricity. But gold is used in high-end electronic connectors. Justify.

3. Identify the role of impurity concentration in the variation of Fermi level in the case of p-type semiconductors.
4. Compare polar dielectrics with non-polar dielectrics.
5. Analyse the features of hard and soft magnetic materials.
6. Compare the six properties of dia, para and ferro magnetic materials
7. Differentiate top down approach from bottom up approach.
8. Select the four important features of TEM
9. Justify the electronic polarizability of Argon is much greater than that of Helium.
10. Intrinsic semiconductors are insulators at 0K. Justify.

3 0 2 4

15PH205 SOLID STATE PHYSICS

Course Objectives

- To explain the properties of conducting, semiconducting and dielectric materials
- To understand the working mechanism of junction diodes
- To impart knowledge in optical and magnetic materials

Programme Outcomes (POs)

a. **Engineering Knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

Course Outcomes (COs)

1. Identify different types of emission of electrons and significance of Fermi function
2. Explore the carrier concentration and its variation with temperature of different semiconducting materials
3. Analyze the I-V characteristics of a junction diode
4. Investigate the various polarization mechanisms in dielectrics
5. Select appropriate optical and magnetic materials for data storage devices

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3												1	
2	2												2	
3	1												3	
4	2												1	
5	1												1	2

UNIT I **10 Hours**

EMISSION PROPERTIES AND QUANTUM THEORY OF SOLIDS

Emission of electrons: types thermionic emission-principle- Richardson equation- secondary emission- principle- work function- Fermi-Dirac distribution function and its temperature dependence significance of Fermi energy- density of energy states- calculation of density of electrons and Fermi energy at 0K- average energy of electrons at 0K problems.

UNIT II **9 Hours**

SEMICONDUCTOR PHYSICS

Intrinsic semiconductors: the law of mass action - expressions for density of electrons and holes - determination of carrier concentration - band gap energy. Extrinsic semiconductors: carrier concentration in p-type and n-type semiconductors. Hall effect: theory - experimental determination of Hall voltage - applications - problems.

UNIT III **9 Hours**

JUNCTION DIODE CHARACTERISTICS

Introduction - pn junction diode - volt-ampere characteristics - diode current equation - static and dynamic resistances - space charge - diffusion capacitance - junction diode switching times. Diode circuit with DC voltage source. Applications: full wave rectifier - capacitor filters - clamper circuits.

UNIT IV **9 Hours**

DIELECTRICS

Introduction: fundamental definitions in dielectrics - expressions for electronic and ionic polarizations - orientation polarization (qualitative) - space charge polarization - Langevin Debye equation - frequency and temperature effects on polarization - expression for internal field (cubic structure) - Clausius-Mosotti equation - dielectric loss - applications of dielectrics - problems.

UNIT V **8 Hours**

OPTOELECTRONICS AND MAGNETIC MATERIALS

Principle, working and characteristics of LED and LCD - blue ray disc. Magnetic materials: basic definitions - properties of dia, para and ferro magnetic materials - explanation of hysteresis curve based on domain theory - hard and soft magnetic materials. Magnetic storage device: principle - working - giant magnetoresistance.

FOR FURTHER READING

Motion of an electron in uniform and non-uniform magnetic fields - electric and magnetic fields in a crossed configuration.

1 **2 Hours**

INTRODUCTION

Exposure to Engineering Physics Laboratory and precautionary measures

2 **4 Hours**

EXPERIMENT 1

Using Lees disc apparatus, determine the coefficient of thermal conductivity of a bad conductor.

3 **4 Hours**

EXPERIMENT 2

Find the band gap value of the given semiconductor diode. Based on the band gap value, identify the given semiconductor.

4 **4 Hours**

EXPERIMENT 3

With the aid of traveling microscope, find the refractive index of a transparent solid and liquid material.

5 **4 Hours**

EXPERIMENT 4

Determine the wavelength of polychromatic source in the visible region using spectrometer.

6 **4 Hours**

EXPERIMENT 5

Based on Hall effect, calculate the charge carrier density of a given semiconductor and identify the nature of the semiconductor.

7 **4 Hours**

EXPERIMENT 6

Draw the B-H curve of a ferromagnetic material subjected to external magnetic field and hence identify the nature of the material.

8 **4 Hours**

EXPERIMENT 7

Determine the V-I characteristics of a solar cell.

Total: 75 Hours

Reference(s)

1. Jacob Millman, Christos Halkias and Satyabrata JIT, Electronic Devices and Circuits, McGraw Hill Education (India) Private Limited, New Delhi, 2014.
2. William D. Callister, Materials Science and Engineering an Introduction, John Wiley and sons, Inc, 2010.
3. Halliday and Resnick, Fundamentals of Physics, John Wiley and Sons, Inc, 2011.
4. R. S. Sedha, A textbook of Applied Electronics, S. Chand & Company Ltd., New Delhi, 2010.
5. S. O. Pillai, Solid State Physics, New Age International Publications, New Delhi, 2010
6. M. N. Avadhanulu and P.G. Kshirsagar, A Text Book of Engineering Physics, S. Chand & Company Ltd., New Delhi, 2011.

Assessment Pattern

Unit/RBT	Remember				Understand				Apply				Analyse				Evaluate				Create				Total
	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	
1	1	2	2		2	4	2		2	5			2												22
2	2	2			2		3		2	3					6										20
3	2		1		3		2		5				2	2				3							20
4	2	2	2		2	3			2	5			2												20
5	2	2			3	2	2		2				5												18
																								Total	100

Assessment Questions

Remember

1. Recall the Richardson equation.
2. Define dynamic resistance.
3. State the law of mass action.
4. Define Hall Effect.
5. List the three practical applications of p-n junction diode.
6. List the three practical applications of p-n junction diode.
7. List the four types of polarizations in dielectrics
8. Reproduce the expressions for electronic and ionic polarization.
9. State the working principle of LED.
10. Define retentivity and coercivity.

Understand

1. Explain the variation of Fermi-Dirac distribution function with temperature.
2. Indicate the importance of Fermi level.
3. Indicate the reason for preferring extrinsic semiconductors over intrinsic semiconductors.
4. Represent four applications of Hall Effect.
5. Represent the switching action of a diode.
6. Interpret the relation between polarization and polarisability in dielectrics.
7. All the dielectrics are insulators but all the insulators are not dielectrics. Illustrate with examples.

8. Interpret the relation between the dielectric constant and electric susceptibility.
9. Explain the phenomenon of electroluminescence in LED.
10. Summarize the working principle of giant magnetoresistance.

Apply

1. Find the expression for density of electrons and Fermi energy at 0 K.
2. Using the Fermi function, compute the temperature at which there is 1% probability that an electron in a solid will have energy 0.5 eV above EF of 5 eV.
3. Explain how phosphorous atoms donate electrons to the conduction band.
4. Apply the law of mass action to determine the carrier concentration of intrinsic semiconductors.
5. Construct a circuit using p-n junction diode and execute its V-I characteristics.
6. Construct a diode circuit with DC voltage source and demonstrate its working conditions.
7. Show that electronic polarizability is independent of temperature.
8. Explain frequency dependence of dielectrics with a neat sketch.
9. Apply the domain theory to the hysteresis effect observed in ferromagnetic materials.
10. Compute the wavelength of light emitted by an LED with band gap energy of 1.8 eV.

Analyse

1. The average energy of electrons at 0 K depends on Fermi level. Justify.
2. Differentiate p-type and n-type semiconductors.
3. Outline the working principle of full wave bridge rectifier.
4. At optical frequencies the total polarization is less. Justify.
5. Outline the causes for dielectric loss in dielectric materials.
6. Analyze the magnetic behavior of dia, para and ferromagnetic materials.
7. Compare the properties of LED and LCD.
8. Outline the difference between hard and soft magnetic materials.

Evaluate

1. Evaluate the resistance value using V-I characteristics of a p-n junction diode.
2. Evaluate the value of Fermi distribution function for an energy kT above the Fermi energy at that temperature and comment on the answer.

15CH201 ENGINEERING CHEMISTRY

3 0 2 4

Course Objectives

- Recall the terminologies of electrochemistry and explain the function of batteries and fuel cells with its electrochemical reactions
- Understand the fundamentals of corrosion, its types and polymers with its applications
- Choose appropriate instrumentation technique for interpreting analytical data

Programme Outcomes (POs)

a. **Engineering Knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

b. **Problem Analysis**: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

d. **Conduct Investigations of Complex Problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

Course Outcomes (COs)

1. Construct an electrochemical cell and measure its potential using selected reference electrode
2. Identify the electrodes, electrolyte and cell reactions in batteries, fuel cells and infer the selection criteria for commercial battery systems with respect to commercial applications

3. Analyze the type of corrosion, factors influencing rate of corrosion on metals and identify suitable corrosion control method
4. Differentiate polymers based on its source, properties and applications
5. Select suitable analytical method for the estimation of alkali and alkaline earth metals in aqueous media

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2	3											2	
2	2												1	2
3	3	2		1									2	
4	2	2											3	
5	3	3		1									2	

UNIT I **10 Hours**

INTRODUCTION TO ELECTROCHEMISTRY

Types of electrodes - electrode potential - salt bridge - cell reaction - cell representation - silver-silver chloride electrode - calomel electrode - determination of single electrode potential - electrochemical series and its importance. Ion-selective electrode: glass electrode - measurement of pH using glass electrode. Concentration cells (electrode and electrolyte). Potentiometry - potentiometric titrations (redox titration). difference between electrochemical and electrolytic cells

UNIT II **9 Hours**

ENERGY STORAGE DEVICES

Batteries - characteristics of battery - types of batteries. construction, working and applications: Primary (alkaline) and secondary (lead-acid and nickel-cadmium) - Modern batteries (zinc air battery and lithium batteries) - precautions for battery maintenance. Comparison with conventional galvanic cells. Fuel cells - Types of fuel cells: solid polymer electrolyte fuel cell - solid oxide fuel cells - microbial fuel cell. Hydrogen-oxygen fuel cell - construction, working, advantages and limitations

UNIT III **8 Hours**

CORROSION SCIENCE

Corrosion: definition - types of corrosion: chemical and electrochemical corrosion - Pilling-Bedworth ratio - types of oxide layer (stable, unstable, volatile and porous) - hydrogen evolution and oxygen absorption mechanism for electrochemical corrosion - mechanism for rusting of iron. Types of electrochemical corrosion: Galvanic corrosion - differential aeration corrosion (pitting, waterline and pipeline). Galvanic series - applications. Factors influencing corrosion: nature of metal and environment. Corrosion control methods: sacrificial anode method - impressed current cathodic protection method - electroplating - electroless plating

UNIT IV **10 Hours**

POLYMERS AND ITS PROCESSING

Advantages of polymers over metals. Monomers - polymers - polymerization - functionality - degree of polymerization - classification of polymers based on source and applications - Molecular weight determination. Types of polymerization: addition, condensation and copolymerization - mechanism of free radical polymerization. Preparation, properties and applications of thermosetting (epoxy resin and bakelite) and thermoplastics (polyvinyl chloride and polytetrafluoroethylene). Compounding of plastics - injection and extrusion moulding methods

UNIT V **8 Hours**

INSTRUMENTATION TECHNIQUES FOR CHEMICAL ANALYSIS

Beer - Lamberts law. Principle, instrumentation (block diagram only) and applications: UV-visible spectroscopy - Atomic absorption spectroscopy - Colorimetry (estimation of a transition metal) - Flame photometry (estimation of an alkali metal)

FOR FURTHER READING

Nobel prize winners in chemistry over past 5 years

1 **2 Hours**

EXPERIMENT 1

Preparation of N/10 oxalic acid and M/10 sodium carbonate solution.

2 **4 Hours**

EXPERIMENT 2

Determination of strength of hydrochloric acid present in the given solution by pH measurement.

3 **4 Hours**

EXPERIMENT 3

Determination of strength of HCl by conductometric titration.

4 **4 Hours**

EXPERIMENT 4

Conductometric titration of mixture of acids (Hydrochloric acid and acetic acid).

5 **4 Hours**

EXPERIMENT 5

Estimation of iron in the given sample by potentiometric method using saturated calomel electrode.

6 **4 Hours**

EXPERIMENT 6

Measurement of rate of corrosion on zinc/mild steel in aerated neutral/acidic/alkaline solution by weight loss method.

7 **4 Hours**

EXPERIMENT 7

Determination of molecular weight of polyvinyl alcohol using Ostwald viscometer.

8 **4 Hours**

EXPERIMENT 8

Estimation of iron (thiocyanate method) in the given solution by spectrophotometric method.

Total: 75 Hours

Reference(s)

1. M. Munjal and S.M. Gupta, Wiley Engineering Chemistry, Second edition, Wiley India Pvt. Ltd, New Delhi, 2013.
2. A. Pahari and B.Chauhan, Engineering Chemistry, Infinity Science press LLC, New Delhi, 2010.
3. P.H. Rieger, Electrochemistry, Springer, Netherland, Second Edition (Reprint) 2012.

4. Fred W. Billmeyer JR, Textbook of polymer science, John Wiley & sons, Third edition, 2008.
5. Willard Merritt and Dean Settle, Instrumental methods of analysis, CBS publishers, Seventh edition, 2012.

Assessment Pattern

Unit/RBT	Remember				Understand				Apply				Analyse				Evaluate				Create				Total
	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	
1	1	1	1		3	4	2			4	4				1			2							23
2	1	1	1		4	4	3		1	2				1	2										20
3	1	1	1		2	2	1			2	2			2	1			1				1			17
4	5	3	2		3	1	1		1				1	2	2		1	1							23
5	1					3					3				7			2				1			17
																								Total	100

Assessment Questions

Remember

1. List any four significances of EMF series.
2. Define the term single electrode potential.
3. Recall the four advantages of H2-O2 fuel cell.
4. Define the term functionality of a monomer.
5. State Pilling-Bedworth rule.
6. Name two monomers used for the preparation of epoxy resin.
7. Label the parts and charge carried by electrodes in electrochemical and electrolytic cells.
8. List any two significances of monomer functionality.
9. State Beer - Lamberts law.
10. Define concentration cell.

Understand

1. Classify two types of polymers based on source.
2. Compare electrochemical cell and electrolytic cell with suitable diagrams.
3. Illustrate the mechanism involved in electrochemical corrosion.
4. Explain the principle and five components of UV-visible spectrophotometer.
5. Outline the mechanism for the synthesis of –(CF2-CF2)n– polymer.
6. Identify any two analytical methods to estimate sodium present in aqueous media.
7. Illustrate the injection molding process with a necessary explanation and two advantages.
8. Indicate any two importance of salt bridge in an electrochemical cell.
9. Ilustrate the route to synthesis epoxy resin from its two monomers.
10. Summarize any four advantages of polymers over metals in everyday life.

Apply

1. Calculate the single electrode potential value zinc half-cell dipped in a 0.01M ZnSO4 solution at 25°C? E° Zn/Zn 2+ = 0.763 V, R=8.314 JK -1 Mol -1 , F= 96500 Coulombs.
2. Identify two advantages of degree of polymerization.
3. Find the concentration of given solution using spectrophotometer, if %T, bath length and molar adsorption coefficient are 18, 1 cm and 6000 L/mol. cm.
4. Derive an equation for determination pH of unknown solution using glass electrode.
5. Elaborate any six applications of electrochemical series.
6. Select and explain suitable potentiometric titration to estimate the amount of ferrous ion in the given solution.
7. Discuss the construction and working of electrolyte concentration cell with suitable example.
8. Assess the significance of functionality of monomer in the properties and structure of polymer.

Analyse

1. Outline any two methods for preventing chemical and electrochemical corrosion.
2. Compare the advantages and limitations of electro and electroless plating of nickel.
3. The statement "prevention is better than cure" is not suitable for corrosion science and engineering-Justify your answer.
4. Differentiate addition and condensation polymers based on its synthesis.
5. Arrange the following polymers based on the increasing order of resistance towards chemical 1. poly(ethylene) 2. Starch 3.Baklite 4.Teflon

Evaluate

1. Calculate the electrode potential of zinc metal if EMF of the cell is 1.10 V (Sat. Calomel electrode was used for complete cell formation.
2. Electrode potentials of A and B are E 0 A/A+ = +0.76 V and E 0 B/B+ = -0.34 V respectively. Choose the appropriate anode half-cell and cathode half-cell by giving the cell representation
3. Find out the degree of polymerization for a low density polytetrafluoroethylene with a molecular weight of 10002 amu. (Atomic weights of F=18.9; C=12)
4. The standard reduction potentials of metals Ag, Fe, Cu and Zn are +0.80v,-0.44v, +0.34v and -0.76v respectively. Arrange the metals in the increasing order of their ability to undergo corrosion.

Create

1. A ship hull in ocean is safe against corrosion under any circumstance - Give reason.
2. Derive the probable reason and possible solution for the following:
   i. Stainless steel should not be used to build ship hull.
   ii. Small anodic area results in intense corrosion.

iv. Metal under water drop undergoes accelerated corrosion.

v.

15CH202 APPLIED CHEMISTRY

3 0 2 4

Course Objectives

- Attribute the internal and external treatment methods for the removal of hardness in water for domestic and industrial applications.
- Aware the causes and consequences of corrosion
- Acquaint the applications of alloying and phase rule in metallurgy
- Recognise the fundamentals and applications of fuels
- Characterize the chemical compounds using analytical techniques.

Programme Outcomes (POs)

a. **Engineering Knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

b. **Problem Analysis:** Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

d. **Conduct Investigations of Complex Problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

Course Outcomes (COs)

1. Attribute the internal and external treatment methods for the removal of hardness in water for domestic and industrial applications.
2. Analyze the type of corrosion, factors influencing rate of corrosion on metals and corrosion control methods
3. Differentiate ferrous and non ferrous alloys based on its properties, applications and illustrate the importance of phase rule in the field of mettallurgy
4. Distinguish the three types of fuels based on calorific value for selected applications
5. Apply suitable analytical methods for the estimation of elements in aqueous media

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2	2		1									2	
2	2	3											2	
3	1	2											1	
4	2	1											2	
5	2	3		1									2	

UNIT I **10 Hours**

WATER PURIFICATION

Hardness of water - classification of hardness (temporary and permanent) - units of hardness (ppm, mg/l, degree Clark, degree French) - expression of hardness in terms of calcium carbonate equivalence - estimation of hardness by EDTA Method - Uses of water for industrial purpose - requirements of boiler feed water - disadvantages of using hard water in industrial boilers: scale, sludge, priming, foaming and caustic embrittlement. Removal of dissolved salts from hard water: internal conditioning (phosphate, carbonate, calgon and colloidal methods), external conditioning (ion exchange process, reverse osmosis, electrodialysis). Uses of water for domestic purpose - municipal water treatment (screening, aeration, coagulation, sedimentation, filtration and disinfection of water - break point chlorination).

UNIT II **8 Hours**

CORROSION SCIENCE

Corrosion - chemical and electrochemical corrosion - Pilling-Bedworth rule - mechanism (types of oxide layer, oxygen absorption - hydrogen evolution) - Galvanic series -types of electrochemical corrosion: Galvanic corrosion - differential aeration corrosion (pitting, pipeline and waterline)-Factors influencing corrosion (nature of metal and environment). Corrosion control: sacrificial anode - impressed current method.Protective coatings - paint -constituents and functions.

UNIT III **9 Hours**

ALLOYS AND PHASE RULE

Alloys: purpose of alloying - function and effects of alloying elements - properties of alloys - classification of alloys. Ferrous alloys: nichrome and stainless steel. Non-ferrous alloys: brass and bronze. Heat treatment of alloys (annealing, hardening, tempering, normalising, carburizing and nitriding). Phase rule: phase - component - degree of freedom - phase rule - phase diagram - applications- one component system (water system). Reduced phase rule - two component system (lead and silver system).

UNIT IV **10 Hours**

FUELS

Classification - characteristics - calorific value - solid fuel - coal - types - analysis of coal (proximate and ultimate analysis) - processing of coal to coke - carbonization - types (low temperature and high temperature carbonization) - manufacture of metallurgical coke (Otto Hoffmann method). Liquid fuels - petroleum - refining of crude oil - knocking - octane number - cetane number. Liquid fuel from coal (Bergius process). Gaseous fuels - natural gas (CNG) - coal gas - producer gas - syn gas - shale gas.

UNIT V **8 Hours**

INSTRUMENTAL METHODS

Beer - Lamberts law. Principle, instrumentation (block diagram only) and applications: Ultra violet spectroscopy - Infrared spectroscopy - Atomic absorption spectroscopy - Colorimetry (estimation of transition metal) - Flame photometry (estimation of alkali metal).

FOR FURTHER READING

Synthesis and applications of bio-fuels.

1 **2 Hours**

EXPERIMENT 1

Preparation of N/10 oxalic acid and N/10 sodium carbonate solution.

2 **4 Hours**

EXPERIMENT 2

Water quality of BIT campus - River - Bore well water with respect to hardness, TDS and pH.

3 **4 Hours**

EXPERIMENT 3

Conductometric titration of mixture of acids (HCl CH3COOH).

4 **4 Hours**

EXPERIMENT 4

Determination of strength of hydrochloric acid in a given solution using pH meter.

5 **4 Hours**

EXPERIMENT 5

Determination of the strength of Fe(II) in the given sample by potentiometric method.

6 **4 Hours**

EXPERIMENT 6

Measurement of rate of corrosion on mild steel in aerated / neutral / acidic / alkaline medium by weight loss method.

7 **4 Hours**

EXPERIMENT 7

Estimation of copper content in brass by EDTA method.

8 **4 Hours**

EXPERIMENT 8

Estimation of iron (thiocyanate method) in the given solution by spectrophotometric method.

Total: 75 Hours

Reference(s)

1. A. Pahari and B.Chauhan, Engineering Chemistry, Infinity Science press LLC, New Delhi, 2010.
2. M. Munjal and S.M. Gupta, Wiley Engineering Chemistry, Second edition, Wiley India Pvt. Ltd, New Delhi, 2013.
3. Willard Merritt and Dean Settle, Instrumental methods of analysis, CBS publishers, Seventh edition, 2012.
4. Jain and Jain, Engineering Chemistry, Dhanpat Rai Publishers New Delhi, 16th Edition, 2013.
5. R. Mukhopadhy and S. Datta, Engineering Chemistry, New age international Pvt. Ltd, New Delhi, 2010.
6. Shashi Chawla, Engineering Chemistry, Dhanpat Rai Publishers New Delhi, 2nd Edition, 2003.

Assessment Pattern

Unit/RBT	Remember				Understand				Apply				Analyse				Evaluate				Create				Total
	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	
1	1	1	1		3	4	2			4	4				1			1				1			23
2	1	1	1		2	2	1			2	2			2	1			1				1			17
3	1	1	1		4	4	3		1	2					2							1			20
4	5	3	2		3	1	1		1				1	2	1		1	1				1			23
5	1					3					3				7			2				1			17
																								Total	100

Assessment Questions
Remember

1. Define the term hardness of water.
2. List any two internal conditioning methods to convert hard water to soft water.
3. List the two types of electrochemical corrosion.
4. Recall any two reasons for galvanic corrosion.
5. List the four major objectives of alloying steel.
6. State Gibbs phase rule.
7. Define octane number.
8. State Beer-Lambert’s law.
9. Recall any four applications of colorimetry.

Understand

1. Compare temporary and permanent hardness in water.
2. Illustrate the estimation of carbonate, non-carbonate and total hardness by EDTA method.
3. Identify the needs of corrosion control methods with suitable examples.
4. Indicate the two suitable conditions for electrochemical corrosion to occur.
5. Classify the three types of alloys based on metal composition.
6. For one component water system, the triple point is an invariant point. Reason out.
7. Distinguish between syn gas and coal gas.
8. With a neat diagram, explain the processes involved in Bergius process to get synthetic petrol.
9. Diiferentiate chromophore and auxochrome with an example.
10. Infer the role of ammonium thiocyanate in the colorimetric estimation of iron.

Apply

1. Illustrate the necessary steps involved in municipal water treatment.
2. Suggest a suitable laboratory method to estimate carbonate, non-carbonate and total hardness of water.
3. Sketch a suitable protection method to prevent ship's hull made of iron from corrosion.
4. Assess the effects of alloying elements.
5. Apply Gibbs phase rule for one component water system with a neat diagram.
6. Find the combusted products of the following components.
   (i) 2H2 (ii) CH4

7. Find the application of colorimetry for the estimation of iron.
8. Calculate the number of the modes of vibrations for the following molecules.
   (i) C6H6 (ii) CO2

Analyse

1. How can the effect of caustic embrittlement in boiler be resolved?
2. Identify the problems created in boilers if priming and foaming takes place.
3. Increase in temperature increases corrosion rate. Justify
4. Zinc is more corroded when coupled with copper than lead – Reason out.
5. Distinguish ferrous and non-ferrous alloys with examples.
6. Arrange the following materials based on their increasing calorific value. peat, lignite, bituminous, wood, anthracite and sub-bituminous.

Evaluate

1. Bolt and nut made of the same metal is preferred in practice. Give reason.
2. Support the statement "Coke is a better fuel than coal".
3. Calculate the absorbance if 10% of light is transmitted.
4. Determine the effect of pH of the conducting medium on corrosion.
5. Determine the number of phases present in the following systems.
   (i) Two miscible liquids (alcohol & water)
   (ii) Two immiscible liquids (benzene & water)

Create

1. Derive the probable reason and possible solution for the following:
   i) Stainless steel should not be used to build ship hull.
   ii) Small anodic area results in intense corrosion.
   iii) Metal under water drop undergoes accelerated corrosion.
2. AAS is a better method for environmental analysis than calorimetric analysis. Justify.

15CH203 APPLIED ELECTROCHEMISTRY 3 0 2 4

Course Objectives

- Understanding the basic concepts of electrochemistry and their application
- Expanding knowledge about corrosion and methods of control
- Gaining information regarding principle, working and application of batteries and fuel cells

Programme Outcomes (POs)

a. **Engineering Knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. **Problem Analysis:** Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

Course Outcomes (COs)

1. Construct an electrochemical cell and calculate its cell potential.
2. Measure the emf of a cell using different electrodes.
3. Identify the components and processes in batteries and infer the selection criteria for commercial battery systems with respect to different applications.
4. Differentiate types of corrosion and its prevention by suitable techniques.
5. Recognize the importance of fuel cells and solar battery.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2	2											2	
2	2	3											1	
3	2	1											2	
4	2	2											1	
5	3	1											1	2

UNIT I **9 Hours**

FUNDAMENTALS OF ELECTROCHEMISTRY

Introduction - electrical conductance in solution - electrical double layer - electrode potential - importance of electrode potential. Electrochemical cell - standard cell: Weston cadmium cell - Concentration cell: electrode and electrolyte - applications. Applications of electrolytic cells: electrolysis of water, electrolysis of brine and electroplating of copper and gold

UNIT II **9 Hours**

REFERENCE ELECTRODES

Primary and secondary reference electrodes - metal-metal ion electrode, metal-metal insoluble salt electrodes: silver-silver chloride electrode, calomel electrode - ion-selective electrode: glass electrode - measurement of pH of a solution using glass electrode. Quinhydrone electrode: construction - advantages - limitations. Applications of EMF measurements: Potentiometric titrations: acid-base titration - oxidation-reduction titration - precipitation titration

UNIT III **10 Hours**

ENERGY STORING DEVICES

Types of batteries - alkaline, lead-acid, nickel-cadmium and lithium batteries - construction, working and commercial applications. Electrochemical sensors. Decomposition potential: variation of decomposition potential for different metals - importance of decomposition potential. Over voltage: factors affecting over voltage value. Maintenance and precautions in battery handling

UNIT IV **10 Hours**

CORROSION SCIENCE

Corrosion - causes - dry and wet corrosion - Pilling-Bedworth rule - mechanism (hydrogen evolution and oxygen absorption) - rusting of iron. Galvanic series - applications. Galvanic corrosion - differential aeration corrosion (pitting, waterline and stress) - factors influencing corrosion. Corrosion control - sacrificial anode and impressed current cathodic protection methods - Metallic coatings: chromium plating - nickel plating - galvanizing and tinning

UNIT V **7 Hours**

FUEL CELL AND SOLAR BATTERY

Introduction - types of fuel cell: low, medium and high temperature fuel cell. Hydrogen-Oxygen fuel cell - advantages. Solid polymer electrolyte fuel cell, solid oxide fuel cells, biochemical fuel cell. Solar battery - domestic, industrial and commercial applications. Environmental and safety issues

FOR FURTHER READING

Document the various batteries with its characteristics used in mobile phones and laptops Maintenance free batteries, Battery recycling

1 **2 Hours**

EXPERIMENT 1

General instructions to students - Handling reagents and safety precautions.

2 **4 Hours**

EXPERIMENT 2

Determination of strength of a commercial mineral acid by conductometric titration.

3 **4 Hours**

EXPERIMENT 3

Electroplating of copper onto a stainless steel object.

4 **4 Hours**

EXPERIMENT 4

Determination of strength of iron in a given solution by potentiometric method.

5 **4 Hours**

EXPERIMENT 5

Determination of amount of hydrochloric acid present in the given sample using pH meter.

6 **4 Hours**

EXPERIMENT 6

Conductometric titration of mixture of acids.

7 **4 Hours**

EXPERIMENT 7

Determination of corrosion inhibition on mild steel using natural inhibitors.

8 **4 Hours**

EXPERIMENT 8

Estimation of barium by precipitation titration.

Total: 75 Hours

Reference(s)

1. J. C. Kuriacose and J. Rajaram, Chemistry in Engineering & Technology, Vol. 1&2, Tata McGraw-Hill, New Delhi, 2010.
2. B. S. Chauhan, Engineering Chemistry, 3rd Edition, Laxmi Publication Ltd, New Delhi, 2010.
3. B. R. Puri, L. R. Sharma and Madan S Pathania, Principles of physical chemistry, 46th Edition, Vishal publishing Ltd, New Delhi, 2013.

4. B. S. Bahl, G. D. Tuli and Arun Bahl, Essentials of Physical Chemistry, 5th Edition, S. Chand & Company, New Delhi, 2012.
5. S. Vairam, Engineering Chemistry, 1st Edition, John -Willy, India private limited, New Delhi, 2014.
6. Sashi Chawla, Text Book of Engineering Chemistry, Dhanpat Rai Publications, New Delhi, 2010.

Assessment Pattern

Unit/RBT	Remember				Understand				Apply				Analyse				Evaluate				Create				Total
	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	
1	2	2			2	1	1			2	1		1	1	2			2	1			1	1		20
2	1	4			2	4	1			2			1	2				1	2						20
3		1	1		4	5			2	4			2	1			1	2							23
4	2	1			2	5	1			3				2			2	2				2			22
5	2	2			1	4			2	1			1	1				1							15
																								Total	100

Assessment Questions
Remember
1. List any two advantages of hydrogen oxygen fuel cells.
2. Name any two secondary batteries used in electronic appliances.
3. State pilling bedworth rule.
4. List any two applications of lithium battery.
5. Define overvoltage.
6. Recall the two limitations of quinhydrone electrode.
7. List the three major applications of galvanic series.
8. Recall the term redox reaction.
9. Define standard electrode potential.

Understand
1. Identify any two factors affecting the rate of corrosion based on the nature of metal.
2. Compare solar battery with lead acid-battery with respect to cell reactions, advantages and limitations.
3. Explain the working of hydrogen-oxygen fuel cell with necessary diagram and cell reactions. Mention its two advantages and limitations.
4. Identify the four advantages of electroless plating over electroplating.
5. Explain the difference between galvanic and differential aeration corrosion with an example each.
6. Summarize any five factors that affect overvoltage value of a cell.
7. Differentiate cell from battery.
8. Sketch and explain the construction and working of saturated calomel electrode with necessary cell reactions.
9. With a neat sketch explain the working of a silver – silver chloride electrode.
10. Elucidate the working principle of Weston cadmium cell with suitable cell reactions.
11. Distinguish galvanic and electrolytic cells based on cell reactions.

Apply
1. Assess the six advantages of solid polymer electrolyte fuel cell.
2. Many metals form oxide layer when exposed to atmospheric conditions due to corrosion. Predict the four types of metal oxide layers formed with two examples each.
3. An iron pipe line buried under soil is used to carry natural gas, suggest any two corrosion control techniques that can be employed to minimize/control corrosion.
4. Predict the type of corrosion taking place when a piece of iron rod is exposed to moisture and explain the mechanism of rust formation.

5. Illustrate the construction of 6V lead-acid battery and explain its functioning during discharging and charging process.
6. Select a suitable secondary storage battery used in mobile phones. Explain its reactions during charging and discharging process.
7. Find the electrode potential of zinc rod using saturated calomel electrode as reference electrode (E cell value is 1.10 V).
8. Apply the principle of ion selective electrode to find the pH of HCl solution using glass electrode with necessary equations.
9. Can we use KCl salt bridge to construct a cell using Ag and Pb half-cell. Give reason.
10. Identify a suitable technique to achieve copper coating on stainless steel object with a neat diagram.

Analyse

1. Can you store zinc sulphate solution in a copper container? Give reason if your answer is yes/no.
2. Predict why copper cannot displace hydrogen from mineral acid solution.
3. Compare a deep cycle battery and a starting battery based on its application.
4. Zinc corrodes at a faster rate when coupled with copper than lead. Give reason.
5. Does the water exhaust from hydrogen - oxygen fuel cell is drinkable? Give reasons if Yes/No.

Evaluate

1. Electrode potentials of A and B are E0A/A+ = +0.76 V and E0B/B+ = -0.34 V respectively. Choose the appropriate anode half-cell and cathode half-cell by giving the cell representation.
2. Glass electrode cannot be used in solutions having pH greater than 9.0. Give reason.
3. The standard reduction potentials of metals Ag, Fe, Cu and Zn are +0.80v,-0.44v, +0.34v and -0.76v respectively. Arrange the metals in the increasing order of their ability to undergo corrosion.
4. Identify any two advantages of microbial fuel cell over lead acid battery.
5. Represent diagrammatically an electrochemical cell that produces 1.1 volt as an output. Write the half-cell reactions responsible for that.

Create

1. As an engineer, which type of metal oxide forming metal you will choose for your design? Reason out.
2. Derive the probable reason and possible solution for the following:
   i) Stainless steel should not be used to build ship hull.
   ii) Small anodic area results in intense corrosion.
   iii) Metal under water drop undergoes accelerated corrosion.

15CH204 INDUSTRIAL CHEMISTRY 3 0 2 4

Course Objectives

- impart knowledge on the principles of water characterization, treatment methods and industrial applications
- understand the principles and application of electrochemistry, fuel and combustion
- recognize the fundamentals of polymers, nano chemistry and analytical techniques

Programme Outcomes (POs)

a. **Engineering Knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. **Problem Analysis:** Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

Course Outcomes (COs)

1. Identify the internal and external treatment methods for the removal of hardness in water for domestic and industrial applications.
2. Utilize the concepts of electrochemistry in real time applications.
3. Realise the importance of fuel chemistry in day to day life.
4. Differentiate the polymers used in day to day life based on its source, properties and applications
5. Familiarize with the synthesis and characterization techniques of nanomaterials.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO 2
1	2	2											2	
2	1	2											1	
3	3	1											2	
4	2	1											1	
5	2	2											1	2

UNIT I **10 Hours**

WATER PURIFICATION TECHNOLOGY: SOFTENING AND DESALINATION

Hardness of water: Equivalents of calcium carbonate - Units of hardness - Degree of hardness and estimation (EDTA method). Use of water for industrial purposes: Boiler feed water-scale-sludge - priming and foaming -caustic embrittlement. Softening of hard water: External conditioning - ion exchange methods - Internal conditioning - trisodium, dihydrogen, trihydrogen phosphate and sodium hexameta phosphate- carbonate- colloidal methods. Desalination: Reverse osmosis - electrodialysis. Domestic water treatment - Disinfection of water - break point chlorination

UNIT II **10 Hours**

ELECTROCHEMISTRY

Introduction - EMF - Single electrode potential -Calomel electrode - Glass electrode -pH measurement using glass electrode - Electrochemical series. Cells: Electrochemical cells - Cell reactions- Reversible cells and irreversible cells. Batteries - characteristics of battery - types of batteries, construction, working and applications: Primary (alkaline) and secondary (lead-acid and nickel-cadmium) - Modern batteries (zinc air battery and lithium batteries) - precautions for battery maintenance. Fuel cell: Hydrogen - Oxygen fuel cell.Electroplating of copper and electroless plating of nickel

UNIT III **8 Hours**

FUELS AND COMBUSTION

Fuel: Introduction - classification of fuels - calorific value - higher and lower calorific values - analysis of coal (proximate and ultimate) - carbonization - manufacture of synthetic petrol (Bergius process) - knocking - octane number - cetane number - natural gas - Compressed Natural Gas (CNG)- Liquefied Petroleum Gases (LPG) - producer gas - water gas. Combustion of fuels: introduction-theoretical calculation of calorific value - calculation of stoichiometry of fuel and air ratio - ignition temperature

UNIT IV **9 Hours**

POLYMER AND COMPOSITES

Monomers - functionality - degree of polymerizations - classification of polymers based on source and applications; porosity - tortuosity - molecular weight determination by Ostwald method - polymerization methods: addition, condensation and copolymerization - mechanism of free radical polymerization -thermosetting and thermoplastics. Polymer blends - composites, significance, blending-miscible and immiscible blends, phase morphology, fibre reinforced plastics, long and short fibre reinforced composites

UNIT V **8 Hours**

NANOMATERIALS

Types of Nanomaterials - Nano particles - nanoclusters - nano rod - nanowire -nano tube. Synthesis: Top down process: laser ablation - electrodeposition - chemical vapor deposition. Bottom up process: Precipitation - thermolysis - hydrothermal - solvothermal process. Carbon nanotubes: Types - production - properties - applications. Working principle and applications - Scanning Electron Microscope (SEM) - Transmission Electron Microscope (TEM) - UV-Visible spectrophotometer

FOR FURTHER READING

Application of nanomaterials in medicine, environment, energy, information and communication sectors

1 **2 Hours**

EXPERIMENT 1

General instructions to students - Handling reagents and safety precautions

2 **4 Hours**

EXPERIMENT 2

Water quality of BIT campus - River - Bore well water with respect to hardness, TDS and pH

3 **4 Hours**

EXPERIMENT 3

Determination of strength of hydrochloric acid in a given solution using pH meter

4 **4 Hours**

EXPERIMENT 4

Determination of strength of a commercial mineral acid by conductometric titration

5 **4 Hours**

EXPERIMENT 5

Conductometric titration of mixture of acids

6 **4 Hours**

EXPERIMENT 6

Determination of the strength of iron in the given sample by potentiometric method

7 **4 Hours**

EXPERIMENT 7

Determination of molecular weight of polyvinyl alcohol by Ostwald viscometry method

8 **4 Hours**

EXPERIMENT 8

Estimation of iron (thiocyanate method) in the given solution by spectrophotometric method

Total: 75 Hours

Reference(s)

1. M. Munjal and S.M. Gupta, Wiley Engineering Chemistry, Second edition, Wiley India Pvt. Ltd, New Delhi, 2013

2. A. Pahari and B.Chauhan, Engineering Chemistry, Infinity Science press LLC, New Delhi, 2010
3. P.H. Rieger, Electrochemistry, Springer, Netherland, Second Edition (Reprint) 2012
4. Fred W. Billmeyer JR, Textbook of polymer science, John Wiley & sons, Third edition, 2008
5. G. Cao, Ying Wang, Nanostructures and Nanomaterials: Synthesis, Properties, and Applications, World Scientific, New Jersey, 2011
6. S. Sarkar, Fuels and combustion, 3rd edition, Orient Longman Ltd. New Delhi, 2010

Assessment Pattern

Unit/RBT	Remember				Understand				Apply				Analyse				Evaluate				Create				Total
	F	**C**	**P**	**M**	**F**	**C**	**P**	**M**	**F**	**C**	**P**	**M**	**F**	**C**	**P**	**M**	**F**	**C**	**P**	**M**	**F**	**C**	**P**	**M**	
1	1	1	1		2	4	3			1	3		1		3				1						21
2	2	1	2		2	5	2		1	1	3				1				1						21
3	1	2	2		1	3	3			2	2			1	1				1						19
4	1	1	1		3	4	1		1	1	3			1	2				1						20
5	1	1	1		1	2	2			2	3			2	2				2						19
																								Total	100

Assessment Questions

Remember

1. Define the term break point chlorination.
2. Name a method to prevent the scale formation in the industrial boilers.
3. Define single electrode potential of an electrode.
4. List any two advantages of H2-O2 fuel cell.
5. Define functionality of a monomer.
6. Name any two thermoplastic and thermosetting polymers.
7. List any two applications of SEM.
8. Recall any two application of X-Ray diffractometer.
9. List three factors which affects the standard electrode potential of cell.

Understand

1. Distinguish between alkaline and non alkaline hardness.
2. Identify two significances of RO method in water treatment.
3. Illustrate any three applications of electrochemical series.
4. Identify the reasons for change of properties of materials at nanoscale.
5. Summarize the four applications of calorimeter.
6. Explain the components of TEM with a neat sketch.
7. Compare bottom up approach with top down approach of nanoparticle synthesis.
8. Indicate any two advantages of water gas over producer gas.
9. Differentiate between thermoplastic and thermosetting plastics.
10. Compare nanocluster with nanocrystal.
11. Why copper cannot displace hydrogen from mineral acid solution?

Apply

1. A water sample contains 204 mgs of CaSO4 and 73 mgs of Mg(HCO3)2 per litre. Calculate the total hardness in terms of CaCO3 equivalence.
2. 100 ml of sample water has hardness equivalent to 12.5ml of 0.08N MgSO4. Calculate hardness in ppm.
3. Find out the single electrode potential of a half cell of zinc electrode dipped in a 0.01M ZnSO4 solution at 25°C? E° Zn/Zn 2+ = 0.763 V, R=8.314 JK-1Mol-1, F= 96500 Coulombs.
4. Calculate the reduction potential of Cu2+/Cu=0.5M at 25°C. E° Cu 2+/ Cu= +0.337V.
5. Find out the weight and volume of air required for the complete combustion of 1 kg of coke.
6. A sample of coal containing 60% C, 6% H, 33% O, 0.5 % S, 0.2% N and 0.3% of ash. Find the gross and net calorific value of coal.

7. Calculate the degree of polymerization of polypropylene having molecular weight of 25200.
8. Apply the principle of ion selective electrode to determine the pH of HCl solution using glass electrode with equations.

Analyse

1. Calgon conditioning is advantageous over phosphate conditioning- reason out.
2. Soft water is not demineralized water whereas demineralized water is a soft water- Jusify.
3. Hydrogen electrode is not generally used for pH measurements – Why?
4. Zinc reacts with dil.H2SO4 to give hydrogen but silver doesn't liberate hydrogen. Give reasons.
5. Good fuel should have low ash content- Give reasons.
6. Sugar is an example of non-electrolyte -Reason out.

Evaluate

1. Hydrogen fuel is an ideal fuel for the future among all other fuels- Justify.
2. Choose a best method for water purification and explain their components.

15CH205 WATER TECHNOLOGY AND GREEN CHEMISTRY

3 0 2 4

Course Objectives

- Imparting the knowledge on the principles of water technology and green chemistry
- Understanding the principles and applications of green technology in water treatments
- Infer the engineering applications of green chemistry in dyes, corrosion engineering and nanotechnology

Programme Outcomes (POs)

a. **Engineering Knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. **Problem Analysis:** Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

Course Outcomes (COs)

1. Understand the importance of green chemistry with its emergence and development.
2. Realize the designing of safer methodologies for green technology to meet the objectives of green engineering.
3. Identify the type of corrosion and its mechanism which will help to develop the corrosion control methods.
4. Apply suitable technique to extract natural dye from its source.
5. Familiarize with the synthesis and characterization techniques of nanomaterials.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2	2											1	
2	2	3											2	
3	2	2											2	
4	1	3											1	
5	2	2											2	

UNIT I **9 Hours**

WATER TREATMENT

Water quality parameters - Hardness of water - Disadvantages of hard water - Degree of hardness and its estimation (EDTA method) - Boiler feed water - Boiler troubles: Priming, foaming and caustic embrittlement - Softening of hard water: Internal conditioning: Sodium hexameta phosphate - Phosphate methods; External conditioning: Ion exchange method - Desalination: Reverse osmosis - Electrodialysis. Domestic water treatment - Disinfection of water - Break point chlorination.

UNIT II **8 Hours**

WASTE WATER ANALYSIS

Basic principles and concept of green chemistry - Need of green chemistry in day-to-day life - Scientific areas for practical applications of green chemistry - Industrial effluents - Waste water analysis: Concept of chemical oxygen demand (COD) and biological oxygen demand (BOD) - Removal of trace pollutants in waste water: Membrane Bioreactor (MBR) technology - Wet oxidation method.

UNIT III **10 Hours**

CHEMISTRY OF CORROSION

Corrosion: Mechanism of corrosion - chemical and electrochemical - Pilling-Bedworth rule - oxygen absorption - hydrogen evolution - galvanic series. Types of corrosion: Galvanic corrosion - differential aeration corrosion (pitting, pipeline, water line and wire fence corrosion) - factors influencing corrosion. Methods of corrosion control: choice of metals and alloys - proper designing - cathodic protection (Sacrificial anode method, impressed current method)-modifying the environment. Protective coatings: Concept of electroplating: electroplating (gold and copper) - electroless plating (nickel and copper).

UNIT IV **9 Hours**

NATURAL DYES

Introduction - definition - classification of natural dyes - concept of chromophores and auxochromes - Extraction process of colour component from natural dyes: Aqueous extraction, non-aqueous extraction - Purification of natural dyes: Chromatography techniques - Types - Column chromatography - thin layer chromatography - Qualitative analysis: UV-Visible spectroscopic study - Mordant: Metallic and non-metallic mordant - advantages and disadvantages of natural dyes.

UNIT V **9 Hours**

NANOMATERIALS

Types of Nanomaterials - Nano particles - nanoclusters - nano rod - nanowire - nano tube. Synthesis: Top down process: laser ablation - electrodeposition - chemical vapor deposition. Bottom up process: Precipitation - thermolysis - hydrothermal - solvothermal process. Carbon nanotubes: Types - production - properties - applications. Working principle and applications: Scanning Electron Microscope (SEM) - Transmission Electron Microscope (TEM) - UV- Visible spectrophotometer. Synthesis of Au and Ag nanoparticles using plant extract - Advantages.

FOR FURTHER READING

Protection of metals in concrete against corrosion , Microwave technology on green chemistry

1 **2 Hours**

EXPERIMENT 1

General instructions to students - Handling reagents and safety precautions

2 **4 Hours**

EXPERIMENT 2
Water quality- river/bore well water with respect to hardness and TDS

3 **4 Hours**

EXPERIMENT 3
Determination of strength of hydrochloric acid in a given solution using pH meter

4 **4 Hours**

EXPERIMENT 4
Estimation of strength of iron by potentiometric method using calomel electrode

5 **4 Hours**

EXPERIMENT 5
Extraction of a natural dye by aqueous extraction method

6 **4 Hours**

EXPERIMENT 6
Measurement of rate of corrosion of mild steel in aerated neutral/acidic/alkaline solution by weight loss measurements/Tafel polarization method

7 **4 Hours**

EXPERIMENT 7
Determination of dye concentration in a given sample by using UV-Visible spectroscopic method

8 **4 Hours**

EXPERIMENT 8
Estimation of iron (thiocyanate method) in the given solution by spectrophotometric method

Total: 75 Hours

Reference(s)

1. M. Munjal and S.M. Gupta, Wiley Engineering Chemistry, Second edition, Wiley India Pvt. Ltd, New Delhi, 2013
2. V K Ahluwalia, Green Chemistry - Environmentally Benign Reactions, Ane Books Pvt. Ltd., New Delhi, 2nd Edition, 2012
3. Giusy Lofrano, Green Technologies for Wastewater Treatment - Energy Recovery and Emerging Compounds Removal, Springer Dordrecht Heidelberg, New York, London, 2012
4. Ashis Kumar Samanta and Adwaita Konar, Natural Dyes - Dyeing of Textiles with Natural Dyes, Dr.Emriye Akcakoca Kumbasar (Ed.), InTech Publisher, New Delhi, 2011
5. J. C. Kuriacose and J. Rajaram, Chemistry in Engineering & Technology, Vol. 1&2, Tata McGraw-Hill, New Delhi, 2010
6. David Pozo perez, Nanotechnology and Nanomaterials, InTech Publishers, NewDelhi, 2010

Assessment Pattern

Unit/RBT	Remember				Understand				Apply				Analyse				Evaluate				Create				Total
	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	
1	2	2			3	3				3	3			2	1							1			20
2	2				3	4				2	2			2	1			1							17
3	1	2	1		4	3	3			1	3			1	2			2							23
4	1	2			6	6				3												2			20
5	3	2	2		3	6	2		2																20
																								Total	100

Assessment Questions
Remember

1. List out any four water quality parameters.
2. Name the salts responsible for temporary hardness of water.
3. Recall any two practical applications of green chemistry.
4. Define wet oxidation in waste water treatment.
5. State Pilling Bed-worth′s rule.
6. Recall any two examples for differential aeration corrosion.
7. Name any two natural dyes.
8. Recall the role of auxochromes in dyes.
9. Name the four methods of nanomaterial synthesis.
10. Name any two plant extracts used in silver nanoparticles synthesis.

Understand

1. Hardness of water is always expressed in terms of CaCO3 equivalent. Reason out.
2. Soft water is not demineralized water whereas demineralized water is soft water - Justify.
3. Represent the need of green chemistry in waste water treatment.
4. Indicate the importance of MBR technology in waste water treatment.
5. Express the mechanism of wet corrosion.
6. Bolt and nut made from same metal is preferred in practice. Reason out.
7. Classify the types of natural dyes based on their chemical structure.
8. Compare the properties of metallic and non-metallic mordents.
9. Infer any two important needs of green chemistry in nanotechnology sector.
10. Identify the physicochemical and engineering properties of nanomaterials.

Apply

1. A sample of water contains 180 mgs of MgSO4 per litre. Calculate the hardness in terms of CaCO3 equivalents. (Molecular weight of MgSO4 is 120).
2. Calculate the non-carbonate hardness of a sample of water containing the dissolved salts as given below in mg/l Mg(HCO3)2 = 7.3; Ca(HCO3)2 = 40.5 and NaCl =50.
3. Select the scientific areas for the practical applications of green chemistry.
4. Predict the significance of sacrificial anode in the prevention of corrosion.
5. Execute the principle of electro-deposition to achieve copper coating on stainless steel object with a neat diagram.
6. Select a suitable technique used for the purification of natural dye.
7. Assess the role of Scanning Electron Microscope (SEM) in nano-materials characterization.

Analyse

1. Distinguish between scale and sludge.
2. Identify the four reasons for boiler troubles.
3. Differentiate between BOD and COD.
4. The rate of corrosion increases with increase in temperature. Give reason.
5. Outline the effect of pH of the conducting medium on corrosion.
6. Differentiate chromophores & auxochromes in dyes.

Evaluate

1. Substantiate the statement that nature of the environment affects corrosion.
2. Choose any two best methods to synthesis nanoparticles.

Create

1. Plan and execute a method to get pure water from waste water using available low coast material in your area.
2. Relate the characteristic properties of natural with synthetic dyes.

15EE001 ADVANCED POWER SEMICONDUCTOR DEVICES 3 0 0 3

- **Course Objectives** To learn the characteristics of different types of semiconductor devices.
- To learn the applications of semiconductor devices.
- To study the need for isolation circuits and protection circuits.

Programme Outcomes (POs)

a. **Engineering Knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

b. **Problem Analysis:** Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

c. **Design/ Development of Solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for thepublic health and safety, and the cultural, societal, and environmental considerations.cultural, societal, and environmental considerations.

Course Outcomes (COs)

1. Examine the performance characteristics of ideal and real switches
2. Explain the operation and performance characteristics of Bipolar Junction Transistor (BJT).
3. Apply two transistor analogy of thyristor in power converter circuits.
4. Analyze the static and switching characteristics of power controlled devices.
5. Design of snubber and driver circuits for power controlled devices

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3	2											3	
2	3	2											3	
3	3	2											3	1
4	3	2											2	1
5	2	2	3										3	2

UNIT I **9 Hours**

INTRODUCTION

Power switching devices -Attributes of an ideal switch, application requirements- circuit symbols - Power handling capability (SOA); Device selection strategy - On-state and switching losses - EMI due to switching - Power diodes - Types, forward and reverse characteristics, switching characteristics - Rating. Introduction to wide band gap semiconductors such as silicon carbide and gallium nitride..

UNIT II **9 Hours**

POWER TRANSISTOR

BJTs - Construction, static characteristics, switching characteristics - Negative temperature coefficient and Secondary breakdown - Power Darlington - Thermal protection-dynamic models of BJT

UNIT III **10 Hours**

THYRISTOR

Thyristors - working principle and its operating modes- Two transistor analogy- concept of latching - Gate and switching characteristics - Converter grade and inverter grade and other types; series and parallel operation -Comparison of BJT and Thyristor- Steady state and dynamic models of BJT and Thyristor - thermal protection

UNIT IV **8 Hours**

POWER CONTROLLED DEVICES

Principle, construction, types of Power MOSFETs and IGBTs- static and switching characteristics - Steady state and dynamic models of MOSFET and IGBTs; Basics of GTO, MCT,and IGCT.

UNIT V **9 Hours**

FIRING AND PROTECTING CIRCUITS

Necessity of isolation circuit- Pulse transformer- Opto-coupler; Gate drive circuit for SCR,MOSFET, IGBTs and base driving for power BJT - Overvoltage, over current and gate protections, Design of snubbers.

FOR FURTHER READING

EMI control methods - Harmonics Types - Standards - Mitigation Techique- Types of filters

Total: 45 Hours

Reference(s)

1. Timothy L.Skvarenina, The power electronics handbook, CRC press, New Delhi, 2012.
2. M. H. Rashid, Power Electronics circuits, Devices and Applications, Prentice Hall of India, New Delhi, 2011.
3. Shen, Shyh-Chiang, Wide-bandgap device research and development at SRL, Georgia Institute of Technology Semiconductor Research Laboratory, retrieved 2014-09-03.
4. Baliga, B. Jayant, Fundamentals of Power Semiconductor Devices springer, 2008.
5. Ned Mohan, Undeland and Robins, Power Electronics Concepts, applications and design, John Wiley and sons, Singapore, 2000.
6. M. D. Singh and K. B. Khanchandani, Power Electronics, Tata McGraw Hill book Co,New Delhi, 2003.

Assessment Pattern

Unit/RBT	Remember				Understand				Apply				Analyse				Evaluate				Create				Total
	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	
1	1				1	12			1	2							1	2							20
2	1				1	2				1			1	2				12							20
3		1			1	1				2				12			2	1							20
4	1	2			1	12			1				2				1								20
5	2	1			1	2				12			1					1							20
																								Total	100

Assessment Questions

Remember

1. Mention the applications of power diodes
2. Design a dynamic model of a thyristor
3. Distinguish between the two processes of current flow- drift & diffusion.
4. Differentiate BJT with Thyristor
5. List the advantages of CMOS logic circuit over other MOS circuits
6. Define pinch off voltage
7. Draw the energy band diagram for a metal semiconductor junction under forward & reverse bias
8. List the drawbacks of MOSFET
9. Differentiate MCT with IGCT
10. Mention the necessity of isolation circuit
11. list the applications of snubber circuit
12. Define the term diode

Understand

1. Analyse the characteristics of power diode
2. Differentiate intrinsic and extrinsic semiconductor
3. Enlist the properties of silicon carbide and gallium nitride..
4. Which of the following material has highest electron mobility at a given temperature & low doping concentration –silicon, GaAs or Germanium ?
5. What is meant by 'storage time' for a BJT? Explain its role in limiting the speed of a switching transistor.
6. Distinguish between zener & avalanche mechanism of breakdown in a reverse biased PN junction diode.
7. Explain 'Early effect' in a BJT. Apply how is the 'Early voltage' determined using the IC versus VCE plot ?
8. Explain "Early effect" in BJT. How "Early voltage" is determined using the Ic versus VCE plot.
9. What is meant by diffusion resistance of a PN junction diode? Explain how it is assessed from the V-I Characteristic of the diode.
10. Generalise the inverted mode of operation of a BJT?
11. Enlist the importance of thermal protection in thyristor
12. Derive the ideal current-voltage relationship of a PN junction diode.
13. Draw the output characteristic plot for a p-n-p CE transistor configuration. Indicate the active, saturation and cutoff regions in the above plot.
14. Mention the differences between a Schottky barrier diode & pn junction diode.

Apply

1. Describe the switching characteristics of power diode
2. List the draw backs of on state losses and switching losses
3. What is meant by diffusion resistant of a PN junction diode ? construct how it is assessed from the V-I characteristics of the diode.
4. With the help of suitable diagrams, explain the minority carrier distribution in an npn bipolar transistor operation
5. Enlist the basic frequency limitation factors in the MOSFET .Which of them is important ? why ?
6. Describe the basic operation of an enhancement-type MOSFET. Sketch the transfer & drain characteristics of a typical n-channel enhancement-type MOSFET.
7. With a neat sketch , describe the basic structure of an n-channel enhancement mode MOSFET.

Analyse

1. Explain the two transistor analogy of thyristor
2. Define the term "Early effect" ? Draw Ic Vs VCE plot for a BJT showing the Early effect & Early voltage.
3. With the help of suitable diagram, analyse the minority carrier distribution in an npn bipolar transistor operating in saturation mode.
4. Why BJT is a bipolar device, whereas MOSFET is a unipolar device? analyse in detail
5. Is |VBE.sat| greater or less than |VCE.sat| in Transistor? Analyse briefly.
6. Plot minority carrier concentration as a function of distance from the p-n junction under different bias conditions, indicate the excess concentration in the diagram. What is the law of junction?
7. Derive the expression for Ic versus Ib for the active region of the transistor operation.
8. BJT is a bipolar device, whereas MOSFET is a unipolar device.Justify in detail
9. State the difference between n-type MOSFET and p-type MOSFET. Analyse with any one parameter
10. Summarize the difference between MOSFET & JFET

11. Analyse the significant difference between the construction of an enhancement type & a depletion –type MOSFET ?
12. Draw the ID versus VDS characteristics of the above MOSFET for different values of VGS and also analyse its characteristics in detail
13. Compare the characteristics of GTO and MCT
14. Compare the characteristics of IGBT and MOSFET

15. Analyse the operation of pulse transformer and its applications
16. Draw the opto-coupler circuit and Analyse its operation

Evaluate

1. Discuss the factors limiting the switching speed of a transistor.
2. In a silicon bipolar transistor, β =100 & the base doping concentration NB =1017cm-3. What should be the minimum open-emitter junction breakdown voltage if the minimum open-base breakdown voltage is 15V?

Create

1. Select which of the bipolar transistor configuration has the highest input resistance Ri and the lowest output resistance Ro? Design with proper equations

15EE002 SPECIAL ELECTRICAL MACHINES

3 0 0 3

Course Objectives

- Analyze the performance of synchronous reluctance motor and compute the voltage and torque equation.
- Explain the characteristics of switched reluctance motor and Design the closed loop control of SRM for suitable applications.
- Understand the principle of operation of permanent magnet brushless DC motor and compute EMF and torque equation
- Design power controller circuit of Permanent magnet synchronous motor to enhance the performance characteristics.
- Analyze the performance characteristics of stepper motor and examine the closed loop operation.

Programme Outcomes (POs)

a**. Engineering Knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

b. **Problem Analysis:** Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

c. **Design/ Development of Solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for thepublic health and safety, and the cultural, societal, and environmental considerations.cultural, societal, and environmental considerations.

d. **Modern Tool Usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

Course Outcomes (COs)

1. Analyze the performance of synchronous reluctance motor and compute the voltage and torque equation.
2. Examine the characteristics of switched reluctance motor and Design the closed loop control of SRM for suitable applications.
3. Explain the principle of operation of permanent magnet brushless DC motor and compute EMF and torque equation
4. Design power controller circuit of Permanent magnet synchronous motor to enhance the performance characteristics.
5. Analyze the performance characteristics of stepper motor and examine the closed loop operation.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3	2											3	
2	2	3			1						-		3	1
3	2	3	1										3	1
4	2	3	1										3	1
5	3	3											3	2

UNIT I **7 Hours**

SYNCHRONOUS RELUCTANCE MOTORS

Construction and operating principle, Axial and radial air gap motors, Phasor diagram, Voltage and torque equation - Characteristics and its Applications.

UNIT II **10 Hours**

SWITCHED RELUCTANCE MOTORS

Constructional features- Rotary and Linear SRMs - Principle of operation - Torque production - Steady state performance prediction- Analytical method -Power Converters and their controllers - Methods of Rotor position sensing- Sensor-less operation - Closed loop control of SRM - Characteristics.

UNIT III **9 Hours**

PERMANENT MAGNET BRUSHLESS DC MOTORS

Permanent Magnet materials -Magnetic Characteristics - Permeance coefficient Principle of operation - Types -Magnetic circuit analysis - EMF and torque equations -Commutation - Power controllers - Motor characteristics and control.

UNIT IV **10 Hours**

PERMANENT MAGNET SYNCHRONOUS MOTOR

Principle of operation - Ideal PMSM - EMF and Torque equations - Armature reaction MMF - Synchronous Reactance-Sinewave motor with practical windings - Phasor diagram -Torque/speed characteristics - Power controllers - Converter Volt-ampere requirements.

UNIT V **9 Hours**

STEPPER MOTOR

Constructional features - Principle of operation - Variable reluctance motor,Permanent magnet motor,Hybrid motor,Static and dynamic characteristics ,open and closed loop control,Microprocessor based control.

FOR FURTHER READING

Linear Induction Motor-Construction and Operating principle, Equivalent Circuit, Characteristics, Design Aspects, Choice of specific magnetic loading, Choice of specific electric loading,Goodness factor AC Servo Motors.

Total: 45 Hours

Reference(s)

1. Miller T J E, Brushless Permanent Magnet and Reluctance Motor Drives, Clarendon Press, Oxford, 2008.
2. Kenjo T, Stepping Motors and Their Microprocessor Controls, Clarendon Press London, 2009.
3. Kenjo T and Nagamori S,Permanent Magnet and Brushless DC Motors, Clarendon Press, London, 1985.
4. R.Krishnan, Switched Reluctance Motor Drives - Modeling, Simulation, Analysis, Design and Application, CRC Press, New York, 2001.
5. E.G.Janardanan Special Electrical Machines PHI Learning private Limited, 2014.
6. http://nptel.ac.in/syllabus/syllabusphpsubjectId=108104011.

Assessment Pattern

Unit/RBT	Remember				Understand				Apply				Analyse				Evaluate				Create				Total
	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	
1	1	2				12			2	1			1					1							20
2	1		2			2	1						1	12					1						20
3		2	1			1	2			1				1				12							20
4	2	1					12						2	1				1	1						20
5		2	1			2	1							1	12			1							20
																								Total	100

Assessment Questions

Remember

1. Define synchronous reluctance motor
2. List the advantages of synchronous reluctance motor.
3. List the applications of synchronous reluctance motor
4. Define reluctance torque
5. Define switched reluctance motor.
6. List the advantages of switched reluctance motor.
7. Define synchronous reluctance.
8. List the various types of permanent magnet materials
9. Mention the applications of permanent magnet brushless dc motor.
10. Define step angle

Understand

1. Compare PMBLDC motor and switched reluctance motor
2. Explain the working principle of square wave permanent magnet brushless dc motor
3. Explain the speed torque characteristics of switched reluctance motor.
4. Explain the construction and operating principle of synchronous reluctance motor and their various rotor designs
5. Explain the hysteresis and duty cycle control schemes for switched reluctance motor

6. With a neat block diagram explain the control of permanent magnet synchronous motor using a microprocessor based controller
7. Compare mechanical and electronic commutators.
8. With a neat block diagram explain the control of switched reluctance motor using a microprocessor based controller.
9. Explain any two controllers in detail
10. Write the emf equation of permanent magnet synchronous motor

Apply

1. Show the block diagram of switched reluctance motor
2. Draw the magnetic equivalent circuit of two pole permanent magnet brushless dc motor
3. Describe the hysteresis type and PWM type current regulator for one phase of a SRM with relevant circuit diagram.
4. Describe the opeartion of power controllers for PMBLDC motor with neat diagram
5. Find the Torque equation of SRM.
6. Find the troque equation of stepper motor.
7. A 3phase, 400v, 50Hz, 4 pole star connected synchoruns relutance motor with negligible armature resistance has Xsd=8ohm and Xsq=2ohm for a particular load torque 80Nm. find i) Load angle ii) Line current iii) input power factor. Assume there is no rotational losses.
8. A 3phase, 230v, 60Hz, 4pole star connected reluctance motor has direct axis reluctance of 22.5 ohm Xsq 3.5ohm. the armature resistance is negligible. the load torque is 12.5 N-m. the voltage and frequency ratio is maintanied constant at rated value. if the supply frequency is 60Hz. Find i) Torque angle ii) linecurrent iii) input power factor.
9. Design the tools for intelligent control technique.
10. Design the various sensor devices to control the speed of rotation.

Analyse

1. Conclude the features of permanent magnet synchronous motor.
2. Conclude the limitations of stepper motor.
3. Distinguish between axial and radial air gap motors with relevant diagrams
4. Justify the permanent magnet brushless dc motor is called as electronically commutated motor
5. Justify power semiconductor switching circuits is needed for switched reluctance motor
6. Justify rotor position sensor is essential for switched reluctance motor.
7. Differentiate between switched reluctance motor and stepper motor.
8. Differentiate Synchorance reluctance motor with switched reluctance motor
9. Differentiate Synchorance reluctance motor with Stepper motor.
10. Differentiate BLDC motor with DC motors

Evaluate

1. A variable reluctance stepper motor has 8 poles in the stator and they have five teeth in each pole. If the rotor has 30 teeth calculate the step angle and resolution.
2. Calculate the pulse rate required to obtain the rotor speed of 2000 rpm for a stepper motor having a resolution of 25 steps per revolution
3. A brushless permanent magnet dc motor has a no load speed of 6000 rpm when connected to 120V dc supply. The armature resistance is 2.5???.Rotational and iron losses neglected. Determine the speed when the supply voltage is 60V and the torque is 0.5 Nm.
4. A permanent magnet brushless dc motor has a torque constant 0.12Nm / A referred to dc supply. Find no load speed when connected to 48V dc supply. Find stall current and stall torque if the armature resistance is 0.15 ohm per phase and the voltage drop in the controller is 2V.
5. A permanent magnet dc commutator motor has a stall torque of 1Nm with a stall current of 5A.Estimate its no load speed in rpm when fed from a 28V dc voltage supply.

6. A variable reluctance stepper motor has 8 poles in the stator and they have six teeth in each pole. If the rotor has 25 teeth calculate the step angle and resolution
7. Determine the pulse rate required to obtain the rotor speed of 3000 rpm for a stepper motor having a resolution of 30 steps per revolution.
8. A brushless permanent magnet dc motor has a no load speed of 5000 rpm when connected to 120V dc supply. The armature resistance is 2.0???.Rotational and iron losses neglected. Determine the speed when the supply voltage is 50V and the torque is 0.6 Nm.
9. Determine the torque equation of synchronous reluctance motor from the phasor diagram.
10. Determine the EMF equation of brushless permanent magnet sine wave motor.

Create

1. Generate the digital control signal to stepper motor.
2. Formulate the FOC algorithm.

15EE003 COMPUTER NETWORKS

3 0 0 3

Course Objectives

- To understand the detection & correction of errors and apply link control and link protocols of data link layer.
- To apply access method, electrical specification and implementation of different networks, types of switching.
- To study about various protocols used in different layers of networks.

Programme Outcomes (POs)

b. **Problem Analysis**: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

d. **Conduct Investigations of Complex Problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

e. **Modern Tool Usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

Course Outcomes (COs)

1. Explain the organization of computer networks, factors influencing computer network.
2. Examine the network and transport layers.
3. Apply the routing and congestion control algorithms in networks
4. Analyze the presentation Protocols in Networks
5. Asses the various network management protocols

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1		2		1	3								3	
2		2		1	3								3	
3		2		1	3								3	
4		2			3								3	
5		2		1	3								3	

UNIT I **9 Hours**

DATA COMMUNICATION-AN OVERVIEW

Introduction: Networks -Protocols and Standards - Line configurations - Topology - Transmission mode - Categories of networks-OSI model & DOD Model: Functions of the layers - Transmission media: Guided media - Unguided media -Transmission impairment- Performance.

UNIT II **11 Hours**

MEDIUM ACCESS SUB LAYER

Data link control: Service primitives -Flow control mechanisms-Stop and wait - Sliding window protocols -Error detection and correction: Types of errors -Error detection - Vertical Redundancy Check (VRC) -Longitudinal Redundancy Check (LRC) -Cyclic Redundancy Check (CRC) - Check sum - Error correction-Single bit error correction-Hamming Code formation - Medium Access Control Protocols: Conventional channel allocation methods, pure ALOHA, S-ALOHA, IEEE Standards for LAN - Ethernet, Token Bus, Token Ring, FDDI.

UNIT III **9 Hours**

NETWORK

Networking and inter-networking devices: Repeaters, Bridges, Gateways -Switching -Circuit and packet switching- Network layer design issues -Routing Algorithms - Congestion control algorithms - Principles of inter-networking - Internet addresses - TCP / IP protocol suite.

UNIT IV **7 Hours**

PRESENTATION

Domain Name System (DNS) -Telnet -File Transfer Protocol (FTP) -Simple Mail Transfer Protocol (SMTP) -Electronic Mail -Overview of ISDN - ISDN protocols.

UNIT V **9 Hours**

NETWORK MANAGEMENT

Architecture of network management protocols - Information extraction - Configuration Management - Fault Management - Performance management - Security Management - Cryptography - Case study - Substation Automation.

FOR FURTHER READING

Transmission impairment- Longitudinal Redundancy Check (LRC), Cyclic Redundancy check, Error correction- Case study - Substation Automation

Total: 45 Hours

Reference(s)

1. Behrouz A.Forouzan, Data Communication and Networking, Tata McGraw Hill Ltd, New Delhi, 2006.
2. William Stallings, Data and Computer Communication, Pearson Education, Asia Ltd, 8thEdition, New Delhi, 2003.
3. A.S.Kernel Explain, Communication Network Management, Prentice Hall of India Ltd, New Delhi 2005.
4. S. Andrew Tannenbaum Computer Networks, Pearson Education, Asia Ltd, New Delhi, 2003.
5. Uylers Black, Network Management Standards, McGraw Hill book Co, New York 1995.
6. http://nptel.ac.in/syllabus/106105081.

Assessment Pattern

Unit/RBT	Remember				Understand				Apply				Analyse				Evaluate				Create				Total
	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	
1	2					6					8			4											20

2	2					4				4					4				6						20
3		2									12								6						20
4		2					6				6				6										20
5																									0
																								Total	80

Assessment Questions

Remember

1. Define networks.
2. Recognise the spread spectrum
3. Define addressing
4. List out the various error detecting algorithm
5. Define ARQ
6. Reproduce the key idea of Stop & Wait Protocol
7. Recall CSMA/CD
8. State the uses of ethernet.
9. Define Repeater.
10. List out the steps followed is checksum checker side.

Understand

1. Classify three criteria necessary for an effective and efficient network
2. Compare NRZ-L & NRZ-I.
3. Interpret the guided media differing from unguided transmission media
4. Classify the function of go-back N-ARQ.
5. Classify the three HDLC station types.
6. Explain the relationship of IEEE Project to the OSI model
7. Indicate the use of CIDR.
8. indicate the guided media differing from unguided transmission media
9. Identify the address class of 123.167.23.20 and 250.10.24.96.
10. Classify multiple circuits share a single optical fiber in a circuit-switched network

Apply

1. Construct IP datagram format and explain the fragmentation and reassembly of IP packet in Internetworking
2. Demonstrate the various substation automation using Network Management.
3. For the bit stream 100010100, draw the waveform for Manchester and Differential Manchester Coding and also discuss the advantages of the coding schemes
4. Predict the latency of a packet transferred between two hosts A and B on a local network, where they are connected via a cable of length 6.21 m, the packet size is 2024 bytes, and the capacity of the cable is 56 bps. (Assume that queuing delays are not considered. Also recall that 1 byte = 8 bits, and the speed of light = 3.0x108 m/s.)
5. An end system sends 50 packets per sec using UDP protocol over a full duplex 100Mbps Ethernet LAN connection. Each packet consists of 1600 bytes of Ethernet frames payload data. Compute the throughput at UDP layer.
6. Convert a classless (CIDR) network address (e.g. 192.168.0.0/24) to its IP address/mask equivalent (e.g. 192.168.0.0 255.255.255.0) and vice versa
7. A collection of five routers is to be connected in a point-to-point subnet. Between each pair of routers, the designers may put a high-speed line, a medium-speed line, or a low-speed line, or no line. If it takes 100 ms of computer time to generate and inspect each topology, compute the time required to inspect all of them
8. Constuct the architecture of network management protocols
9. Find the no of connections required to connect 20 computers in a mesh network
10. Demonstate the data frame format of IEEE 802.11 Standard

Analyse

1. Differentiate network layer delivery and the transport layer delivery
2. Differentiate the request reply and message stream protocol.
3. Resolve the needs of protocols.
4. Compare headers and trailers and how do they get added and removed.
5. Conclude transport layer creates the connection between source and destination
6. Differtiate between UDP and TCP

Evaluate

1. Determine the two types of implementation formats in virtual circuits.
2. Criticise the two problems of wireless communication.
3. Judge the overview of ISDN
4. Execute the operation of TCP
5. Check the factors that affect the security of the network.

Create

1. Combine the State Transition Diagram and explain the connection establishment and Termination in TCP Protocol.
2. Generate the Network layer with practical issues.

15EE004 NETWORK ANALYSIS AND SYNTHESIS **3 0 0 3**

Course Objectives

- To make the students to analyze any given electrical network and circuits with its network function.
- To make the students to synthesize an electrical network from a given impedance/admittance function.

Programme Outcomes (POs)

a. **Engineering Knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. **Problem Analysis:** Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
c. **Design/ Development of Solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for thepublic health and safety, and the cultural, societal, and environmental considerations.cultural, societal, and environmental considerations.
d. **Conduct Investigations of Complex Problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
e. **Modern Tool Usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

Course Outcomes (COs)

1. Apply the concept of poles and zeros to analyze the response and stability of the transfer function.
2. Analyze the Characterization of Linear Two-Port Networks to derive input and output parameters of the network.
3. Analyze the Interconnection of networks with T and n representation.
4. Design the filters for given the cut-off frequency and to analyze its Characteristics.
5. Analyze the characteristics of LC, RL and RC network from the given impedance function.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2	3		1									1	
2	1	3		1									1	
3		2	1	1										1
4	1			2	2								1	
5	2	2		1										1

UNIT I **10 Hours**

NETWORK FUNCTIONS

Concept of complex frequency - complex impedance and admittance - Concept of poles and zeros - frequency response from pole - zero configuration - Properties of driving point and transfer functions - Time response and stability from pole- zero plot.

UNIT II **9 Hours**

TWO PORT NETWORKS

Driving point impedance and admittance of one port networks - Characterization of LTI two port networks, Z, Y, ABCD and h-parameters, reciprocity and symmetry.

UNIT III **9 Hours**

INTERCONNECTION OF NETWORKS

Inter-relationships between the parameters, inter-connections of two port networks, Ladder and Lattice networks - T and n representation.

UNIT IV **8 Hours**

FILTERS

Characteristics of ideal filters - low pass and high pass filters - Attenuation and phase shift - Constant K and M - derived filters - Band pass filters.

UNIT V **9 Hours**

ELEMENTS OF NETWORK SYNTHESIS

Reliability of one port networks - Hurwitz polynomials - PR function - Necessary and sufficient conditions of PR function - Properties of driving point impedance - Synthesis of LC, RL and RC driving point impedance.

FOR FURTHER READING

Application of graph theory, Stability from plot, T and n representation, Band stop filters, Properties of Positive real function.

Total: 45 Hours

Reference(s)

1. A. Sudhakar, Shyammohan S Palli, Circuits and Networks Analysis and Synthesis, Fourth Edition, Tata McGraw Hill Education Private Ltd, New Delhi, 2013.
2. William H Hayt , Jack E Kemmerly, Steven M Durbin, Engineering Circuit Analysis, 8th Edition, Tata McGraw Hill Education Private Ltd, New Delhi, 2011.
3. S P Ghosh, A K Chakraborty, Network Analysis and Synthesis, Tata McGraw Hill Education Private Ltd, New Delhi, 2010.
4. S. P. Eugene Xavier, Electric Circuit Analysis, New Age International (P) Ltd. Publishers, 2008. Ravish R. Singh, Electrical Networks, Tata McGraw Hill, 2009.

5. M.E.Van Valkenburg, Network Analysis PHI Learning, Third Edition, 2014.
6. Anbukumar kavitha and Govindarajan Uma, Experimental Verification of Hopf Bifurcation in DC-DC Luo Converter, Vol.23, No.6, IEEE Transaction on Power Electronics, 2008, pp 2878-2883.

Assessment Pattern

Unit/RBT	Remember				Understand				Apply				Analyse				Evaluate				Create				Total
	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	
1	1		2			1			1		2				12		1								20
2		1			1	2				1	2		1						12						20
3		2	1				1		1					1	2								12		20
4		2	1				1		1					1	2								12		20
5	1					1			12	2	1						1			2					20
																								Total	100

Assessment Questions

Remember

1. Define transfer function?
2. State graph theory?
3. List the types of tree
4. Define Pole and zero
5. Define resonance.
6. Formulate the condition for resonance
7. List the types of filters
8. Define positive real function
9. List the difference between incidence matrix and cutest matrix
10. Recall the formula to convert from ABCD parameter to hybrid paamenter

Understand

1. Differentiate network analysis and network synthesis?
2. Infer the short comings of constant K filter section.
3. Classify the various filters?
4. Compare ideal and practical voltage and current sources.
5. Select the parameters which are preferred for cascade network connection.
6. Identify the necessary conditions for transfer functions
7. Represent the basic equations used in tansmission parameters.
8. Formulate the expression of resonant frequency of tank circuit.
9. Examplify the expression for open circuit parameters.
10. Infer the expression for hybrid parameters.

Apply

1. A network has Z(s) = 1/s + 2/s+1 + 3/2s+1. Derive a circuit with the given Z(s).
2. The driving point impedance of LC network is given by:

   $$Z(S) = \frac{2S5+12S3+16S}{s4+4s2+3}$$

3. Determine the second Cauer form of the network.
4. For the given network function, draw the pole zero diagram and hence obtain the time domain response. Verify the result analytically.
   V(s) = 5(s+5) / (S +2) (S + 7)
5. Design a constant K low pass T-section filter to be terminated in 600ohms having cut off Frequency of 3KHz.Determine: A: attenuation at 6 KHz. B: the characteristic impedance at 2 KHz.
6. Realize the driving point impedance as Foster's first and second forms from
   Z(s) = (S2+l) (S2+4) / s (s2+2)
7. Derive the relation for resonant frequency for series RLC circuit.

8. Synthesize the following impedance function in Foster-1 and Cauer forms
   Z(s) = (s2+4) (s2+25) / {s (s2+9) }
9. For the given denominator polynomial of a network function, verify the stability of the network using Routh criteria.
   Q {s) = s5 + 3s4 + 4s3 + 5s2 + 6s + 1
10. State the properties of LC driving point impedance function and Synthesize the LC driving point impedance function
    Z (s) = (10s+1) / (4s2 +s+4)
11. Draw the T and pi-sections of a conventional filter using impedance Zi and Zo. Show that they can be made equivalent to two L or two T sections. Finally obtain the input impedance of a p-section filter

Analyse

1. For the given network function, draw the pole zero diagram and hence obtain the time domain response. Verify this result analytically.
   I(s) =3s / {(s + 1)(s+ 3)}
2. For the given network function, draw the pole zero diagram and hence obtain the time domain response. Verify the result analytically.
   I(s) =5s/{ (s + 3) (s2 + 2s + 2)}
3. For the given denominator polynomial of a network function, verify the stability of the network using Routh criteria.
   Q {s) = 10s5 + 8s4 + 6s3 -2s2 + 9s + 8
4. For the given denominator polynomial of a network function, verify the stability of the network using Routh criteria.
   Q(s) = s4 + s3 + 2s2 + 2s +12
5. Find the second Cauer form of the function
   Z(s) =(s2 + 4s + 3) / (s2 + 8s + 12)
6. Find the first Foster form and the Cauer form of the network whose driving point admittance is
   3(s + 2)(s + S) / s(s + 3)

Evaluate

1. For the given network function, Evaluate the pole zero diagram and obtain the time domain response.
   V(s) = 10(s-6) / (S +13) (S + 9)
2. Evaluate the resonant frequency for series RLC circuit and parallel RLC circuit.
3. Evaluate the driving point impedance for
   Z (s) = s+10 / 24s2 +s+10
4. Evaluate and verify the stability of the network using Routh criteria.
   Q(s) = 12s4 + 8s3 + 42s2 + 2s +162

Create

1. Design a high pass pi-section filter having a cut-off frequency of 3.5 KHz to operate with a terminated load resistance of 400 ohms.
2. Design a low pass pi-section filter with a cut-off frequency of 2 KHz to operate with a load resistance of 400 ohms.

15EE005 HIGH VOLTAGE ENGINEERING

3 0 0 3

Course Objectives

- Analyze the performance of gaseous insulating medium using different methods
- Explain the conduction and break down characteristics of liquid and solid dielectrics.
- Analyze the characteristics of high voltage, high current and impulse voltage generator.
- Apply suitable methods to measure high voltage, high current and impulse voltage
- Analyze different high voltage tests for electrical apparatus

Programme Outcomes (POs)

a. **Engineering Knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

c. **Design/ Development of Solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, , and the cultural, societal, and environmental considerations.

e. **Modern Tool Usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

Course Outcomes (COs)

1. Analyze the performance of gaseous insulating medium using different methods.
2. Explain the conduction and break down characteristics of liquid and solid dielectrics.
3. Analyze the characteristics of high voltage, high current and impulse voltage generator.
4. Apply suitable methods to measure high voltage, high current and impulse voltage.
5. Analyze the procedure for different high voltage tests conducted on electrical apparatus.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3		1										3	
2	3		1										3	
3			2		1								3	
4	3		2		1								3	
5	3		1		2								3	2

UNIT I **8 Hours**

CONDUCTION AND BREAKDOWN OF GASEOUS INSULATION MATERIALS

Ionization process and current growth - Townsend's criterion for breakdown- breakdown in electronegative gases-time lags for breakdown -Paschen's law - corona discharges - breakdown in non - uniform fields- factors to be considered for selecting gases as insulating material.

UNIT II **10 Hours**

CONDUCTION AND BREAKDOWN IN LIQUID AND SOLID DIELECTRICS

Breakdown mechanisms in liquid dielectrics-liquid dielectrics used in practice-various processes of breakdown in solid dielectrics-solid dielectrics -solid dielectrics used in practice.

UNIT III **9 Hours**

GENERATION OF HIGH VOLTAGE AND CURRENTS

Generation of high DC voltages - multiplier circuits -Van de Graff generator - high alternating voltage generation using cascade transformers-production of high frequency AC high voltages-standard impulse wave shapes-Marx circuit-generation of switching surges-impulse current generation-tripping and control of impulse generators.

UNIT IV **10 Hours**

MEASUREMENT OF HIGH VOLTAGES AND CURRENTS

HVDC measurement techniques - measurement of power frequency A.C voltages-sphere gap measurement technique-potential divider for impulse voltage measurements-measurement of high D.C, A.C and impulse currents.

UNIT V **8 Hours**

HIGH VOLTAGE TESTING

Indian standards for HV testing, Tests on insulators-testing of bushings-testing of isolators and circuit breakers-cable testing-testing of transformers-surge diverter testing-radio interference measurement.

FOR FURTHER READING

Breakdown in Non Uniform fields and Corona Discharges, Applications in high voltage Bushings, Composite dielectrics, Marx circuit, generation of switching surges, Use of CRO for impulse voltage and current measurements, Use of I.S for testing.

Total: 45 Hours

Reference(s)

1. M.S.Naidu, and Kamaraju, High Voltage Engineering, Tata McGraw Hill, 4th Edition, 2014.
2. C.L. Wadhwa, High Voltage Engineering Wiley Eastern Limited, 2014.
3. E.Kuffel and M. Abdullah, High Voltage Engineering, Pergamon Press, 2013.
4. Dieter Kind, An Introduction to High Voltage Experimental Technique Wiley Eastern Limited, 2012.
5. Alston, High Voltage Technology BS Publications, 2011.

Assessment Pattern

Unit/RBT	Remember				Understand				Apply				Analyse				Evaluate				Create				Total
	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	
1	2					6					8			4											20
2	2					6				8					4										20
3		2				6					12														20
4		2				12	6																		20
5	2						4			6				8											20
																								Total	100

Assessment Questions

Remember

1. Define photo ionization
2. Recall four mechanisms of vacuum breakdown
3. State Paschen's law
4. Define Townsend's first and second ionization coefficients
5. State stressed oil volume theory.
6. Define instrinsic breakdown
7. List the various breakdown mechanisms in solid dielectrics
8. Define thermal breakdown
9. Recall the different forms of high voltages
10. Draw the voltage multiplier circuits.

Understand

1. Reproduce the equivalent circuit of resonant transformer
2. Illustrate the difference between photo ionization and photo electric emission
3. Rederive the criterion for breakdown in electronegative gases
4. Illustrate the different types of rectifier circuits for producing high dc voltages
5. Interpolate the factors that influence conduction in pure liquid dielectrics and commercial liquid dielectrics
6. Illustrate the circuit arrangement for producing lightning current waveforms in laboratories.

7. List out four process of thermal breakdown in solid dielectrics
8. Illustrate the process of breakdown in electronegative gases.
9. Illustrate the block diagrams of voltage multiplier circuits and explain its working principle.
10. Construct with neat diagram of electro static voltmeter used for measuring high dc voltages

Apply

1. Predict the mechanism of short term breakdown of composite insulation
2. Selectdifferent schemes for cascade connection of transformers
3. Demonstrate the different methods of high current measurements with their merits and demerits.
4. Demonstrate the various processes involved in electric breakdown in vacuum.
5. Demonstrate the Marx circuit arrangement for multistage impulse generators.
6. Use capacitive voltage divider arrangement for high ac voltage measurements and explain the testing of transormer
7. Find the breakdown strength of air be for small gaps (1mm) and large gaps (20 cm) under uniform field conditions and standard atmospheric conditions
8. Three 350 KV, 350 KVA testing transformers are connected in cascade and have a short circuit impedance 5%. Evaluate i) full load current, ii) short circuit current, iii) maximum capacitive load that can be tested without exceeding the power rating
9. Carry-out impulse test conduted on power ransformer
10. Assess the breakdown capability of insulator by conducting impulse withstand test

Analyse

1. Compare different methods of generation of high alternating voltages
2. Outline the current growth phenomenon in a gas subjected to uniform electric fields
3. Demonstrate the working of a Van de Graff Generator
4. Outline different methods of producing switching impulses in test laboratories
5. Compare various methods of testing high dc voltages and mention the limitations in each method
6. Compare various types of circuits used for generation of high voltages and currents.
7. The primary and secondary winding inductance of a tesla coil is 0.093 H and 0.011 H respectively with a mutual inductance included between the windings equal to 0.026 H. The capacitance included in the primary and secondary circuits are respectively 1.5 µF and 18 nF.Â If the tesla coil is charged through a 10 KV dc supply determine the output voltage and its waveform .Neglect the winding resistances.
8. Conclude Townsend’s first and second ionization coefficients.
9. Outline the mechanism of short term breakdown of composite insulation
10. Compare methods of generating high voltages and high currents.

15EE006 ENERGY AUDITING CONSERVATION AND MANAGEMENT **3 0 0 3**

Course Objectives

- To understand the international energy policy
- To study the energy audit techniques using suitable tools.
- To gain the knowledge on financial and energy management

Programme Outcomes (POs)

a. **Engineering Knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. **Problem Analysis**: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

g. **Environment and Sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

Course Outcomes (COs)

1. Explain the importance of energy policies, energy conservation act features and energy security
2. Apply the energy conservation technique in electromechanical devices
3. Choose the suitable energy audit technique using appropriate tools to improve the system efficiency with mass and energy balance concept
4. Analyze the features of energy action planning and bench marking
5. Analyze the energy conservation opportunities and the various financial technique adopted in energy management

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	1	2					2						1	
2	2	1											2	
3	1	2											3	3
4	2	1											2	1
5	1	2											2	

UNIT I **10 Hours**

ENERGY SCENARIO AND ENERGY POLICY

Role of energy in economic development and social transformation- Energy and GDP,GNP and its dynamics- international energy policies-G20 and OPEC countries, Need for use of new and non renewable energy-Energy conservation act-2001 & its features - Energy conservation act-2003 & its features - Energy Security- Role of CEA,CERC and ERC.

UNIT II **8 Hours**

ELECTRICAL AND MECHANICAL ENERGY UTILITY SYSTEM

Transmission and Distribution losses-Transformer losses - Electricity Tariff- Load management and maximum demand control- Electric motor: Types-losses in induction motor- efficiency calculation-factors affecting motor performance-power factor improvement -rewinding and motor replacement issues- energy efficient motors.

UNIT III **7 Hours**

ENERGY AUDIT INSTRUMENTS AND ENERGY BALANCE

Electrical measurements-Light- Instruments used in energy audit: Wattmeter - flue gas analyzers- PQ analyzers- Energy efficiency calculation in lighting and pumping applications-Thermal energy measurements- Material and energy balance diagram.

UNIT IV **10 Hours**

ENERGY MANAGEMENT AND AUDIT

Definition and objective of energy management - Principle of energy management - Key elements of energy management, Force field analysis, Top management support, Roles and responsibilities of energy manager, -energy audit definition -types- Detailed energy audit procedure- understanding energy cost -Bench marking.

UNIT V **10 Hours**

EVALUATION OF SAVING OPPORTUNITIES AND FINANCIAL MANAGEMENT

Determination of cost saving -conservation opportunities - Estimating cost of implementation - Financial analysis techniques-plant energy audit report - Simple payback period, Return on investment, Net present value, Internal rate of return, Free cash flow analysis.

FOR FURTHER READING

Energy conservation and management -case studies - BEE rules and regulations.

Total: 45 Hours

Reference(s)

1. Jose Golden Berg; Thomas Johansson, A K N Reddy ,Robert Williams Energy for a sustainable world, Wiley Eastern, 1988.
2. BEE reference book 1/2/3/4
3. Albert Thumann,Terry Niehus A Handbook of Energy Audits, Ninth Edition, 2012.
4. Charles E Brown, Springer, World Energy Resources, 2012.

Assessment Pattern

Unit/RBT	Remember				Understand				Apply				Analyse				Evaluate				Create				Total
	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	
1	2					2					6				4				6						20
2	4					4				2				6					4						20
3	2				4					4					4			6							20
4	4					6				4					6										20
5	4					4				12															20
																								Total	100

Assessment Questions

Remember

1. Define the term an energy audit
2. Name the various energy demand management types
3. Define automated demand response
4. State the application of automated demand response
5. Define peak saving in the DSM
6. Define the term energy management
7. Define crest factor
8. list any four energy audit devices
9. Name any two energy conservation act in india
10. Show the energy efficient characteristics of one of the lamp
11. List the types of energy audit
12. Define power factor
13. List the features of energy efficient motor

Understand

1. State the importance of energy policy for industries.
2. Explain the role of training and awareness in energy management programme
3. Explain briefly the difference between preliminary and detailed energy audits?
4. What is the significance of knowing the energy costs?
5. What are the benefits of benchmarking energy consumption?
6. Explain the implications of part load operation of energy equipment with examples
7. What do you understand by the term fuel substitution? Give examples.
8. Combine the various steps involved in (a) preliminary energy audit (b) detailed energy audit methodology.

9. Apply different power factor correction methods in detail and mention the advantages of each method
10. Explain the features of rewound motors
11. State the term load shifting in DSM

Apply

1. Discuss the subsidies and cross subsidies in oil sector in India
2. Describe the Greenhouse effect.
3. Select the managerial functions involved in energy management
4. Build the various steps in the implementation of energy management in an organization
5. Develop the payback period term in energy efficient light at one of the process industry
6. Choose at least three financing options for energy management and discuss their features.
7. Organise the role of an ESCO with real time problem in energy management
8. Make use of energy aucit technique find the energy conservation issues in your home
9. Develop an efficient pump in your home
10. Apply any one energy efficient technique in electric motor and show its improvement

Analyse

1. Compare any three places of oil reserves located in India and their capacity
2. Compare the % shares of commercial energy consumption in industrial and agricultural sectors
3. Categorize the economic growth linked to energy consumption
4. Inspect the strategies required for long-term management of energy in India
5. Compare the functions of the pillars of energy management system
6. Inspect why CO2 is regarded as a potential threat to the planet.
7. Differentiate between energy conservation and energy efficiency.
8. Why fresh investments are needed for energy conservation in industry? justify your answer
9. Name at least three selling points to top management for investing in energy efficiency over other competitive projects and analyse with an exambles
10. The Cost of an heat exchanger is Rs.1.00 lakhs .Calculate simple pay back period which considering annual saving potential of Rs.60,000/- and annual operating costof Rs.15,000/- .
11. Analyse the advantages of simple pay back method with suitable examble
12. Analyse the term " present value of money" with time
13. Categorize the term " discounting" in energy audit

Evaluate

1. Estimate atleast five States where coal deposits are concentrated in India and apply their potential to generate electric power.
2. Determine the percentage of our Country's oil consumption is imported and how much does it cost (approximately) per year?
3. Appraise the hydro power generation potential available in India, and how much is exploited so far?
4. Conclude in few words about the various reforms in the energy sector.
5. Compare the major pollutants in burning fossil fuels
6. Estimate the objective of energy management.
7. Choose the parameters that can be measured by on line power analyser. Evaluate in detail
8. A project entails an investment for initial cost of installation and series of annual costs and/or cost savings through out the life of project. Recommend a suitable financial analysis techniques and explain.

Create

1. Combine the various implications of Global warming
2. Discuss effects of any three green house gases. Which one of them produces the maximum Green house effect?
3. Develop the conditions to be followed in a using of rewound motors.
4. Compare the five designated consumers under the energy conservation act.
5. Discuss why managerial skills are as important as technical skills in energy management

15EE007 FLEXIBLE AC TRANSMISSION SYSTEMS 3 0 0 3

Course Objectives

- To understand the needs and working of FACTS and Shunt compensation devices
- To understand the operation of series compensation devices and Static Voltage Phase Angle Regulator.
- To understand the working of FACTS controllers.

Programme Outcomes (POs)

a. **Engineering Knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. **Problem Analysis**: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

c. **Design/ Development of Solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety,and the cultural, societal, and environmental considerations.

Course Outcomes (COs)

1. Explain the necessity and benefits of FACTS controllers.
2. Classify shunt compensation devices used for power factor improvement.
3. Compare the types of series compensation devices based on their operating characteristics.
4. Examine the working of thyristor controlled voltage and phase angle regulators.
5. Analyze the working of UPFC and IPFC FACTS controllers.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1		3											1	
2	1	2											1	
3	1	2											1	
4		2	1											1
5		2	1										1	2

UNIT I

INTRODUCTION TO FACTS

Electrical Transmission Network - Necessity - Power Flow in AC System - relative importance of controllable parameter - opportunities for FACTS - possible benefits for FACTS.

UNIT II **10 Hours**

SHUNT COMPENSATION

Need for compensation - introduction to shunt & series compensation - objectives of shunt & series compensation - configuration & operating characteristics - Thyristor Controlled Reactor (TCR) - Thyristor Switched Capacitor (TSC) - Comparison of TCR & TSC.

UNIT III **9 Hours**

SERIES COMPENSATION

Variable Impedance Type Series Compensation: Thyristor Switched Series Capacitor (TSSC) - Thyristor Controlled Series, Capacitor (TCSC) - Basic operating control schemes for TSSC & TCSC.

UNIT IV **8 Hours**

STATIC VOLTAGE PHASE ANGLE REGULATOR

Static Voltage Phase Angle Regulator, Objectives of voltage & phase angle regulators - approaches to Thyristor - Controlled Voltage & Phase Angle Regulator.

UNIT V **9 Hours**

EMERGING FACTS CONTROLLER

STATCOM - Introduction to Unified Power Flow Controller (UPFC) & Interline Power Flow Controller (IPFC) - basic operating principles of UPFC - introduction to sub synchronous resonance.

FOR FURTHER READING

Possible benefits for FACTS- Comparison of TCR & TSC- Principle operation and control schemes for TSSC & TCSC- Controlled Voltage & Phase Angle Regulator - Operating principle of UPQC.

Total: 45 Hours

Reference(s)

1. R. Mohan Mathur and Rajiv K.Varma, Thyristor Based FACTS Controller for Electrical Transmission Systems, Wiley Interscience Publications, 2012.
2. Narain G. Hingorani & Laszlo Gyugyi, Understanding FACTS - Concepts & Technology of Flexible AC Transmission Systems, Standard Publishers, New Delhi, 2011.
3. T. J. E. Miller, Reactive Power Control in Electric System, John Wiley & Sons, 2007.
4. G. K. Dubey, Thyristerized Power Controller, New Age international (P) Ltd., New Delhi 2011.
5. Narain G. Hingorani, Flexible AC Transmission, IEEE Spectrum, April 1993, pp 40-45.
6. Elinar V. Larsen, Juan J Sanchez - Gasca Joe H. Chow, Concepts for design of FACTS controllers to damp power swings, IEEE Transactions on Power Systems, Vol. 10, No. 2, May 1995.

Assessment Pattern

Unit/RBT	Remember				Understand				Apply				Analyse				Evaluate				Create				Total
	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	
1		2				6								12											20
2		2				6								12											20
3		2				6				12															20
4		4				6				10															20
5	4						6				10														20
																								Total	100

Assessment Questions

Remember

1. List the two main reason for incorporating FACTs devices
2. State the features of interline power Flow control
3. List the three basic modes of SVC
4. State the voltage instability.
5. List the advantages of TCSC
6. List the functions of damping control of a TCSC
7. List the any two power system performance that can be iproved by STATCOM
8. List the applicatio of UPFC
9. State the main problem of multiple SVCs
10. Recall the maximum power trasfer theory

Understand

1. Explain Load compensation
2. Explain the working of the two types of SVC
3. Explain the advantages of slope in the dynamic charcterstics of SVC
4. Explain the basic principle and different modes of operation of TCSC
5. Classify the compenstion
6. compare the shunt compensator with series compensator
7. Explain the operation of STATCOM.
8. Explain the operatin of TCSC
9. Exemlipy the types ofÂ shunt compensators.
10. Compare TCSC with TSSC

Apply

1. Construct th block diagram of for a basic UPFC control scheme
2. Implement the UPFC scheme using two back to back voltage source.
3. Show the basic two converter scheme for IPFC
4. Show the block diagram for generalized IPFC
5. Find the expression for active as well as reactive power flow in a losslesstransmission line
6. By using power angle explain changing the value of line impedance the maximum amount of active power flow will change
7. Give the functional control scheme for a SSSC
8. With the help of power angle curve explain how transient stability is improved with the help of series controllers
9. Show thw VI characteristics and characteristics of GCSC
10. Show thw VI characteristics and characteristics of SSSC

Analyse

1. Compare FACTS and HVDC
2. Compare VSI with CSI
3. Compare STATCOM with SVS
4. Justify the improvement in transient stability with phase angle regulator by giving the power angle curve
5. Differentiate between an UPFC and IPFC
6. By means of block diagram simulate a generalize IPFC which can be operated as a STATCOM
7. By means of block diagram simulate a generalize IPFC which can be operated as a SSSC
8. By means of block diagram simulate a generalize IPFC which can be operated as a UPFC
9. By means of block diagram simulate a generalize IPFC which can be operated as a IPFC
10. How TCBR is used to improve the transient stability.

Evaluate

1. Choose the possible benefits of FACT'S technology.
2. An SVC is connected to 765 kV system has a reactive power range of 520 MVAR production to 270 MVAR absorption. If the per unit proportional gain of voltage regular is to be 0.75 determine the short-circuit level of the system. The SVC has a slope of 3.5%
3. Consider a SMIB system in which the synchronous machine is generating 0.92 p.u. MW and 0.3 p.u. MVAR. The voltage of Infinite bus is 0.998+j0.0 p.u. The machine transient reactance is 0.3 p.u. and the transmission line reactance is 0.650 p.u. (a) Calculate what should be the net susceptance of SVC to maintain midpoint voltage at 1 p.u. (b) Calculate synchronizing torque co-efficient with and without SVC at midpoint of the line.

4. Consider the SMIB system in which the synchronous machine is generating 0.8 5pu MW and 0.25 MVAR. The infinite bus voltage is 1 at angle of 0. The machine transient reactance is 0.32 p.u and the transmission line reactance is 0.65p.u.Calculate the value of net reactance offered by the TCSC and the voltage that has to be injected by the TCSC to enhance the power flow to 1.0 p.u
5. Consider the SMIB system in which the synchronous machine is generating 0.9pu MW and 0.29 MVAR. The infinite bus voltage is 1 at angle of 0. The machine transient reactance is 0.32 p.u and the
transmission line reactance is 0.0.75p.u.Calculate the value of net reactance offered by the TCSC and the voltage that has to be injected by the TCSC to enhance the power flow to 1.0 p.u
6. Consider a SMIB system generating 0.9 p.u MW and 0.28 p.u MVAR. The infinite voltage is 1 at 0 and the machine transient reactance is 0.3 p.u, transmission line reactance is 0.57 p.u. Calculate.
a) The voltage that has to be injected by SSSC to enhance the power transfer to 0.92 p.u MW
b) Compute the value of degree of compensation that has to be provided to enhance the power transfer to 0.9 p.u
7. Consider a SMIB system generating 0.8 p.u MW and 0.2 p.u MVAR. The infinite voltage is 1 at 0 and the machine transient reactance is 0.3 p.u, transmission line reactance is 0.5 p.u. Calculate.
a) The voltage that has to be injected by SSSC to enhance the power transfer to 0.9 p.u MW
b) Compute the value of degree of compensation that has to be provided to enhance the power transfer to 0.95 p.u
8. An SVC is connected to 700 kV system has a reactive power range of 530MVAR production to 300 MVAR absorption. If the per unit proportional gain of voltage regular is to be 0.8determine the short-circuit level of the system. The SVC has a slope of 3.8%
9. Choose the correct compensator for HVDC.
10. Choose the perfect design of UPS for a single home

Create

1. Derive the eqution of reactive power in the STATCOM.
2. How to redus line harmonics in Facts

15EE008 SWITCHED MODE POWER CONVERTERS 3 0 0 3

Course Objectives

- To understand the basic topologies of switched mode converters.
- To understand the different types of modulation schemes and control techniques of the converters.
- To estimate the switching and conduction losses taking place in switched mode converters.

Programme Outcomes (POs)

a. **Engineering Knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
c. **Design/ Development of Solutions**: Design solutions for complex engineering problems and design system components or processes that meet the consideration for thepublic health and safety, and the cultural, societal, and environmental considerations.cultural, societal, and environmental considerations
d. **Conduct Investigations of Complex Problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

e. **Modern Tool Usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

Course Outcomes (COs)

1. Explain the different types of converter topolgies and their modes of operation.
2. Analyze the different types of pulse width modulation techniques and switching schemes in inverters.
3. Design the fixed band and variable band hysteresis controller for current regulated inverters.
4. Analyze the performance of single phase and three phase bridge rectifiers in closed loop control.
5. Evaluate the performance of series and shunt reactive power compensators and their control techniques.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2		3		2								1	
2	1			3	2								1	
3	1			2	3									2
4	1			3	2									1
5	1		2	3										2

UNIT I **9 Hours**

CONVERTER TOPOLOGIES

Buck, Boost- Buck, Boost SMPS Topologies- Basic Operation-Waveforms- modes of operation-switching stresses- switching and conduction losses- optimum switching frequency- practical voltage-current and power limits- design relations- voltage mode control principles- Data sheets.

UNIT II **10 Hours**

CARRIER MODULATION

Switch-Mode dc-ac Inverters - Basic Concepts - Single Phase Inverters - Push Pull - Half Bridge and Full Bridge Square Inverters - Blanking Time - Single Pulse Modulation of Single Phase Square Wave Inverters - Multi pulse modulation - PWM Principles - Sinusoidal Pulse Width Modulation in Single Phase Inverters - Choice of carrier frequency in SPWM - Bipolar and Unipolar Switching in SPWM.

UNIT III **9 Hours**

CURRENT CONTROL SCHEMES

Current Regulated Inverter - Current Regulated PWM Voltage Source Inverters - Methods of Current Control - Hysteresis Control - Variable Band Hysteresis Control - Fixed Switching Frequency Current Control Methods - Switching Frequency Vs accuracy of Current Regulation - Areas of application of Current Regulated VSI.

UNIT IV **9 Hours**

CLOSED LOOP CONTROL

Switched Mode Rectifier - Operation of Single/Three Phase Bridges in Rectifier Mode - Control Principles - Control of the DC Side Voltage - Voltage Control Loop - The inner Current Control Loop.

UNIT V **8 Hours**

POWER FACTOR CONTROL

Shunt Reactive Power Compensators - Switched Capacitors - Static Reactor Compensators based on thyristor - Static Reactive VAR Generators using PWM Current Regulated VSIs - Principles - Control Strategies - Series Compensation by PWM-VSI based Voltage Injection Scheme - Principles - Control Strategies.

FOR FURTHER READING

STATCOM - Principle of operation - VI characteristics - Harmonic Performance, steady state model.

Total: 45 Hours

Text Book(s)

1. Apraham I Pressman, Switching Power Supply Design, McGraw Hill Publishing Company, 2008.

Reference(s)

1. Daniel M Mitchell, DC - DC Switching Regulator Analysis, Mc Graw Hill publishing Company, 2005.
2. Ned Mohan, Power Electronics, John Wiley and Sons, 2006.
3. Otmar Kilgenstein, Switched Mode Power Supplies in practice, John Wiley and Sons, 2002.
4. Keith H Billings, Handbook of Switched Mode Power Supplies, McGraw Hill Publishing Conpany, 2000.
5. Mark J Nave, Power Line Filter Design for Switched Mode Power Supplies, Van Nostrand Reinhold, New York, 2004.

Assessment Pattern

Unit/RBT	Remember				Understand				Apply				Analyse				Evaluate				Create				Total
	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	
1	2	2				12			1	3															20
2		2					2			14	2														20
3		2				3			3					12											20
4		2				2			1	3				12											20
5	2					2			2	2									12						20
																								Total	100

Assessment Questions

Remember

1. Mention any two limitations of linear regulator.
2. What is mean by fly back effect?Give its significance?
3. List the advantages and disadvantages of a buck regulator.
4. Define amplitude modulation ratio.
5. Mention any two applications of current regulated VSI.
6. Write the expression for maximum switching frequency & average switching frequency.
7. List the advantages and disadvantages of a hysteresis current control
8. Define harmonic factor.
9. Why the power factor control is necessary in power system?
10. Define reverse recovery time.
11. What is multi pulse modulation?
12. List any two applications of current regulated VSI.
13. What are the advantages of variable band hysteresis control?

Understand

1. Explain the modes of operation of buck – boost converter with relevant waveforms.
2. Design an inductor to maintain continuous mode of operation in buck regulator.
3. Compare voltage mode control and current mode control
4. Construct a single phase square wave inverter and draw its waveform.
5. Illustrate the effect of Blanking Time on the output voltage PWM inverter.
6. Describe the bipolar switching of sinusoidal pulse width modulation.
7. Discuss the various methods of current controlled schemes involved in switched mode converter
8. Enumerate the features of switching frequency over current regulation.
9. Classifiy the different switching techniques of FET.
10. Compare the diferent types of converter topology.

Apply

1. Discuss how boost converter can be used for PFC application in ac –dc converter.
2. The boost converter in figure 15.5 is to operate with a 50μs transistor fixed on-time in order to convert the 50 V input up to 75 V at the output. The inductor is 250μH and the resistive load is 2.5Ω.
   i. Calculate the switching frequency, hence transistor off-time, assuming continuous inductor current.
   ii. Calculate the mean input and output current.
   iii. Draw the inductor current, showing the minimum and maximum values.
   iv. Calculate the capacitor rms ripple current.
   v. Derive general expressions relating the operating frequency to varying load resistance.
3. A switched mode Buck regulator is used to regulate a output voltage to + 15 V. The supply input voltage an vary from +27 V to 102 V. Find out the ratings of the transistor and the diode if the maximum output current is 1 Amp.
4. Find out the value of the coupling capacitor Cc for a half bridge converter of 200 W working at 40 kHz and having a turns ratio of 5. Also verify if this value is acceptable. Otherwise find out the new value. Assume filterÂ inductance of 40 μH and η = 80%.
5. Illustrate the differnt converter schenes in AC drives.
6. Calculate the avarage and rms vale in controlled and uncontrolled rectifier.
7. Solve the current flowing to the drive during discontinous mode of operation.
8. Paint the common mode dual converter for open end Induction motor.
9. Apply the equation for solving direct torque control topology during dynamic behaviour.
10. Illustrate the JTO during reverse condution mode.
11. Explain the operation of four quadrant converter.
12. Develop the model for blocked rotor induction motor.
13. Explain the operating modes in SCR.
14. Determine the performance of AC drive in fully converter and semi converter topology.

Analyse

1. Formulate the relation between Switching Frequency and accuracy of Current Regulation.
2. Analyze the performance of Push Pull - Half Bridge and Full Bridge Square Inverters.
3. Explain any one type of load torque.
4. Analyse the sweeing rate in textile drive.
5. Derive the transfer function of AC motor.
6. Differentiate Armature control and field control.
7. Distingush VSI and CSI fed drive.
8. Illustrate the closed loop speed control for converter fed drives.
9. Calculate the voltage swell time for transient load.
10. Illustrate the armature voltage control.
11. Analyse the power converter topologies.

Create

1. Construct a buck converter and push pull converter.
2. Design a pull converter using Pspice.
3. Obtain the design of PWM inverter using MATLAB.
4. Construct a boost converter and switched capacitor using electronic equipments.
5. Evaluate the operation of static VAR generators using suitable design.
6. Deisgn the ramp controller for AC drive.
7. Write the EMF equation of slip ring induction motor.
8. List the different types of electrical drives
9. Write the different factors for the selection of electric drives.
10. Write different types of braking in a dc motor.
11. Prepare the constant current control drive scheme.
12. Rewrite the frequency control of IM.

15EE009 POWER ELECTRONICS APPLICATIONS TO POWER SYSTEM 3 0 0 3

Course Objectives

- To impart knowledge on different types of converter configurations.
- To study the different applications of converters in HVDC systems.
- To analyze the different types of reactive power compensation and stability analysis.

Programme Outcomes (POs)

a. **Engineering Knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. **Problem Analysis**: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
c. **Design/ Development of Solutions**: Design solutions for complex engineering problems and design system components or processes that meet the consideration for thepublic health and safety, and the cultural, societal, and environmental considerations.cultural, societal, and environmental considerations.
d. **Conduct Investigations of Complex Problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

Course Outcomes (COs)

1. Examine the characteristics of different types of converter configurations for large power control.
2. Analyze the different control functions required for HVDC link.
3. Compare various methods of reactive power compensation and stability analysis.
4. Analyze the Reactive Power Compensation Methods
5. Asses the power flow and stability analysis for different converter model

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3		2										2	
2	2	2											2	
3		2	2										3	
4	3	2	-										2	
5	3	2	2	1									2	1

UNIT I **7 Hours**

INTRODUCTION

High Power devices for Power systems controllers - Characteristics - Converters Configuration for Large power control.

UNIT II **10 Hours**

SINGLE PHASE AND THREE PHASE CONVERTERS

Properties - Current and voltage harmonics - Effect of source and load impendence - Choice of best circuit for power systems- Converter Control - Gate Control - Basic means of Control - Control characteristics - Stability of control - Reactive power control - Applications of converters in HVDC systems - Static VAR control - Source of reactive power - Harmonics and filters.

UNIT III **11 Hours**

HIGH VOLTAGE DC (HVDC)

HVDC configurations, components of HVDC system: Converter, transformer, smoothing reactor, harmonic filter. Reactive power support, operation of 6-pulse controlled rectifier in inverting mode of operation - Operation of 12-pulse converter - Control of HVDC system, Rectifier and inverter characteristics, mode stabilization, current control, voltage dependent current order limit, combined rectifier-inverter characteristics, modern HVDC system - HVDC light.

UNIT IV **9 Hours**

REACTIVE POWER COMPENSATION

Introduction, methods of Var generation, analysis of uncompensated AC line, Passive reactive power compensation, static var compensators, Compensation by a series capacitor connected at the mid-point of the line, Effect on Power Transfer capacity, Compensation by STATCOM and SSSC, Fixed capacitor-Thyristor controlled reactor (FC-TCR), Thyristor-switched capacitor- Thyristor controlled reactor (TSC-TCR).

UNIT V **8 Hours**

POWER FLOW AND STABILITY ANALYSIS

Component models - Converter control - Power flow analysis of converter - Transient and dynamic stability analysis - Protection against overcurrent and over voltage.

FOR FURTHER READING

Synchronous condenser, Power factor and Harmonics in industrial loads.

Total: 45 Hours

Reference(s)

1. Acha E and Agilidis VG, Power Electronic Control in Electrical Systems,Elsevier India Pvt. Ltd., 2006.
2. K.R. Padiyar, HVDC Power Transmission System Technology and System Interaction, New Delhi, New Age International, 2005.
3. J. Arrillaga, High Voltage Direct Current Transmission, The institute of electrical engineers, London, UK, 2014.
4. Narain G. Hingorani, Laszio Gyugyl, Understanding FACTS Concepts and Technology of Flexible AC Transmission Systems, Standard Publishers Distributors, New Delhi, 2011.
5. Erich Uhlmann, Power Transmission by Direct Current, New York, Springer Publications, 2013.

Assessment Pattern

Unit/RBT	Remember				Understand				Apply				Analyse				Evaluate				Create				Total
	F	**C**	**P**	**M**	**F**	**C**	**P**	**M**	**F**	**C**	**P**	**M**	**F**	**C**	**P**	**M**	**F**	**C**	**P**	**M**	**F**	**C**	**P**	**M**	
1	2	2				12			1	3															20
2		2					2			14	2														20
3		2				3			3					12											20
4		2				2			1	3				12											20
5	2					2			2	2									12						20
																								Total	100

Assessment Questions

Remember

1. What is the need for isolation in power electronics circuits?
2. What are the disadvantages of DC transmission?
3. What is transient reliability?
4. What is reverse recovery time?
5. Draw the gate characteristics of SCR.
6. Define pulse number.
7. List out the assumptions made in detailed analysis of converters?
8. What are the sources of reactive power?
9. List the types of static VAR compensator systems?
10. What are the functions of smoothing reactors?
11. What is meant by corona?
12. Name any four high power devices used in power system applications.
13. Draw the converter configuration of Graetz circuit.
14. What are the two basic firing schemes used for firing pulse generation in HVDC valves?
15. Define dynamic stability.
16. Specify the functions of smoothing reactors.
17. Give some of the factors that must be considered in designing a protection system.

Understand

1. Why vertical structure type construction is preferred for power transistors?
2. What are the problems associated with series connected SCRs?
3. What type of power MOSFET preferred for practical use?
4. Mention the assumptions made to draw the equivalent circuit of a two terminal DC link.
5. Mention any four problems associated with the injection of harmonics.
6. Draw the block diagram of constant firing angle control scheme.
7. Specify some of the effects of corona.
8. Mention any four problems associated with the injection of harmonics.
9. What are the factors that must be considered in designing a protection system?
10. List the various schemes available for power factor improvement.
11. Draw the converter configuration which is used for high power applications.
12. Mention the two basic firing schemes used for firing pulse generation in HVDC valves.
13. Sketch the converter controller characteristics of both rectifier and inverter.
14. Construct the device structure and explain the i-v characteristics of IGBT with its equivalent circuit.
15. Mention the difference of ac and dc transmission system.
16. Explain the major components of HVDC transmission system.
17. Draw and demonstrate the graetz converter circuit, without overlap and with overlap conditions.
18. Explain the converter bridge characteristics in rectifier mode of operation.
19. Illustrate the characteristics of twelve pulse converter.
20. Examine the characteristics of six pulse converter with filters.
21. Explain the basic principles of converter control characteristics.
22. Implement the hierarchical control structure for a dc link.

Apply

1. Explain different methods to turn on the thyristor?
2. Interpet latching current.
3. Explain holding current.
4. Demonstrate the use od snubber circuit.
5. Explain Why IGBT is very popular nowadays?
6. Show the difference between power diode and signal diode.
7. Report the advantages of GTO over SCR.
8. interpet the few losses occur in a thyristor during working conditions?
9. Calculate SOA of power switch for drive application.
10. Calculate SOA of power switch for drive application.

Analyse

1. Analyze the two different firing angle control schemes for HVDC valves.
2. Identify and discuss the functions of higher level controllers for HVDC converters.
3. Organize the reactive power requirements in steady state operating condition for converters.
4. Analyze the sources of reactive power based upon its performance.
5. Analyze the different types of ac filters and dc filters used in converter station for harmonic suppression
6. Investigate the converter model based upon transient stability analysis.
7. Examine the dynamic stability analysis of the converter.
8. Infer the basic circuit of UPFC.
9. Discuss in detail about SVC-SVC interaction.
10. Design the basic block diagram of open loop control of TCSC.

Evaluate

1. Identify the three different types of fault occurs in converters and explain any one.
2. Judge how load compensation is achieved using static var system.
3. Evaluate the problems associated with generation of harmonics in ac and dc system.
4. Identify and discuss the different types of stability evaluation method for multi machine system.
5. How dc transmission line protected against corona effects?
6. Summerize the modelling of GCSC for load flow studies.
7. Design modelling of UPFC for power flow studies.
8. Write any three factors to test the effectiveness of SVC.
9. Formulate basic procedure for the design of controller.
10. Rewrite three factors to test the effectiveness of SVC.

15EE010 POWER SYSTEM OPERATION AND CONTROL

3 0 0 3

Course Objectives

- Apply the tools like load curve, load duration curve and load factor to estimate the future demand and to predict the reserve capacity.
- Deduce the state variable model of frequency control loop in isolated and grid connected generating units.
- Compose the transfer function model of excitation system and to classify the three major system level control schemes.
- Prepare an economic load sharing schedule for a given demand based on generating unit's cost characteristics.

- Explain the hardware components required to design a SCADA system for power system monitoring and control.

Programme Outcomes (POs)

a. **Engineering Knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. **Problem Analysis**: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
e. **Modern Tool Usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

Course Outcomes (COs)

1. Compute the future load demand and predict the reserve capacity
2. Construct the state variable model of frequency control loop in isolated and grid connected generating units.
3. Analyze the transfer function model of excitation system and classify the system level control schemes.
4. Prepare an economic load sharing schedule for a given demand based on generating units cost characteristics
5. Analyse the layout of SCADA system for power system monitoring and control

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3	2											3	
2	3	2											3	
3	3	2											3	
4	2	3											3	
5					3								3	

UNIT I **9 Hours**

INTRODUCTION

System load variation: System load characteristics, load curves, Load-duration curve, load factor and diversity factor. Reserve requirements: Installed reserves, spinning reserves, cold reserves and hot reserves. Overview of system operation: Load forecasting, unit commitment and load dispatching. Overview of system control,Need for voltage and frequency regulation in power system, Plant level and System level controls.

UNIT II **10 Hours**

REAL POWER - FREQUENCY CONTROL

Fundamentals of speed governing mechanism and modeling: Speed-load characteristics-Load sharing between two synchronous machines in parallel; concept of control area, LFC control of a single-area system: Static and dynamic analysis. Multi-area systems: Two-area system modeling; static analysis; tie line with frequency bias control of two-area system. State variable model.

UNIT III **8 Hours**

REACTIVE POWER VOLTAGE CONTROL

Typical excitation system, modeling, static and dynamic analysis, stability compensation; generation and absorption of reactive power: Relation between sending end and receiving end voltage; method of voltage control: Injection of reactive power. Tap-changing transformer, static VAR system.

UNIT IV **8 Hours**

POWER SYSTEM ECONOMICS

Incremental cost curve, co-ordination equations without loss and with loss, solution by direct method and lambda iteration method. (No derivation of loss coefficients.) Base point and participation factors. Economic dispatch controller added to LFC control.

UNIT V **10 Hours**

COMPUTER CONTROL OF POWER SYSTEMS

Energy control centre: Functions, Monitoring, data acquisition and control. System hardware configuration - SCADA and EMS functions: Network topology determination, state estimation, security analysis and control. Various operating states: Normal, alert, emergency, in extremis and restorative. State transition diagram showing various state transitions and control strategies.

FOR FURTHER READING

Thermal power plants, Pumped Storage plants, Demand Side Management

Total: 45 Hours

Reference(s)

1. Olle. I. Elgerd, Electric Energy Systems Theory, Tata McGraw Hill Publishing Company Ltd,New Delhi, Second Edition, 30th reprint 2008.
2. Allen.J.Wood and Bruce F.Wollenberg, Power Generation, Operation and Control, John Wiley & Sons Inc., New York 2006.
3. P.Kundur,Power System Stability and Control, McGraw Hill Publishing Co, New York, 2009.
4. D P Kothari and I J Nagrath,Modern Power System Analysis, Tata McGraw Hill Publishing Co, New Delhi, 2011.
5. Narain G. Hingorani, Flexible AC Transmission, IEEE Spectrum, April 1993, pp 40 â€“ 45.
6. Narain G. Hingorani, High Power Electronics in Flexible AC Transmission, IEEE Power Engineering Review, 1998.

Assessment Pattern

Unit/RBT	Remember				Understand				Apply				Analyse				Evaluate				Create				Total
	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	
1	4	4				6				6															20
2		2				6				6				2				4							20
3	2	2				6				5				5											20
4						10				10															20
5		6				14																			20
																								Total	100

Assessment Questions

Remember

1. Define load factor.
2. Define plant capacity factor.
3. Define hot reserve.
4. Recall the difference between hot reserve and spinning reserve.
5. Define interconnected system.
6. Define ACE.
7. State AFRC.
8. Recall spinning reserve.
9. Define load forecasting.
10. Recall the need for voltage and frequency regulation in power system.
11. List the functions of SCADA.
12. Recall incremental cost curve.

Understand

1. Compare a tie line with a transmission line.
2. Illustrate the plant level control loop.
3. Interpret the P-f and Q-v control loops.
4. Illustrate the mathematical equivalent of speed governing system.
5. Explain the typical AVR system.
6. Exemplify the static response of a two area system.
7. Illustrate the system's state transition diagram.
8. Explain the Hardware setup of a base station in SCADA system.
9. Illustrate the hardware setup of a Remote terminal unit in a SCADA system
10. Explain the hardware configuration and functions of energy centre with neat diagram.

Apply

1. A 210 MVA, 50 Hz Turbo Alternator operates at no load at 3000 rpm. A load of 75 MW is suddenly applied to the machine and the steam valves to the turbine commence to open after 1 sec due to the time lag in the governor system. Assuming Inertia Constant H of 5Kw-sec per KVA of generator capacity. Calculate the frequency to which the generated voltage drops before the steam flow commences to increase to meet the new load.
2. The data pertaining to a single area power system with linear load-frequency characteristics are as follows:Rated Capacity = 2000 MW, System Load = 1000 MW,Inertia Constant = 5 sec Speed regulation 0.03 pu,Load damping factor 1pu, Nominal Frequency = 50 Hz ,Governor Time constant = 0 sec Turbine time constant = 0 sec.For a sudden change in load of 20 MW, determine the steady state frequency deviation and the change in generation in MW and reduction in original load in MW.
3. A two area power system has two identical areas with parameters are given below:Rated Capacity of the area = 3000 MW, Nominal Operating load = 1500 MW,Inertia Constant = 4 sec Speed regulation = 4% Load damping factor = 1 pu Nominal Frequency = 50 Hz , Governor Time constant = 0.06 sec, Turbine time constant = 0.3 sec. A load increase M2 = 30 MW, occurs in area 2. Determine the following parameters (i) the steady state frequency deviation ii) ∆Ptie12.
4. Compute the stability of a typical automatic voltage regulator loop.
5. Construct the block diagram of load frequency control of a single area system.
6. Implement the mathematical modeling of the line power in an interconnected system and show its block diagram.
7. Design the block diagram of single area and two area system.
8. Show the block diagram of two area system.
9. Implement a two area system with load frequency control technique with neat diagram.
10. Implement the suitable controller for energy monitoring process in power system.
11. Show the SCADA system for power system monitoring process.

Analyse

1. Justify the steady state response of a single area system.
2. Conclude the reserve requirement of interconnected system.
3. Differenciate between load curve and the load duration curve.
4. Conclude the load forecasting procedures.
5. Differentiate the steady state and dynamic operations of an isolated system.
6. Justify the functions of SCADA system.
7. Integrate the various operating states of power system.
8. Differentiate the functions of SCADA and EMS in power system monitoring process.
9. Outline the structure of multi area system with neat diagram.
10. Resolve the power system economic problem using lambda iteration method with and without losses.
11. Differentiate single area system and multi area system in real power and frequency control technique.

Create

1. Combine the signifigance of single area power system and multi area power system.
2. Relate the control area concept for sinle area and multiple area system in power system.
3. Derive the mathematical modeling of the line power in an interconnected system.
4. Generate the optimal two area load frequency control system.
5. Combine the block diagram of single area and two area system.
6. Derive the expression for static error frequency and tie line power in an identical two area system.
7. Relate the features of single area and multi area systems with neat diagram.
8. Generate the different types of operating states in power system.
9. Combine the functions of SCADA and EMS.
10. Relate the coordination equations without loss and with loss for power system economics.

15EE011 WIND ENERGY CONVERSION SYSTEMS 3 0 0 3

Course Objectives

- To learn the design and control principles of Wind turbine.
- To understand the concepts of fixed speed and variable speed, wind energy conversion systems.
- To analyze the grid integration issues.

Programme Outcomes (POs)

a. **Engineering Knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

b. **Problem Analysis:** Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

c. **Design/ Development of Solutions**: Design solutions for complex engineering problems and design system components or processes that meet the consideration for thepublic health and safety, and the cultural, societal, and environmental considerations.cultural, societal, and environmental considerations

g. **Environment and Sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

Course Outcomes (COs)

1. Analyze the performance of WECS and select a suitable site.
2. Analyze the control mechanism for wind turbine.
3. Analyze the different types of generator for fixed speed wind turbine systems.
4. Explain the characteristics of generators for variable speed constant frequency systems.
5. Analyze the steady-state and dynamic performance of grid connected systems.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3	2					1							1
2	3	2	1											1
3	2	3	1											1
4	3	2												1
5	2	3					1							1

UNIT I **8 Hours**

INTRODUCTION

Wind source-wind statistics-Wind Energy Conversion System (WECS) siting-Classification-Components of WECS-WECS schemes-Power obtained from wind-simple momentum theory-Aerodynamics of Wind turbine.

UNIT II **10 Hours**

WIND TURBINES

HAWT - VAWT - Power developed-Thrust-Efficiency-Rotor selection-Rotor design considerations-Tip speed ratio-Number of Blades-Blade profile-Power Regulation-yaw control-Pitch angle control-stall control-Schemes for maximum power extraction.

UNIT III **9 Hours**

FIXED SPEED SYSTEMS

Generating Systems- Constant speed constant frequency systems -Choice of Generators-Deciding factors-Synchronous Generator-Squirrel Cage Induction Generator- Model of Wind Speed- Model of wind turbine rotor - Drive Train model- Generator model for Steady state and Transient stability analysis.

UNIT IV **8 Hours**

VARIABLE SPEED SYSTEMS

Need of variable speed systems-Power-wind speed characteristics-Variable speed constant frequency systems synchronous generator- DFIG- PMSG -Variable speed generators modelling - Variable speed variable frequency schemes.

UNIT V **10 Hours**

GRID CONNECTED SYSTEMS

Wind interconnection requirements, low-voltage ride through (LVRT), ramp rate limitations, and supply of ancillary services for frequency and voltage control, current practices and industry trends wind interconnection impact on steady-state and dynamic performance of the power system including modelling issue.

FOR FURTHER READING

Hybrid Energy systems- wind - photovoltaic systems-wind- diesel hybrid systems-diesel generator and photovoltaic systems.

Total: 45 Hours

Reference(s)

1. L.L.Freris,Wind Energy conversion Systems, Prentice Hall, 1990.
2. S.N.Bhadra, D.Kastha,S.Banerjee,Wind Electrical Sytems,Oxford University Press,2010.
3. Ion Boldea,Variable speed generators, Taylor & Francis group, 2006.
4. E.W.Golding,The generation of Electricity by wind power, Redwood burn Ltd.,Trowbridge,1976.
5. N. Jenkins,Wind Energy Technology, John Wiley & Sons,1997.
6. S.Heir, Grid Integration of WECS, Wiley 1998.

Assessment Pattern

Unit/RBT	Remember				Understand				Apply				Analyse				Evaluate				Create				Total
	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	
1	2		2				12							4											20
2		2					6								6				6						20
3	2										2			4					12						20

4						2	12				2			4											20
5		2			6					6					6										20
																								Total	100

Assessment Questions
Remember

1. State the basic principle of wind energy conversion.
2. Recall the schemes in WECS.
3. List various maximum power points tracking schemes.
4. List any four different types of generators used in WECS.
5. Define cut-in speed.
6. Define cut- out speed.
7. State the advantages of wind power.
8. Recall the purpose of anemometer in WECS.
9. Define the term tip speed ratio.
10. List any two types of vertical axis wind turbine generator.
11. Define pitch angle control.

Understand

1. Exemplify the power quality issues that affect wind power integration.
2. Interpret the factors to be considered for desidning rotor blades.
3. Infer on constant speed frequency system.
4. Identify the need for variable speed systems.
5. Explain the issues created in grid integrated PMSG based WECS.
6. Explain the reactive power compensation techniques in wind energy conversion systems.
7. Illustrate the variable frequency scheme for wind turbine generator.
8. Illustrate the operation of variable voltage and variable frequency scheme for wind energy conversion system.
9. Explain the construction and operating principle of horizontal axis wind turbine generator.
10. Explain the basic components of wind energy conversion system with neat diagram.

Apply

1. Predict the main applications of Wind energy.
2. Find the expression for power developed due to wind in WECS.
3. Compute power coefficient and torque coefficient of wind energy conversion system.
4. Construct the horizontal axis multibladed wind turbine.
5. Compute the overall conversion efficiency of wind turbine.
6. Demonstrate low voltage ride through in grid connected systems.
7. A 440V,250A,120 pole,50Hz, there phase permanent magnet motor has a reactance of 0.3 ohm per phase.The generated emf per phase is (Eg) equal to 1.05 of angular frequency of the rotor.The generator is driven by a wind turbine whose optimum power(P) as a function of the speed in rpm is equal to 1.38 N3 . The generator feeds power to a dc link through a diode-bridge rectifier.Find the optimal dc-link current- voltage characteristic for a rotational speed range of the 30% to 100% of the rated speed. Ignore transmission losses.
8. A horizontal axis wind turbine has a diameter of 5m.When the wind speed unaffected by turbine is 10 m/s, the turbine rotates at 300rpm and produces 5kW of mechanical power.Find the tip speed ratio and power coefficient.
9. A 440V,250A,120 pole,50Hz, there phase permanent magnet motor has a reactance of 0.3 ohm per phase.The generated emf per phase is (Eg) equal to 1.05 of angular frequency of the rotor.The generator is driven by a wind turbine whose optimum power(P) as a function of the speed in rpm is equal to 1.38 N3 . The generator feeds power to a dc link through a diode-bridge rectifier.Find the optimal dc-link current- voltage characteristic for a rotational speed range of the 30% to 100% of the rated speed. Ignore transmission losses.

10. Design a horizontal axis wind turbine generator with four blades.

Analyse

1. Justify the steady state operation of self excited induction generator with neat diagram.
2. Compare working principle and power obtained of the fixed and variable speed wind energy conversion systems.
3. Differentiate between self excited induction generator and synchronous generator for WECS.
4. Differentiate fixed speed and variable speed wind energy conversion systems.
5. Conclude the various schemes for maximum power extraction from wind turbines.
6. Differentiate the fixed speed and variable speed wind energy conversion systems.
7. Resolve the effect of rotor- injected Emf-Slip Power Recovery scheme.
8. Differentiate horizontal axis wind turbine with verticle axis wind turbine.
9. Integarate the wind energy conversion system with solar power to obtain the maximum output power.
10. Justify,how variable speed variable frequency WECS is more advantages than fixed speed wind energy conversion systems?

Evaluate

1. Determine the major problems related with grid interconnections of WECS.
2. Check the circuit model and also analyze the steady state operation for the self excited induction generator.
3. Choose the electrical layout of a typical wind form by means of single line diagram.
4. Determine the d-q axis model for squirrel cage induction motor.

Create

1. Produce a hybrid system for extracting maximum power from renewable energy resources.
2. Generate a three bladed horizontal axis wind turbine with solar photovoltaic system.
3. Generate the solar wind hybrid system.
4. Generalize the characteristics of horizontal axis wind turbine generator.
5. Generalize the characteristics of variable speed constant frequency systems.
6. Generalize the characteristics of three bladed verticle axis wind turbine generator.
7. Combine the features of constant speed variable frequency system with variable speed variable frequency system in WECS.
8. Derive the maximum efficiency of the wind turbine generator.
9. Relate the power versus velocity characteristics of wind turbine generator unit.
10. Combine the power coefficients and tip speed ratio for various types of wind turbine generators.

15EE012 SOLAR ENERGY CONVERSION SYSTEMS 3 0 0 3

Course Objectives

- To provide an overview of available solar energy conversion systems.
- To understand the solar radiation and its measurement techniques.
- To attain a broad comprehension on solar photovoltaic system and solar thermal energy conversion system.

Programme Outcomes (POs)

a. **Engineering Knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

b. **Problem Analysis**: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

c. **Design/ Development of Solutions:** Design solutions for complex engineering problems and design system components or processes that meet the consideration for the public health and safety, and the cultural, societal, and environmental considerations.cultural, societal, and environmental considerations.

d. **Conduct Investigations of Complex Problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

e. **Modern Tool Usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

Course Outcomes (COs)

1. Explain the world, Indias energy resources along with solar radiation spectrum and measuring instruments for solar energy.
2. Analyse the I-V characteristics of Solar PV System and MPPT algorithm
3. Design a converter control topologies for stand alone and grid connected PV systems.
4. Classify the different types of solar thermal energy collectors.
5. Construct a solar PV and thermal systems for various domestic and industrial applications.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO 2
1	2	1											1	
2	2	2		3	1								2	
3	2	2	3	1	1									1
4	2		2		1									1
5	3		2		1									2

UNIT I **9 Hours**

SOLAR RADIATION AND MEASUREMENT

World energy resources-Indian energy scenario- Importance of Renewable energy -Global solar resources-spectrum, Electromagnetic spectrum-Solar angles-Sun path diagrams-Solar insolation- -Radiation absorption, scattering -Measurement of radiation-Pyranometer-Pyrheliometer-Sunshine recorder.

UNIT II **8 Hours**

SOLAR PV SYSTEM

Solar cell - Construction-operation-types - I-V characteristics- -Conditions for maximum power transfer-Conversion efficiency - Maximum Power Point Tracking algorithms.

UNIT III **8 Hours**

STAND ALONE AND GRID CONNECTED PV SYSTEMS

Grid interconnection standards- - Inverter control topologies for stand alone and grid connected systems-Feasible operating region of inverter for grid connected system -Real time issues in grid connected systems.

UNIT IV **10 Hours**

SOLAR THERMAL ENERGY CONVERSION

Solar thermal energy- Solar flate plate collector, solar evacuated tube collector-Pool and Air collectors Construction -Function - Solar heating and cooling system - Real time issues in solar thermal systems-Comparison of solar thermal and Solar PV systems.

UNIT V **10 Hours**

APPLICATIONS OF SOLAR PV AND SOLAR THERMAL SYSTEMS

Solar PV power plant - Photovoltaic applications: battery charger, domestic lighting, street lighting, water pumping -Solar thermal electric power plant -solar thermal applications: heating, cooling, desalination, drying, cooking, Solar Ponds.

FOR FURTHER READING

Indian and International Energy Policies-Recent trends in solar thermal and Solar PV systems - Limitations of solar thermal and PV systems.

Total: 45 Hours

Reference(s)

1. G.D.Rai, Non Conventional Energy Sources, Khanna Publishers, New Delhi, 2011.
2. CS Solanki, Solar Photovotaics,Fundamentals, Technologies and Applications, 2nd edition, PHI Learning Pvt. Ltd., 2011.
3. Martin A. Green, Solar Cells Operating Principles, Technology, and System Applications PrenticeHall, 2008.
4. H.P. Garg and J. Prakash., Solar Energy,Fundamentals & Applications, Tata McGraw Hill book Co, New Delhi, 1997.
5. S.P. Sukhatme, J.K. Nayak, Solar Energy-Principle of thermal storage and collection, Tata McGraw Hill book Co, New Delhi, 2008.
6. G.N.Tiwari, Solar Energy-Fundamentals, Design,Modeling and Applications,Narosha Publishing House Ltd.,2002.

Assessment Pattern

Unit/RBT	Remember				Understand				Apply				Analyse				Evaluate				Create				Total
	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	
1	12	2			2	2							2												20
2		2			2					2				2				12							20
3	2	2			2	2					6			4											18
4					2					6				6				2				6			22
5	2	2			2	2					6											6			20
																								Total	100

Assessment Questions

Remember

1. List the types of energy resources.
2. Define non-conventional energy resources.
3. List three non – conventional energy sources of electric energy in India.
4. List the different types of plants in India.
5. Recall any two renewable sources of energy.
6. List any three non renewable sources.
7. Define the law of radiation
8. Define the terms azimuth angle.
9. List the three types of radiation.
10. Define photovoltaic effect.
11. List the conditions for maximum power transfer in solar PV system.
12. List any three applications of solar thermal energy conversion system.

Understand

1. Indicate the importance of solar energy in India.
2. Explain the Physics of the Sun and solar energy.
3. Illustrate the process storing the energy from solar array to batteries with diagram.
4. Illustrate the functions of storage devices available for storing the power from solar array with neat diagram.

5. Explain the need to develop new energy technologies.
6. Explain the terms solar radiation absorption and scattering with neat diagram.
7. Compare diffuse, beam and global radiations?
8. Explain the the principle of solar photovoltaic power generation.
9. Draw and explain the equivalent circuit of solar cell.
10. Draw and explain the solar I-V characteristics.
11. Explain any two maximum power point tracking algorithms.
12. Indicate the effects of variation of solar insolation and temperature on solar PV system?
13. Illustrate the the standalone PV system and grid connected PV system with neat sketch.

Apply
1. Construct the circuits for solar PV based battery charger.
2. Construct the circuits for solar PV basedÂ domestic lighting.
3. Select suitable solar systems for the following applications.
   (i) Solar pumping
   (ii) Solar Cooking
4. Select three applications of solar PV system for rural areas.
5. Design and implement the MPPT scheme for solar PV system.
6. Design and select the BOM forÂ solar water pump.
7. Write a program to track the maximum power in solar system.
8. Select the best method and procedure for solar thermal applications: heating, cooling, desalination.
9. Select the best method and procedure for solar thermal applications: drying, cooking and Solar Ponds.
10. Design the Inverter control topologies for stand alone and grid connected systems.

Analyse
1. Consider designing a solar car with a total roof area for solar cells of 6.4m2. Calculate the electrical power available, assuming total cell efficiency of 17% and a constant light intensity of 980 Wm$^{\wedge-2.}$
2. Calculate the hour angle at sunrise and sunset on june 21 & december 21 for a surface inclined at an angle of 10o and facing due south(γ=0o). The surface is located in Mumbai (19o07' N, 72o51'E).
3. Calculate the declination on 23 September 2017.
4. Compare solar thermal and Solar PV systems.
5. Comare solar PV and solar thermal system.
6. Analyze the various measurement of radiation.
7. Analyze the real time issues in solar thermal systems.

Evaluate
1. Derive an expression for air mass in terms of zenith angle (θZ) and altitude angle.
2. Evaluate the various MPPT schemes.
3. Evaluate the different types of solar collectors.

Create
1. Develop a control circuit for home appliences with following specifications supplied from solar PV system and also estimate the electrical parameters.
   a. 100W lamps- 4 Nos
   b. 50W fans- 4 NoS
   c. 500W fridge -1 No
   d. 1000 W iron box -1 No
2. Generate a model of Hybrid power system with solar and wind energy.

15EE013 POWER ELECTRONIC INTERFACES FOR RENEWABLE ENERGY SYSTEMS **3 0 0 3**

Course Objectives

- To study the current scenario of the implementation of renewable energy system.
- To understand the modern power converters for renewable energy power harnessing.
- To understand the interfacing of power converters with grids.

Programme Outcomes (POs)

a. **Engineering Knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. **Problem Analysis**: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
c. **Design/ Development of Solutions**: Design solutions for complex engineering problems and design system components or processes that meet the consideration for thepublic health and safety, and the cultural, societal, and environmental considerations.cultural, societal, and environmental considerations

Course Outcomes (COs)

1. Explain the rules and regulations in development of new energy technologies
2. Analyze the controllers for power converters in solar PV conversion system
3. Apply the basic principle and different configurations of wind energy conversion system
4. Analyze the converters for grid connected solar PV and wind energy conversion system
5. Apply the concepts of solar PV and wind energy conversion system to develop the distributed power systems

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO 2
1	3	2											1	
2	3	2	2										1	
3	3	1	2										2	
4	2	2	1										1	2
5	2	1	3										1	2

UNIT I **7 Hours**

INTRODUCTION

Trends in energy consumption - World energy scenario - Energy sources and their availability - Conventional and renewable energy resources - Need to develop new energy technologies - Current status of renewable energy sources - Government Bodies and its function - MNRE & TEDA.

UNIT II **9 Hours**

SOLAR THERMAL SYSTEM

Solar radiation and measurements - Solar cells - Panels and their characteristics -Influence of insolation, temperature and paracitic capaciance PV arrays - power converters-Maximum power point tracking - Applications.

UNIT III **9 Hours**

WIND ENERGY SYSTEMS

Principle of Wind Energy Conversion System- Nature of Wind - Components of Wind Energy Conversion System- Modern generators for WECS - Power conditioning schemes.

UNIT IV **10 Hours**

GRID CONNECTED WECS AND SECS

Grid codes- grid connectors -Grid related problems and standards-conventional and new grid sychronisation methods-Generator control - Power converters for Grid connected WECS - Grid connected solar energy converter systems- Power converters for Grid connected SECS.

UNIT V **10 Hours**

DISTRIBUTED POWER GENERATION SYSTEMS

Solar PV- Hybrid Systems - Selection of power conversion ratio -Optimization of System components - Micro Hydro, wind, solar, and fuel cell systems - Converters and controllers for integration of renewable energy sources- types of energy storage systems.

FOR FURTHER READING

Need for Hybrid Systems- Range and types of hybrid PV systems -SPV-wind-Battery- fuel cell-Diesel generator & grid interacted hybrid system - Micro hydro power - Co-generation.

Total: 45 Hours

Reference(s)

1. S. Rao and Parulekar, Energy Technology Non Conventional, Renewable and Conventional, New Delhi, Khanna Publishers, 1999.
2. Rai G.D, Non conventional energy sources, Khanna Publishers, 1993.
3. Mukund R. Patel, Wind and Solar Power System, New York, CRC Press LLC, 1999.
4. Ned Mohan, Tore M. Undeland and William P.Robbins, Power Electronics: Converters, Applications and Design, New Jersey, John Wiley and Sons, 2003.
5. V.K.M8. Mustafa, Al-Saffar, Esam H.Ismail, Ahmad J.Sabzali and Abbas A.Fardoun, An Improved Topology of SEPIC Converter with Reduced Output Voltage Ripple, Vol.23, No.5, IEEE Transactions on Power Electronics, September 2008, pp 2377-2386.
6. Anbukumar kavitha and Govindarajan Uma, Experimental Verification of Hopf Bifurcation in DC-DC Luo Converter, Vol.23, No.6, IEEE Transaction on Power Electronics, 2008, pp 2878-2883.

Assessment Pattern

Unit/RBT	Remember				Understand				Apply				Analyse				Evaluate				Create				Total
	F	**C**	**P**	**M**	**F**	**C**	**P**	**M**	**F**	**C**	**P**	**M**	**F**	**C**	**P**	**M**	**F**	**C**	**P**	**M**	**F**	**C**	**P**	**M**	
1	2	2			2	2								12											20
2		2				2				2				2				6				6			20
3	2					2				2				2	6				6						20
4		2				6				2			2	6				2							20
5	2					6			2				2					2				6			20
																								Total	100

Assessment Questions

Remember

1. List the green house gases responsible for global warming.
2. List three non – conventional energy sources of electric energy in India.

3. Define photovoltaic effect.
4. What is MPPT?
5. Define array sizing.
6. Recall the basic principle of wind energy conversion?
7. List the components of WECS.
8. State the principle of operation of PMSG.
9. List the accessories of wind farm
10. Define power conversion ratio.
11. Mention the types of cogeneration processes available?
12. What are Power converters for distributed power systems?

Understand

1. Explain the importance of solar energy in India.
2. Explain the need to develop new energy technologies.
3. Discuss the need for hybrid PV system.
4. Explain the purpose of using IG used in WECS.
5. Mention the advantages of PMSG.
6. What is the significance of buck boost converter?
7. Classify the WECS.
8. What are the merits of matrix inverters?
9. Indicate the minimum value required for the boost converter.
10. Why pitch angle control is used for WECS?
11. What is the necessity of Maximum power point tracking in PV system?
12. Write short notes on (i) Solar pumping (ii) Solar Cooking.

Apply

1. HAWT is installed at a location having free wind velocity of 15m/s. The 80m diameter rotor has three blades attached to the hub. Find the rotational speed of the turbine for optimal energy extraction.
2. How does environment get affected by the use of the renewable energy? Also discuss GHG emissions from the various energy sources.
3. What are the main components of a flat plate solar collector, explain the function of each?
4. Explain about the any three applications of solar PV system in rural areas.
5. Identify the effect on a wind generator connected on the network.
6. Indicate the role of capacitor for boost converter.
7. Apply the generator control method for WECS.
8. Make traffic light control system using SPV system.
9. Illustrate with neat figure the operation of any hybrid system using renewable energy resources.
10. Apply the appropriate MPPT scheme for DC/Dc converter.

Analyse

1. Compare conventional and non-conventional energy resources.
2. Differentiate fixed and variable speed wind energy conversion systems.
3. Analyse the principle of working of buck-boost converter with time ratio and current limit control. Draw the circuit and necessary waveforms.
4. What are the problems faced while connecting the system to the grid.
5. Compare working and power obtained of the fixed and variable speed wind systems.
6. Analyze the reason for harmonic problems in wind energy conversion system and find the solution for it.

Evaluate

1. Wind energy an excellent supplement to the PV-justify.
2. Discuss the influence of different renewable energy sources with special reference to the global warming context.
3. Give case study how to get maximum power generation in wind energy conversion system.
4. Investigate the converter model based upon transient stability analysis.

Create

1. A house has two ceiling fans, five tubelights, three CFL lamps, one TV & one refridgerator. Estimate the power requirement and design a solar PV system for a house.
2. Develop a control circuit for home appliences with following specifications supplied from solar PV system and also estimate the electrical parameters.
   a. 100W lamps- 4 Nos
   b. 50W fans- 4 NoS
   c. 500W fridge -1 No
   d. 1000 W iron box -1 No
3. Generate a model of Hybrid power system with solar and wind energy.

15EE014 ENERGY STORAGE SYSTEMS

3 0 0 3

Course Objectives

- To understand the necessity and usage of different energy storage schemes for different purposes.
- To classify the various energy storage schemes based upon their principle of working.
- To explain the various applications of energy storage systems.

Programme Outcomes (POs)

a. **Engineering Knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
c. **Design/ Development of Solutions:** Design solutions for complex engineering problems and design system components or processes that meet the consideration for thepublic health and safety, and the cultural, societal, and environmental considerations.cultural, societal, and environmental considerations.
e. **Modern Tool Usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
f. **The Engineer and Society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
g. **Environment and Sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

Course Outcomes (COs)

1. Classify various modes of energy storage systems.
2. Compare the different performance parameters of electrochemical batteries.
3. Explain the working of Magnetic and electric energy storage devices
4. Apply the principle of thermal energy conversion in storage systems.
5. Analyze the various industrial applications of energy storage based on storage techniques.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3		2		1								2	
2	3		1		2	2	1						1	2
3	1		3		2		1						1	
4	1		3		2	1							1	
5	2		3		1	1	1						2	1

UNIT I **10 Hours**

ENERGY STORAGE

Need and importance of Energy storage in Conventional and Nonconventional Energy Systems, Different modes of Energy Storage. Potential energy: Pumped hydro storage; KE and Compressed gas system: Flywheel storage, compressed air energy storage; Electrical and magnetic energy storage: Capacitors, electromagnets; Chemical Energy storage: Thermo-chemical, electro-chemical, fossil fuels and synthetic fuels. Solar Ponds for energy storage.

UNIT II **10 Hours**

ELECTROCHEMICAL ENERGY STORAGE SYSTEMS

Fundamental concept of batteries - measuring of battery performance, charging and discharging of a battery, storage density, energy density, and safety issues. Types of batteries : Primary, Secondary, Lithium, Solid-state and molten solvent batteries; Lead acid batteries; Nickel Cadmium Batteries; Zinc Manganese dioxide and Advanced Batteries.

UNIT III **8 Hours**

MAGNETIC AND ELECTRIC ENERGY STORAGE SYSTEMS

Superconducting Magnet Energy Storage (SMES) systems; Capacitor and Batteries: Comparison and application; Super capacitor: Electrochemical Double Layer Capacitor (EDLC), principle of working, structure, performance and application.

UNIT IV **9 Hours**

THERMAL ENERGY STORAGE

Thermal storage - Basic Principles - Benefits - Methods-Sensible TES- Thermally Stratified TES Tanks- Concrete TES- Rock and Water/Rock TES- Aquifer Thermal Energy Storage (ATES)- Solar Ponds- Latent TES: Operational Aspects of Latent TES- Phase Change Materials (PCMs).

UNIT V **8 Hours**

APPLICATION OF ENERGY STORAGE

Food preservation; Waste heat recovery; solar energy storage; Green house heating; Power plant applications; Drying and heating for process industries.

FOR FURTHER READING

Comparison of energy storage technologies - Role of carbon nano-tubes in electrodes- pressurized water storage system - role of activated carbon and carbon nano-tube-Solar assisted Space heating

Total: 45 Hours

Reference(s)

1. Huggins, Robert A., Energy Storage, Springer, 2010.
2. Ibrahim Dincer and Mark A. Rosen, Thermal Energy Storage Systems and Applications, John Wiley & Sons 2011.
3. Ru-shiliu, Leizhang, Xueliang sun, Electrochemical technologies for energy storage and conversion, Wiley publications, 2012.
4. J. Walter Schultze, Tetsuya Osaka ,Electrochemical Microsystem Technologies, Madhav Datta 2002, CRC Press.
5. Jackson and Webster, Medicine and Clinical Engineering, Prentice Hall of India Ltd, New Delhi, 2013.

Assessment Pattern

Unit/RBT	Remember				Understand				Apply				Analyse				Evaluate				Create				Total
	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	
1	1	1			1	12				1			2				2								20

2	2	2							1				2	12			1								20
3		2			1	2			1	1				1				12							20
4	1				2	12				1				2			1	1							20
5	1									8	6		1				2	2							20
																								Total	100

Assessment Questions

Remember

1. Recall the need and importance of energy storage.
2. List the different modes of energy storage.
3. List the three chemical energy storage systems.
4. Define storage density.
5. Recall SMES systems.
6. List three benefits of thermal storage.
7. Define super capacitors
8. List any three methods of thermal storage.
9. Recognize Electrochemical Double Layer Capacitor.
10. Classify various electrical and magnetic energy storage systems.

Understand

1. Classify various electrical and magnetic energy storage systems.
2. Illustrate the working of three point starter and four point starter
3. Exemplify sensible heat storage and latent heat storage of solar energy.
4. Illustrate the structure and Principle of operation of Electrochemical Double Layer Capacitor (EDLC).
5. Exemplify detailed account on energy storage systems.
6. Illustrate the working of solar thermal energy storage.
7. Explain in detail about the battery energy storage.
8. Illustrate in detail about the pumped hydroelectric energy storage
9. Illustrate the operation of sensible heat storage.
10. Illustrate the operation of sensible heat storage.

Apply

1. Assess the requirements for battery to be used for long term.
2. Demonstrate how thermal energy storage is used for solar heating and cooling?
3. Execute the performance characteristics of battery with its equivalent circuit.
4. Demonstrate the principle of fly wheel operation and derive the energy relation equation.
5. Justify the equivalent circuit of a battery.
6. Evaluate the various types of batteries
7. Analyze the different type of charge regulator for batteries.
8. Exemplify Â sensible heat storage and latent heat storage of solar energy for solar water heater.
9. Illustrate the working of solar thermal energy storage for heating the seeds in the agriculture.
10. Illustrate in detail about the pumped hydro electric energy storage using solar energy

Analyse

1. Differentiate flywheel over batteries?
2. Compare and contrast different types of energy storage systems.
3. Justify the equivalent circuit of a battery.
4. Analyze the life cycle of the battery.
5. Compare potential energy and kinetic energy storage systems.
6. Differentiate between Primary and Secondary battery.
7. Compare power rating of battery and battery capacity.
8. Organize the methods of battery charging.

9. Evaluate the various types of batteries
10. Analyze the different type of charge regulator for batteries.
11. Show the different steps in designing a battery.

Create

1. Demonstrate the fly wheel operation and derive the energy relation equation for the UPS application
2. Execute the performance characteristics of battery with its equivalent circuit for battery connected vehicle.

15EE015 POWER PLANT INSTRUMENTATION AND CONTROL **3 0 0 3**

Course Objectives

- To provide an overview of power generation through various methods.
- To enable the students to learn in detail about the various instruments available for monitoring/controlling power plant.
- To explain the operation of nuclear power plant.

Programme Outcomes (POs)

a. **Engineering Knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. **Problem Analysis**: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
c. **Design/ Development of Solutions**: Design solutions for complex engineering problems and design system components or processes that meet the consideration for thepublic health and safety, and the cultural, societal, and environmental considerations.cultural, societal, and environmental considerations.
e. **Modern Tool Usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

Course Outcomes (COs)

1. Explain the various methods of power generation.
2. Choose appropriate measuring instrument to measure the physical quantities at power plants.
3. Design a suitable controller for boiler
4. Evaluate the various parameter of turbine in various operating conditions.
5. Predict a suitable monitoring mechanism for nuclear power plants.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2	1	1										2	1
2	2	2	1										1	1
3	2		1										2	3
4	2				2								3	3
5	2				2								2	2

UNIT I **8 Hours**

OVERVIEW OF POWER GENERATION

Various sources of electrical energy-Non-conventional and conventional energy sources- Importance of instrumentation and control in power plants-Building block of thermal power plant - Details of boiler processes - P&I diagram of boiler - Cogeneration.

UNIT II **10 Hours**

PARAMETERS OF POWER PLANTS AND ITS MEASUREMENT

Measurement of feed water flow, air flow, steam flow and coal flow -Measurement steam temperature & steam pressure - Drum level measurement -Radiations detector - Smoke density measurement -Dust monitor - Speed vibration, shell temperature monitoring & control - Flue gas analyzer - Fuel composition analyzer.

UNIT III **7 Hours**

BOILER CONTROL

Air/fuel ratio control- Burners for liquid and solid fuels - Burner management - Furnace safety interlocks -Firing rate demand - Steam temperature control - Control of deaerator -Furnace draft control - Flue gas dew point control - Trimming of combustion air - Soot blowing.

UNIT IV **11 Hours**

CONTROL OF TURBINE

Types of steam turbines - Impulse and reaction turbines- Turbine governing system- Speed and load control-Transient speed rise- Free governor mode operation -Automatic load Frequency Control - Turbine oil system - Oil pressure drop relay - Oil cooling system -Turbine run up system.

UNIT V **9 Hours**

NUCLEAR POWER PLANT INSTRUMENTATION

Introduction-Types of nuclear power plant-Sensors for nuclear power plants-Nuclear reactor control systems-Radiation detection and monitoring-Nuclear reactor safety.

FOR FURTHER READING

Digital Command Control(DCC)-Supervisory Control and Data Acquisition(SCADA)-Distributed Control System(DCS) .

Total: 45 Hours

Reference(s)

1. Everett Woodruff, Herbert Lammers, Thomas Lammers, Steam Plant Operation,9th Edition McGraw Hill, 2012.
2. Rajput R.K., A Text book of Power plant Engineering, 5th Edition, Lakshmi Publications, 2013.
3. P.K.Nag, Powerplant Engineering, Tata McGraw-Hill Education, 3rd edition, 2007.
4. Sam Dukelow, Control of Boilers, Instrument Society of America, 1991. Krishnaswamy.K and Ponnibala.M.,? Power Plant Instrumentation?, PHI Learning Pvt.Ltd., New Delhi, 2011.
5. Elonka. S.M, and Kohan. A.L, Standard Boilers Operations, McGraw Hill,New Delhi, 2013
6. Jain. R.K, Mechanical and industrial Measurements, Khana Publishers,New Delhi, 2011.

Assessment Pattern

Unit/RBT	Remember				Understand				Apply				Analyse				Evaluate				Create				Total
	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	
1	3	1			2	2				12															20
2	2	2				2	6							8											20

3		2				2	12							4											20
4	2				2				2	2				12											20
5	2					2				2			2					12							20
																								Total	100

Assessment Questions

Remember

1. List any 5 types of conventional power generation.
2. List any 5 types of non-conventional power generation.
3. List the efficiency and availability of coal and nuclear power plants.
4. List the coal properties for combustion.
5. Define thermal efficiency. What is the value for a coal fired power plants?
6. Define thermal efficiency. What is the value for a coal fired power plants?
7. Define dew point temperature.
8. List the various methods of flow measurement for feedwater flow in power plant.
9. List the elements used for flow measurement.
10. List some detectors in gas chromatography.
11. List the Particulate matter (PM) Collectors in the emission from coal fired power plant.

Understand

1. Predict the power is produced in cogeneration technique.
2. Select the factors affecting power plant performance.
3. Identify instrumention plays important role in power plant control?
4. Illustrate and mention the piping and instrumentation diagram of a boiler system in a power plant.
5. Identify the importance of instrumentation in power generation
6. Indicate the cogeneration and also explain the topping and bottoming cycle operation of cogeneration systems.
7. Identify the key difference between wet steam and super heated steam.
8. Represent cogeneration and also explain the topping and bottoming cycle operation of cogeneration systems.
9. Identify the key difference between wet steam and super heated steam.
10. Represent cogeneration and also explain the topping and bottoming cycle operation of cogeneration systems

Apply

1. Asses the operation of thermal power plant and mention the important parameters to be monitored in each block.
2. Show the dew point temperature affects the performance of power plant?
3. Describe the methods to measure energy, rsistance, current and power?
4. Show any three types of Steam Pressure measurement with neat diagram.
5. Represent factors affect the combustion efficiency of boilers?
6. Illustrate chromatographic column.
7. Construct the Drum level measurement with neat sketch
8. Compute the working principle of two types of radiation detectors with clear diagram
9. Compute the working principle of dissolved oxygen analyser with necessary diagram.
10. Demonstrate the Flue gas oxygen analyser.
11. Demonstrate about fuel analyser.

Analyse

1. Conclude percentage smoke density from Ringelmann chart?
2. Justify gas analysis is used in power plants?
3. Justify the temperature of exit flue gas in to the atmosphere and why?
4. Conclude in detail about the analysis of impurities in feed water
5. Justify the correction factor for temperature accounted during measurement of steam flow?

6. Show any three types of Steam Pressure measurement with neat diagram.
7. Use any three types of steam Temperature measurement with neat diagram.
8. Justify the role of superheater control and attemperator in boiler operation.

Evaluate

1. Judge the generating cost per unit of 80 MW power station with the following data:Capital cost = Rs. 160 X 107, Annual cost of fuel = Rs.32 X lO6, Annual wages and taxes = Rs.Â 36, X.106,Interest and depreciation = 10% of capital cost Annual load factor = 45%.
2. Judge the generating cost per unit of 80 MW power station with the following data:Capital cost = Rs. 160 X 107, Annual cost of fuel = Rs.32 X lO6, Annual wages and taxes = Rs.Â 36, X.106,Interest and depreciation = 10% of capital cost Annual load factor = 45%.
3. Determine a PID controller for temperature in thermal power plant.
4. Judge a mathematical modeling for boiler system and analyze the same.
5. Dteremine the power generated per day by fissioning 1g of U235 and 1kg of U235.

Create

1. Justify can you detect nuclear radiation? What are the detectors used?
2. the role of superheater control and attemperator in boiler operation is possible to change

15EE016 HIGH VOLTAGE DIRECT CURRENT TRANSMISSION **3 0 0 3**

Course Objectives

- To understand the concept, planning of DC power transmission and comparison with AC power transmission.
- To analyze HVDC converters and study about compounding and regulation.
- To analyze harmonics and design of filters and learn about HVDC cables.

Programme Outcomes (POs)

a. **Engineering Knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. **Problem Analysis**: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
d. **Conduct Investigations of Complex Problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

Course Outcomes (COs)

1. Outline the structure of HVDC system and compare it with AC system.
2. Analyse the performance of different types of converters used for HVDC transmission system.
3. Classify the types of control methods, faults and protection schemes for HVDC transmission system.
4. Apply reactive power control and harmonic reduction techniques in HVDC systems.
5. Compare the dielectric strength and economics of HVDC cables with AC cables and explain about HVDC lightening system

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2	1											3	
2	3	2											3	
3	2	3		2									3	
4	2	1											3	
5	1	3											3	2

UNIT I **9 Hours**

INTRODUCTION
Introduction of DC Power transmission technology- Comparison of AC and DC transmission - Application of DC transmission - Description of DC transmission system - Planning for HVDC transmission - Modern trends in DC transmission.

UNIT II **9 Hours**

ANALYSIS OF HVDC CONVERTERS
Pulse number - Choice of converter configuration - Simplified analysis of Graetz circuit - Converter bridge characteristics - Characteristics of a twelve pulse converter - Detailed analysis of converters.

UNIT III **10 Hours**
HVDC SYSTEM CONTROL AND PROTECTION
Principle of DC link control-converter control characteristics-control methods. Types of Converter fault-Protection methods for over current and over voltage.

UNIT IV **9 Hours**
REACTIVE POWER CONTROL HARMONICS AND FILTERS
Introduction - Reactive power requirement -source of reactive power -static Var systems- reactive power control during transients. Generation of harmonics - Design of AC filters and DC filters - Interference with nearby communication lines.

UNIT V **8 Hours**
HVDC CABLES AND HVDC LIGHT
Introduction of DC cables - Basic physical phenomenon arising in DC insulation - Practical dielectrics -Dielectric stress consideration - Economics of DC cables compared with AC cables. HVDC light, HVDC PLUS (Power universal link), multi-pulse and multilevel VSC based flexible HVDC systems.

FOR FURTHER READING
Multi-pulse and multilevel VSC based flexible HVDC systems,HVDC Breakers.

Total: 45 Hours

Reference(s)

1. Padiyar, K. R., "HVDC power transmission system", Wiley Eastern Limited, New Delhi 2010. Fifth edition.
2. Edward Wilson Kimbark, "Direct Current Transmission", Vol. V, Wiley Inter-science, New York, London, Sydney, 2011.
3. Colin Adamson and Hingorani N G, "High Voltage Direct Current Power Transmission", Garraway Limited, London, 2010
4. Arrillaga, J.,"High Voltage Direct Current Transmission", Peter Pregrinus, London, 2013.

5. Rakosh Das Begamudre, "Extra High Voltage AC Transmission Engineering", New Age Interantional (P) Ltd., New Delhi, 2000.

Assessment Pattern

Unit/RBT	Remember				Understand				Apply				Analyse				Evaluate				Create				Total
	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	
1	2					6					8			4											20
2	2					6				8					4										20
3		2				6					12														20
4		2				12	6																		20
5	2									12															14
																								Total	94

Assessment Questions

Remember

1. List the HVDC transmission in india
2. State the limitations of EHVAC transmission
3. Reproduce the cost vs distance curve of ac and dc transmission
4. Represent the expression for real power flow through the line
5. List the types of dc links
6. List the advantages of hvdc transmission system.
7. List out the limitations of hvdc transmission system
8. List the applications of hvdc transmission system
9. List uses of reactive power source at converter station
10. List the applications of DC breakers

Understand

1. Represent the variation of voltage along the transmission line during different loading condition
2. Indicate surge impedance loading of transmission line.
3. Represent the multi terminal dc link
4. Infer asynchronous tie in HVDC transmission.
5. Represent block diagram of constant firing angle control scheme
6. Represent the equivalent circuit of a two terminal DC link
7. Illustrate converter configuration which is used for high power applications
8. Illustrate two basic firing schemes used for firing pulse generation in HVDC valves
9. Summarise converter controller characteristics of both rectifier and inverter
10. Illustrate the major components of HVDC transmission system
11. Illustrate the characteristics of twelve pulse converter

Apply

1. Predict uses of filters at converter station
2. Predict short circuit ratio of HVDC transmission systems.
3. Predict any four problems associated with the injection of harmonics
4. Assess the factors that must be considered in designing a protection system
5. Assess why dc transmission system is more prefer than ac transmission system.
6. Predict converter bridge characteristics in rectifier mode of operation
7. Select hierarchical control structure for a dc link
8. Predict the starting and stopping methods for dc link
9. Predict the functions of higher level controllers for HVDC converters
10. Assess reactive power requirements in steady state operating condition for converters
11. Assess the sources of reactive power based upon its performance
12. Predict problems associated with generation of harmonics in ac and dc system
13. Compute the solution methodology for AC to DC power flow
14. Predict the characteristics of dc breakers

15. Carry-out dc transmission line protected against corona effects

Analyse

1. Compare converter and inverter stations
2. Differentiate conventional transformer and converter transformer
3. Outline various schemes available for power factor improvement
4. Compare ac and dc transmission system
5. Outline modern trends in dc transmission system
6. Analyse the graetz converter circuit, without overlap and with overlap conditions
7. Analyse the characteristics of six pulse converter with filters
8. Outline the principle of converter control characteristics
9. Analyse the two different firing angle control schemes for HVDC valves
10. Outline three different types of fault occurs in converters
11. Outline load compensation is achieved using static var system
12. Contrast the different types of ac filters and dc filters used in converter station for harmonic suppression
13. Compare the four types of stability evaluation method for multi machine system
14. Compare different types of converter models based upon transient stability analysis

15EE017 DIGITAL CONTROL OF ELECTRIC DRIVES 3 0 0 3

Course Objectives

- To understand the operation of the converter, choppers fed dc drive and solve simple problems.
- To analyze the operation of both classical and modern induction motor drives and their characteristics.
- To study the basics of power electronic drive systems.

Programme Outcomes (POs)

a. **Engineering Knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. **Problem Analysis**: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

Course Outcomes (COs)

1. Classify the components and technology in the drive system
2. Explain the working of DC industrial drives
3. Examine the characteristics of AC industrial drives
4. Apply the functions of microprocessor in drive technology
5. Analyze different speed control techniques used in control of drives

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2	2											2	
2	3	2												2
3	3	2											1	

4	3	3											2	
5	2	3												3

UNIT I **7 Hours**

INTRODUCTION

Need for a digital control of a drive, Digital techniques in speed control-Advantages and limitations-Trends in drive technology.

UNIT II **9 Hours**

DIGITAL CONTROL OF DC DRIVES

Introduction to Siemens drive system - Speed control with emf feedback & tachogenerator - Current measurement & Torque Measurement - Tuning of drive, Phase locked loop control of DC drives

UNIT III **8 Hours**

DIGITAL CONTROL OF AC DRIVES

Latest trends in Drives: Rotor flux oriented vector control for induction motor drives. Commutator less DC Motor (How Induction Motor is converted to Characteristics of DC Motor), AC Servo Drives.

UNIT IV **12 Hours**

MICROPROCESSOR CONTROL OF DRIVES

Dedicated hardware system versus microprocessor control, application areas and functions of microprocessor in drive technology, Microcomputer and PLC based control of drives, some aspects of control system design of microprocessor based variable speed drives

UNIT V **9 Hours**

DSP CONTROL OF DRIVES

Overview of TMSLF2407m, DSP controller Induction Motor, vector control of IM, field oriented control Speed Control using LF2407 DSP

FOR FURTHER READING

Generation of firing pulses- generation of PWM pulses using embedded processors- IC control of DC drives- fixed frequency/variable frequency/current control- V/F control using PIC microcontroller-vector control using embedded processors.

Total: 45 Hours

Reference(s)

1. Hamid A. Toliyat, "DSP Based Electromechanical Motion Control", 1st Edition, CRC Press, 2004.
2. Ned Mohan, T.M. Undeland and William P. Robbins, "Power Electronics: Converters, Applications", 3rd Edition, John Wiley & Sons, 2009.
3. Bose B K,"Modern Power Electronics and AC Drives", Pearson Education, New Delhi, 2003.
4. Ion Boldea and Nasar S A, "Electric Drives", CRC Press LLC, New York, 2005.
5. Krishnan R," Electric Motor Drives: Modeling, Analysis and Control", Prentice Hall of India, New Delhi, 2002
6. Vedam Subramanyam,"Electric Drives: Concepts and Applications", Tata McGraw-Hill, New Delhi, 2004.

Assessment Pattern

Unit/RBT	Remember				Understand				Apply				Analyse				Evaluate				Create				Total
	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	
1	5					5				5															15
2		5				5					5				5			5							25
3		5			5					5					5			5							25

4		5				5				5					5			5							25
5										5				5											10
																								Total	100

Assessment Questions

Remember

1. Define electrical drives.
2. State the advantages of digial control?
3. List the types of control strategies in dc chopper
4. Mention the need for electrical drive.
5. List the digital controllers used in electric drives.
6. Draw the block diagram of digital drive system
7. Define DC drives
8. Define AC drives
9. List any three methods to tune the drive
10. List any five applications of DC drives
11. List any five applications of AC drives

Understand

1. Explain the multiquadrant operation of a drive.
2. Derive the equation of Mathematical condition for steady state stability
3. Indicate the different types of drives
4. Derive the equation for Steady state analysis of DC drives
5. Derive the equation for Steady state analysis of AC drives
6. Exemplify the Closed loop control of VSI of induction motor drives.
7. Exemplify the concept of AC servo drive
8. Represnt the Closed loop control of cycloconverter fed induction motor drives
9. Illustrate the Closed loop control of VSI of synchoronous motor drives.
10. Represent the Closed loop control of cycloconverter fed synchoronous motor drives.

Apply

1. Explain the uses of chopper controlled dc drives.
2. Determine the vector control of induction motor using PIC controller.
3. Represent the block diagram and explain the PLL concept in electric drives.
4. Demonstrate Phase Locked Loop control of DC drives
5. Implement the emf feedback speed control technique for the dc drive
6. Use any one digital technique to control the speed of the motor.
7. Design and explain the working of tachogenerator.
8. Assess the control system used in AC servo drives
9. Show the PLC based control of induction motor drive
10. Show the vector control of Induction Motor with neat sketch

Analyse

1. Why the PLD based control of drives is used?
2. Compute the role of PLC in control of drive? Explain its working.
3. Conclude the brief analysis over the recent trends available for electric drive system.
4. Exemplify how microprocessors are employed in variable speed drive system.
5. Demonstrate how speed control is achieved using DSP processor LF2407
6. Compare DC drives and AC drives
7. Justify AC drives are advantageous than DC drives.
8. Compare DSP controlled induction motor and vector controlled induction motor
9. Check the application of microprocesor in industrial drives.

Evaluate

1. Argue down the codings required for generation of PWM pulses

Create
1. Demonstrate the use of Rotor resistance control
2. Draw the flowchart and explain the micro computer control of drive
3. Generate a control technique for induction motors used in paper mills.

15EE018 VLSI DESIGN

3 0 0 3

Course Objectives
- To explain the fundamental concepts and techniques involved in the fabrication of VLSI circuits.
- To understand the technology, design concepts and analyzing of VLSI circuits.
- To design the combinational circuits using Verilog HDL

Programme Outcomes (POs)

a. **Engineering Knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

b. **Problem Analysis**: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

c. **Design/ Development of Solutions**: Design solutions for complex engineering problems and design system components or processes that meet the consideration for thepublic health and safety, and the cultural, societal, and environmental considerations.cultural, societal, and environmental considerations.

Course Outcomes (COs)
1. Explain the procedures in the fabrication of integrated circuits
2. Asses the various fabrication methods of CMOS
3. Analyze the characteristics of MOS transistors
4. Apply the rules of stick diagram and layout rules for compact design
5. Develop the programs for combinational and sequential circuit by using Verilog HDL.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3	2											2	
2	3	2	1											1
3	3	2											1	
4	2	3	1										2	
5	2		3										1	

UNIT I **9 Hours**

OVERVIEW AND FABRICATION OF VLSI DESIGN TECHNOLOGY

The VLSI design process - Moore's law, Y chart - Architectural design - Logical design - physical design - Layout styles - Full custom - Semi custom approaches. Overview of wafer fabrication - wafer processing - oxidation - patterning - Diffusion -Ion implantation - Deposition process and metallization.

UNIT II **8 Hours**

TRENDS IN VLSI FABRICATION

Silicon gate NMOS & PMOS fabrication process - CMOS fabrication process, N-well CMOS process, P-well CMOS process - Twintub process-Silicon on insulator-Introduction to BICMOS process - BICMOS fabrication in N-well process.

UNIT III **8 Hours**

MOS TRANSISTOR PROPERTIES AND CMOS INVERTER

Basics of MOS transistors-types & operation-Basic electrical properties of MOS and CMOS circuits-Ids versus Vds relationships, Transconductance-pass transistor and transmission gates - NMOS inverter- Determination of pull up to pull down ratio for an nMOS inverter-CMOS inverter-MOS transistor circuit model.

UNIT IV **10 Hours**

MOS,CMOS CIRCUIT AND SUBSYSTEM DESIGN PROCESS

MOS layers - Stick diagrams - nMOS design style - CMOS design style - Design rules and layout - Lambda based design rules - Contact cuts - Double metal MOS process rules.

UNIT V **10 Hours**

VERILOG PROGRAMMING

Introduction-lexical conventions, Data types, Modules & ports - Gate level modeling - dataflow level modeling - behavioral level modeling (Examples: adders, counters, flip flops, Multiplexers/Demultiplexers, FSM).

FOR FURTHER READING

RTL Design-Combinational logic-Types-Operators-Packages-Sequential circuit-Simple VHDL programs.

Total: 45 Hours

Reference(s)

1. Eshranghian E, Pucknell D A and Eshraghian S,"Essentials of VLSI circuits and systems", PHI, NewDelhi, 2008, 1st edition.
2. Charles H.Roth,"Fundamentals of Logic Design", Jaico Publishing House, 2006, 4th edition.
3. Weste N H, kamran Eshranghian,"Principles of CMOS VLSI Design-A system perspective", Pearson Education, India, 2010, 2nd edition-third impression.
4. Kiran Kumar V. G., Nagesh H. R.,"Fundamentals of CMOS VLSI Design", sanguine technical publishers-pearson, First impression -2012
5. S. M. Kang,Y Leblebici, and C. Kim,"CMOS Digital Integrated Circuits: Analysis and Design", McGraw-Hill, 4th Ed., 2014
6. Samir Palnitkar,"Verilog HDL: A Guide to Digital Design and Synthesis, Volume 1",Sun Micro systems-PHI Second Edition 2006 -ISBN 0-13-044911-3

Assessment Pattern

Unit/RBT	**Remember**				**Understand**				**Apply**				**Analyse**				**Evaluate**				**Create**				**Total**
	F	**C**	**P**	**M**	**F**	**C**	**P**	**M**	**F**	**C**	**P**	**M**	**F**	**C**	**P**	**M**	**F**	**C**	**P**	**M**	**F**	**C**	**P**	**M**	
1	2					6								8					4						20
2	2						6							12											20
3	2					10												8							20
4	2						6							6					6						20
5	2						2				12											4			20
																								Total	100

Assessment Questions

Remember

1. List out the two types of layout design rules.
2. Describe rise time and fall time.
3. Explain pull down device.
4. Describe the special feature of Twin-Tub process.
5. Draw the Isotropic etching process diagram.
6. List the different types of MOS layers.
7. Differentiate between nMOS from pMOS.
8. Give the advantages and disadvantages of SOI.
9. Define FSM.
10. Draw the DC transfer characteristics curve of CMOS Inverter.

Understand

1. Compare VIA and contact cut.
2. Infer a reason for N well to be superior to P well.
3. Explain in detail about the MOS layers.
4. Identify the reason why the single phase dynamic logic structures cannot be cascaded.
5. Extend the gate restoring logic of NMOS NAND gate and infer its disadvantages.
6. Compare MOS and BICMOS technology.
7. Give a reason for using silicides over polysilicon in fabrication.
8. Extend the gate restoring logic of NMOS NAND gate and infer its advantages.
9. Justify that transmission gates are better than pass transistor logic.
10. Give the reason for Twin tub process to be more advantageous than P-well and N-well process.

Apply

1. Draw a stick diagram for CMOS Inverter by implementing logic function.
2. Compute the architecture for dataflow model for half adder by using Verilog.
3. Compute the steps involved in the Berkley's n well process with a neat Flow chart diagram.
4. Sketch out the stick diagram and schematic diagram for NMOS NOR gate by implementing the truth table.
5. Implement the program using Verilog to realize the function of a ripple carry adder.
6. Design a full adder by cascading two half adders and develop a project to realize it in model simulator.
7. Apply Verilog description to design 8:1 MUX using two 4:1 MUX.
8. Construct up - down counter and write its test bench, using Verilog.
9. Apply the Lambda based design rules for the various contact cuts in the CMOS transistor.
10. Implement the structure of NAND gate by using gate restoring logic.

Analyse

1. In what way PMOS differs from NMOS?
2. Illustrate, the steps involved in the N well process with a neat diagram.
3. Recognize the truth table and Sketch out the stick diagram and schematic diagram for two input NAND gate by using NMOS design styles.
4. Outline the layout diagram for CMOS inverter by applying the design rules.
5. Differniate Deposition and ion implantation process.
6. Analyze the relationship of Ids and Vds relationship of MOS transistor in three regions of operation.
7. Justify why the NMOS depletion type transistor is known as pullup transistor.
8. Elucidate the fabrication process of CMOS inverter by using Twintub process.
9. Recognize the pull up to pull down ratio for an nMOS inverterdriven by pass transistor logic.
10. Discriminate the process of silicon gete NMOS fabrication.

Evaluate

1. With neat sketch, evaluate the VLSI design Process.
2. Conclude a reason for superiority of Semi custom over full custom layout design syles.
3. Appraise the steps followed in the fabrication of BICMOS by using N-well process.
4. Jusify the layout design rules for constructing a CMOS NAND gate.

5. Evaluate the structure of MOS transistor Circuit model.

Create

1. Construct the logic gates using CMOS design styles.
2. Design logic gates using stick diagram and layout diagram.
3. Design a program for finite state machines by using verilog.

15EE019 ILLUMINATION ENGINEERING

3 0 0 3

Course Objectives

- To impart knowledge on illumination.
- To determine the calculation and measurement of illumination.
- Design for interior lighting and exterior lighting.
- Explain the characteristic curve for different lamps using software.
- Exemplify the characteristic curve for exterior lighting using software.

Programme Outcomes (POs)

a. **Engineering Knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. **Problem Analysis**: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
c. **Design/ Development of Solutions**: Design solutions for complex engineering problems and design system components or processes that meet the consideration for thepublic health and safety, and the cultural, societal, and environmental considerations.cultural, societal, and environmental considerations.
e. **Modern Tool Usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
h. **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

Course Outcomes (COs)

1. Explain the characteristics of various light sources.
2. Design the lighting procedure for exterior environments.
3. Design the lighting procedure for interior environments.
4. Examine the characteristic curve for different lamps using software.
5. Analyse the characteristic curve for exterior lighting using software.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3	2											1	
2	2		3					1						3
3	2		3					1					1	
4	3				2								3	2
5	3				2								3	2

UNIT I **8 Hours**

LANGUAGE OF LIGHT, LIGHTING AND ACCESSORIES

Eye & vision, Light & Lighting, Light & Vision, Light & Color , Basic Concepts and Units, Quantity and Quality of Lighting. Light sources: Daylight, Incandescent, Electric Discharge, Fluorescent, Arc lamps, Lasers, Neon signs, LED-LCD displays.

UNIT II **8 Hours**

CALCULATION AND MEASUREMENT OF EXTERIOR LIGHTING

Polar curves, Lighting calculations, Solid angle, Inverse square and cosine laws, Illumination from point, line and surface sources. Photometry and Spectro - photometry, photocells. Glare, Lighting Design procedure for Flood, Street, Aviation and Transport lighting.

UNIT III **9 Hours**

INTERIOR LIGHTING

Lighting design procedure for Industrial, Residential, Office, Departmental stores, Indoor stadium, Theatres and Hospitals, Different Light manufacturing industries, Indian standards for lighting.

UNIT IV **10 Hours**

DESIGN OF LAMPS

Study the types of lamps, Measure the luminance , Control the brightness using accessories. Calculation of a fluorescent lamp required for the project using DIALux and verify result with manual calculation. Plot the candlepower, power consumed, current drawn v/s voltage characteristic curve for various lamps and compare with the theoretical curves.

UNIT V **10 Hours**

PRACTICAL ANALYSIS AND DESIGN OF INDOOR LIGHTING SYSTEMS

To study the effect of reflectors on luminaries intensity distribution. Plot the candlepower, power consumed, current drawn v/s voltage characteristic curve of exterior lighting, luminaries and compare with the theoretical curves.

FOR FURTHER READING

Design of illumination systems - residential, industrial, commercial, health care, street lightings, sports, administrative complexes - types of lamps - energy efficiency lamps.

Total: 45 Hours

Reference(s)

1. Joseph B. Murdoch,"Illumination Engineering from Edison's Lamp to the Laser, Visions Communications, Washington DC, USA, 2004.
2. Jack L. Lindsey,"Applied Illumination Engineering", Prentice Hall of India, New Delhi, 2008.
3. Marc Schiler,"Simplified Design of Building Lighting", John Wiley and Sons, 2013.
4. IES Lighting Handbook, 2005.
5. Ronald N. Helms, M. Clay Beicher, "Lighting for Energy Efficient Luminous Environments", Prentice Hall, 2011.
6. Marc Schiler, "Simplified Design of Building Lighting", John Wiley and Sons, 2011.

Assessment Pattern

Unit/RBT	Remember				Understand				Apply				Analyse				Evaluate				Create				Total
	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	
1	1	1			2	12			1				1									2			20

2	1	1			2	12			1				1									2			20
3	1	1			2	12			1				1									2			20
4	1	1			2	6			1				1				6					2			20
5	1	1			2	6			1				1				6					2			20
																								Total	100

Assessment Questions

Remember

1. Define Illumination.
2. Define lamp efficiency.
3. Define luminous intensity.
4. Define reflection factor.
5. Explain stroboscopic effect.
6. List the main fault in lighting system.
7. Define space height ratio.
8. Define luminous flux.
9. Recall the laws of illumination.
10. List out some of the types of Light sources.

Understand

1. Illustrate the properties of light.
2. Describe the construction and working of C.F.L.
3. Illustrate the working of fluorescent lamp with neat diagram.
4. Represent the high pressure mercury vapour lamp.
5. Illustrate the importance of reflectors and refractors with reference to illumination.
6. Illustrate the factors of good lighting design in detail.
7. Represent the flood lighting and street lighting
8. Formulate plane angle and solid angle. Also derive the relation between them.
9. Give the signifance of polar curves.
10. Explain Inverse square and cosine laws.

Apply

1. A room of 12m X 8m X 4m is to have indirect lighting giving illumination of 80 lux on working plane, 70cm above the floor. Coefficient of utilization is assumed to be 0.5 & the maintenance factor is 0.8, find out the no. of lamps & their rating. lamp efficiency may be taken as 1475 lumen / watt.
2. Find a projector lamp that gives out 2000 lumens & has beam divergence of 16 degree. If the beam factor is 0.75, calculate the average illumination on the surface 60m away & normal to the source of light. What will be the illumination if the surface is rotated through 60 degrees.
3. Find a room with dimension 17m X 4m is to be illuminated by 16,200w lamp .The MSCP of each lamp is 250. Assume maintenance factor of 0.8 & utilization factor of 0.7.Find the average illumination produced on the floor.
4. A student’s desk top is 2.5 m from a 1750 lm lamp. What is the illumination of the desk top?
5. A surface is illuminated by a 32 cd bulb. What is the bulb’s luminous flux? If the bulb is located 2m from the surface, what is the surface’s illumination?
6. A 64 cd source is 3 m above the surface of a desk. What is the illumination of the surface?
7. A photometer is used to compare the illumination of two bulbs. It is positioned until it is equally illuminated by each bulb. If it is 75 cm from a 50 cd source, how far is it from a 65 cd source?
8. List the lamps that are used for malls and supermarkets.Give the reasons for choosing the same.
9. Describe the types of polar curves and how it is helpful for an engineer.
10. List the places where LED-LCD displays will be employed.

Analyse

1. Justify how do you detect glare.
2. Justify why should you know about poorly distributed light.

Evaluate

1. Resolve how do you test and correct for insufficient light problems.
2. Resolve how do you detect if there is "improper contrast".
3. Evaluate the procedure of a LED source modeling.

Create

1. Conclude calculation of Food Ball ground using the software.
2. Conclude calculation of Volley ball ground using the software.
3. Derive a Decorating lamp using DIALux.
4. Derive the efficient Lighting & Smart Lighting for Energy Saving.
5. Derive the Tariff Calculation on Energy saving for Indoor / Outdoor.

15EE020 POWER QUALITY

3 0 0 3

Course Objectives

- To study the power quality problems in grid connected system and isolated systems.
- To study the various power quality issues and mitigation techniques.
- To study various methods of power quality monitoring and harmonic elimination techniques.

Programme Outcomes (POs)

a. **Engineering Knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

b. **Problem Analysis**: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

c. **Design/ Development of Solutions:** Design solutions for complex engineering problems and design system components or processes that meet the consideration for thepublic health and safety, and the cultural, societal, and environmental considerations.cultural, societal, and environmental considerations.

e. **Modern Tool Usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

Course Outcomes (COs)

1. Categorize the power quality problems and its standards.
2. Explain the Voltage Sags Interruptions and its protections methods
3. Analyze the lightning and switching over voltages and its protections methods
4. Analyze the Sources and effects of harmonics with suitable control methods
5. Predict the power quality problem using suitable measuring equipment.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3	2											1	1
2	3	2	1										1	1
3	3	2											3	1
4	3	2	2		1								3	1
5	2	2			1								2	1

UNIT I **10 Hours**

INTRODUCTION

Terms and definitions: General classes of power quality problems- Transients - Short duration variations - Long duration variation- voltage imbalance - voltage fluctuation - power frequency variations, International standards of power quality, Computer Business Equipment Manufacturers Associations (CBEMA) and ITI curves.

UNIT II **7 Hours**

VOLTAGE SAGS AND INTERRUPTIONS

Sources of sags and interruptions - Estimating voltage sag performance - Principle of protection- solutions at end user level- Motor starting sags.

UNIT III **8 Hours**

TRANSIENT OVERVOLTAGES

Sources of over voltages - Principle of over voltage protection -Devices for over voltage protection - Utility capacitor switching transients -Lightning protection -Computer tools for transient analysis.

UNIT IV **10 Hours**

HARMONICS

Harmonic distortion- Voltage Vs Current distortion-Harmonic vs Transients-Power system Quantities under Non sinusoidal conditions- Harmonics indices -sources of harmonics-Effect of harmonic distortion-Inter harmonics-Harmonic distortion evaluation - Devices for controlling harmonic distortion - IEEE and IEC standards.

UNIT V **10 Hours**

POWER QUALITY MONITORING

Monitoring considerations - Historical perspective of power quality measuring instruments - Power quality measuring equipment- Assessment of power quality measurement data-Power quality Monitoring standards.

FOR FURTHER READING

Brief introduction to power quality - measurement equipments and power conditioning equipments - Planning, Conducting and Analyzing power quality survey. Benchmarking process, RMS Voltage variation Indices, Harmonics indices, Power Quality Contracts.

Total: 45 Hours

Reference(s)

1. G.T. Heydt, 'Electric Power Quality', 2nd Edition. (West Lafayette, IN, Stars in a Circle Publications, 2004).
2. M.H.J Bollen,Understanding Power Quality Problems: Voltage Sags and Interruptions, (New York: IEEE Press, 2011).
3. J. Arrillaga, N.R. Watson, S. Chen, 'Power System Quality Assessment', (New York: Wiley, 2014).
4. Roger. C. Dugan, Mark. F. McGranagham, Surya Santoso, H.Wayne Beaty,Electrical Power Systems Quality, McGraw Hill, 2003.

Assessment Pattern

Unit/RBT	Remember				Understand				Apply				Analyse				Evaluate				Create				Total
	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	
1	2	1			12	2							1	1			1								20
2	1					2			2				12	1	1		1								20
3	2					12							1	1	2		1	1							20
4	1	2							1	1			2				1	12							20

5	1				1	1			12				2				2	1							20
																								Total	100

Assessment Questions

Remember

1. Define Power Quality.
2. Define Harmonics.
3. List the various power quality issues.
4. Define Total harmonic distortion.
5. List some IEEE Standards Associated with Voltage Sags.
6. Recall Voltage Sag.
7. Define transient over voltages.
8. Recall the basic categories of power quality instruments.
9. Define flicker meter.
10. State power quality monitoring.

Understand

1. Explain the magnitude and duration of voltage variations on power system using CBEMA curve.
2. Illustrate any two voltage sag performance estimating methods with neat diagram.
3. Exemplify any two voltage sag mitigation methods with neat diagram.
4. Expalin in detail about voltage sag due to induction motor starting.
5. Interpret the following sources of transient overvoltages with neat diagram.
   a)Capacitor switching b)Lightning c)Ferroresonance
6. Illustrate the transformer protection and cable protection scheme with neat diagram.
7. Indicate the harmonic sources from industrial loads with neat waveforms.
8. Exemplify any three devices for controlling harmonic distortion with neat diagram.
9. Summarise the different objectives of power quality monitoring process.
10. Explain the different options forpermanent power quality monitoring equipment with neat diagram.

Apply

1. Show the CBEMA and ITI curves for magnitude and voltage variations on power system.
2. Find out the power quality standards and explain the sources of power quality problems.
3. Implement any two the harmonic sources from commercial loads with neat diagram.
4. Predict any two sources of overvoltages with neat diagram.
5. Compute the total harmonic distortion and total demand distortion.
6. Implement the lightning protection scheme against transient over voltages.
7. Execute the concept of ferroresonance using simple RLC circuit.
8. Implement the construction of flicker meter with neat diagram.
9. Find the harmonic distortion evaluation on the utility system and the point of common coupling.
10. Demonstrate any two power quality measuring instruments compute the total harmonic distortion and total demand distortion.with neat diagrams.

Analyse

1. Differentiate over voltage and under voltage.
2. Differentiate voltage sag and voltage swells.
3. Compare different types of long duration voltage variations.
4. Justify the operation of fluorescent lighting with neat diagram.
5. Compare voltage versus current distortion.
6. Justify harmonics versus transients.
7. Differentiate disturbance analyzers with spectrum analyzers.
8. Justify the operation of the permanent power quality monitor at the substation level and selected customer locations.
9. Compare passive and active filters.
10. Compare harmonics versus transients.

Create

1. Generate the different steady state properties of power quality phenomena.
2. Generalise the terms harmonics and Noise.

15EE021 COMPUTER AIDED DESIGN OF ELECTRICAL APPARATUS 3 0 0 3

Course Objectives

- To introduce the basics of Computer Aided Design technology for the design of Electrical Machines.
- To understand the elements of CAD system.
- To apply Finite Element Method for the design of different Electrical apparatus.

Programme Outcomes (POs)

a. **Engineering Knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. **Problem Analysis**: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
c. **Design/ Development of Solutions**: Design solutions for complex engineering problems and design system components or processes that meet the consideration for thepublic health and safety, and the cultural, societal, and environmental considerations.cultural, societal, and environmental considerations.
e. **Modern Tool Usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

Course Outcomes (COs)

1. Explain the use of field analysis based design to understand the basic principle of energy conversion.
2. Compute the mathematical equation of electromagnetic field and stored energy in electric and magnetic fields.
3. Analyze the different methods of Finite Element Method to solve mathematical models and to find solution techniques.
4. Explain the organization of a typical CAD package.
5. Apply Finite Element Method for the design of different Electrical apparatus.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2	1											2	
2		2	3										3	
3		3	2										3	1
4	1				3								2	1
5		1	3										2	

UNIT I **8 Hours**

INTRODUCTION

Conventional design procedures - Limitations - Need for field analysis based design - Review of Basic principles of energy conversion - Development of Torque/Force.

UNIT II **9 Hours**

MATHEMATICAL FORMULATION OF FIELD PROBLEMS

Electromagnetic Field Equations - Magnetic Vector/Scalar potential - Electrical vector /Scalar potential - Stored energy in Electric and Magnetic fields - Capacitance - Inductance- Laplace and Poisson's Equations - Energy functional.

UNIT III **10 Hours**

PHILOSOPHY OF FEM

Mathematical models - Differential/Integral equations - Finite Difference method - Finite element method - Energy minimization - Variational method- 2D field problems - Discretisation - Shape functions - Stiffness matrix - Solution techniques.

UNIT IV **9 Hours**

CAD PACKAGES

Elements of a CAD System -Pre-processing - Modelling - Meshing - Material properties- Boundary Conditions - Setting up solution - Post processing.

UNIT V **9 Hours**

DESIGN APPLICATIONS

Voltage Stress in Insulators - Capacitance calculation - Design of Solenoid Actuator - Inductance and force calculation - Torque calculation in Switched Reluctance Motor.

FOR FURTHER READING

Computer aided design of starters, choke coils and small transformers.

Total: 45 Hours

Reference(s)

1. S.J Salon, "Finite Element Analysis of Electrical Machines", Kluwer Academic Publishers, London, 1995.
2. Nicola Bianchi, "Electrical Machine Analysis using Finite Elements", CRC Taylor& Francis, 2005.
3. Joao Pedro, A. Bastos and Nelson Sadowski, "Electromagnetic Modeling by Finite Element Methods", Marcell Dekker Inc., 2003.
4. P.P.Silvester and Ferrari, "Finite Elements for Electrical Engineers", Cambridge University Press, 1983.
5. D.A.Lowther and P.P Silvester, "Computer Aided Design in Magnetics", Springer Verlag, New York, 1986
6. S.R.H.Hoole, "Computer Aided Analysis and Design of Electromagnetic Devices", Elsevier, New York, 1989. User Manuals of MAGNET, MAXWELL & ANSYS Softwares

Assessment Pattern

Unit/RBT	Remember				Understand				Apply				Analyse				Evaluate				Create				Total
	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	
1	2					6			6				6												20
2		2					6			6			6												20
3		6	2							8									4						20

4						8			6					6											20
5		2					6		6				6												20
																								Total	100

Assessment Questions

Remember

1. State the basic principle of energy conversion.
2. List the source of electric field and magnetic fields.
3. Recognize the elements of CAD system.
4. Define force.
5. Define Torque
6. Define electric flux.
7. Define electric field intensity.
8. Recall preprocessing.
9. Define stiffness Matrix.
10. List some of the material Properties.

Understand

1. Exemplify the Maxwell’ equations for design and analysis.
2. Explain the various steps involved in using a typical CAD software package for the determination of magnetic field distribution in Power transformer.
3. Illustrate the torque calculation in switched reluctance motor.
4. Explain poissons and lapace’s equations.
5. Explain about the various factors affecting size of rotating machines.
6. Indicate the output equation of AC machines.
7. Explain the concept of vector magnetic potential.
8. Explain the steps in preprocessing with an example.
9. Explain the various steps involved in using a typical CAD software Package for the determination of magnetic field distribution in Solenoid Actuator.
10. Interpret the design of solenoid actuators.

Apply

1. Compute an expression from the first principle for the Shape function of first order Finite Element Analysis using triangular elements.
2. ComputeÂ the main dimensions of a 4-pole, 100kW, 1500rpm, DC generator assuming specific electric and magnetic loadings as 19000 Ampere conductors per metre and 0.4 tesla respectively. Assume that the length of armature is equal to the pole pitch.
3. Show how voltage stress is calculated in insulators.
4. A uniform line charge ρ =25Nc/m2 lies on the x=3m and y=4m in free space. Find the electric field intensity at a point (2,3,15)m.
5. Compute the formula for CMRR.
6. A circular disc of radius ‘a’ m is charged uniformly with a charge density of σ c/ m2. Find the electric field at a point ‘h’ m from the disc along its axis.
7. Compute an expressions for energy stored and energy density in magnetic field.
8. Predict the procedures of the conventional design of Electrical machine.
9. Implement the inductance and force calculation.
10. Demonstrate the mathematical model of FEM.

Analyse

1. Conclude the Development of torque and force in a field.
2. Differentiate between electric field intensity and electric flux density.
3. Justify how FDM can be used for the field analysis of 2d magnetostatic field problems.
4. Compare the various modules available in a typical CAD package.
5. Compare preprocessing and post processing.

Evaluate

1. Determine the expression for the Energy Functional of a Poissonian system.
2. Determine Poisson’s and Laplace’s equations in electric and magnetic field.

3. Criticize the properties of shape function.
4. Defend on scalar magnetic potential.
5. Support the various steps involved in using a typical CAD software package for the determination of capacitance.

15EE022 SMART GRID TECHNOLOGIES

3 0 0 3

Course Objectives

- To understand the concept of smart metering and implementation of demand side integration.
- To analyze the concepts of power electronics in smart grid.
- To analyze automated distribution systems and energy storage devices for smart grid.

Programme Outcomes (POs)

a. **Engineering Knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. **Problem Analysis:** Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

Course Outcomes (COs)

1. Explain various Smart Grid Components.
2. Classify the protocols of smart metering used in demand Side Integration.
3. Analyze the performance of Substation automation.
4. Analyze the Energy management system in Smart Grid.
5. Analyze the Power quality improvements in Smart grid.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3	3											3	
2	3	2											3	
3	3	2											3	
4	3	2											3	
5	3	2											3	

UNIT I **10 Hours**

INTRODUCTION

Overview of Electrical Grid - Definition of Smart Grid -Functional Characteristics - Inventory of Smart Grid Technologies - Operating Principles and Models of Smart Grid Components, Implementation of Smart Grid- Early Smart Grid initiatives - Overview of the technologies required for the Smart Grid- Applications.

UNIT II **8 Hours**

SMART METERING AND DEMAND-SIDE INTEGRATION

Introduction - Smart metering - Smart meters- An overview of the hardware used-Communications infrastructure and protocols for smart metering, Demand-side integration- Services provided by DSI , Implementations of DSI,Hardware support to DSI implementations,Flexibility delivered by prosumers from the demand side,System support from DSI.

UNIT III **9 Hours**

DISTRIBUTION AUTOMATION AND MANAGEMENT SYSTEM

Introduction -Substation automation equipment, Current transformers, Voltage transformers, Intelligent electronic devices, Bay controller, Remote terminal units, Faults in the distribution system, Voltage regulation, Data sources and associated external systems-SCADA, Customer information system, Modelling and analysis tools-Applications.

UNIT IV **10 Hours**

TRANSMISSION SYSTEM OPERATION AND ENERGY STORAGE

Introduction-Data sources - IEDs, SCADA and Phasor measurement units; Energy management systems- Wide area applications -On-line transient stability controller ,Pole-slipping preventive controller; Visualisation techniques- Visual 2-D and 3-D presentations ;Energy storage technologies- Batteries, Flow battery, Fuel cell and hydrogen electrolyser, Flywheels, Superconducting magnetic energy storage systems and Supercapacitors.

UNIT V **8 Hours**

POWER ELECTRONICS IN THE SMART GRID

Introduction -Renewable energy generation -Photovoltaic systems ,Wind, hydro and tidal energy systems ,Fault current limiting Shunt compensation, D-STATCOM ,Active filtering ,Shunt compensator with energy storage,.FACTS- Reactive power compensation,Series compensation ,Thyristor-controlled phase shifting transformer,Unified power flow controller.

FOR FURTHER READING

Smart appliance Technology - Pricing for Smart Appliances on demand. Security issues in DG, Distribution Automation, AMI, Electric Vehicle Management Systems - Approach to assessment of smart grid cyber security risks - Methodologies.

Total: 45 Hours

Reference(s)

1. Janaka Ekanayake, Nick Jenkins, Kithsiri Liyanage, Jianzhong Wu, Akihiko Yokoyama, Smart Grid: Technology and Applications, Jo& Sons, New Jersey, 2012.hn Wiley
2. Ryszard Strzelecki, Grzegorz Benysek, Power Electronics in Smart Electrical Energy Networks, Springer, New Zealand, 2008.
3. Xiao, Security and Privacy in Smart Grids, CRC Press, New York, 2012.
4. Tony Flick, Justin Morehouse, Securing the Smart Grid: Next Generation Power Grid Security, Academic Press, Boston, 2011.
5. Yang Xiao, "Communication and Networking in Smart Grids, Taylor and Francis, New Delhi, 2012.
6. James Momoh, SMART GRID: Fundamentals of Design and Analysis, John Wiley and Sons, New York, 2012.

Assessment Pattern

Unit/RBT	Remember				Understand				Apply				Analyse				Evaluate				Create				Total
	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	
1	2					4				6				8											20
2		2			4					8			6												20
3	2					4				6				8											20
4		2				4			6				8												20
5		2			3				6					9											20
																								Total	100

Assessment Questions
Remember

1. Define smart grid.
2. List the advantages of smart grid.
3. List any two the applications of smart grid.
4. State the important features of smart grid
5. List the technologies required for the Smart Grid
6. Define smart metring?
7. List protocols for smart metering.
8. Label some of Services provided by DSI
9. State the function of current transformer?
10. List out the early smart grid initiatives

Understand

1. Identify the drawbacks of conventional grid systems.
2. Summarise technologies required for the Smart Grid.
3. Compare Distribution network active management scheme.
4. Indicate the function of Data concentrator.
5. Indicate the the functionalities available in a bay controller.
6. Exemplify Signal acquisition.
7. Infer the use of Smart meters.
8. Compare Smart meters and conventional mters.
9. Illustrate schematic of Substation automation.
10. Explain the various Energy storage technologies.
11. Assess the Operation of a D-STATCOM.

Apply

1. Assess the early smart grid initiatives.
2. Demonstrate the operation of Phasor measurement units.
3. Select the applications of Distribution Management Systems.
4. Demonstrate Energy management systems.
5. Execute Wide area applications.
6. Demonstrate how Visualisation techniques are used in transmission system operation.
7. Construct Block diagram of a domestic PV system
8. Demonstrate Wind, hydro and tidal energy systems.
9. Demonstrate Fault current limiting in distribution circuits
10. Assess the Operation of a D-STATCOM.

Analyse

1. Support the benefits of Robust state estimators.
2. Organize typical RMU configurations and explain its operation.
3. Conclude the services provided by DSI.
4. D- STATCOM is used for power factor correction
5. Compare Wind, hydro energy systems.
6. Conclude the function of a voltage transformer?

Evaluate

1. Determine the best domestic PV system.
2. Determine the Future power system.
3. Justify how Smart Appliances can be the part of Smart Grid?
4. Determine the concept and formation of Micro Grid.

Create

1. Generalize the power quality issues of grid connected renewable energy sources.
2. Conclude different issues of micro grid when interconnected
3.

15EE023 DIGITAL SIGNAL PROCESSING

3 0 0 3

Course Objectives

- To classify signals and systems & their mathematical representation.
- To analyze the discrete time systems.
- To understand the various transformation techniques & their computation.

Programme Outcomes (POs)

a. **Engineering Knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

c. **Design/ Development of Solutions:** Design solutions for complex engineering problems and design system components or processes that meet the consideration for thepublic health and safety, and the cultural, societal, and environmental considerations.cultural, societal, and environmental considerations.

d. **Conduct Investigations of Complex Problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

e. **Modern Tool Usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

Course Outcomes (COs)

1. Explain the basic of signals, systems, role of sampling and aliasing in digital signal processing.
2. Apply Z transform for discrete time systems.
3. Apply the FFT algorithms for discrete time system
4. Construct the IIR and FIR Digital filters.
5. Asses the applications of digital signal processor in electrical engineering.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3		1										1	
2	2		2										2	
3	2		3										2	
4	1			2	2								2	
5	1				3									3

UNIT I **7 Hours**

DISCRETE-TIME SIGNALS AND SYSTEMS

Need and benefits of digital signal processing- mathematical representation of signals- classification of signals and systems-sampling techniques, quantization, quantization error, Nyquist rate, aliasing effect.

UNIT II **10 Hours**

DISCRETE TIME SYSTEM ANALYSIS

Z-transform and its properties, inverse z-transforms, ROC and its properties; difference equation - Solution by z-transform, application to discrete systems - Stability analysis, Causality analysis and frequency response - Convolution, Correlation.

UNIT III **10 Hours**

DISCRETE FOURIER TRANSFORM AND COMPUTATION

DFT properties, magnitude and phase representation - Computation of DFT using FFT algorithm - DIT & DIF radix 2 FFT. Use of FFT algorithms in Linear Filtering and correlation.

UNIT IV **11 Hours**

DESIGN OF DIGITAL FILTERS

IIR design: Analog filter design - Butterworth and Chebyshev approximations; digital design using impulse invariant and bilinear transformation - Warping, prewarping - Frequency transformation. FIR design: Windowing Techniques - Rectangular, Raised cosine, Kaiser Windows, Blackmann - Linear phase characteristics. FIR & IIR filter realization - Direct form I and II, Parallel & cascade forms

UNIT V **7 Hours**

PROGRAMMABLE DSP CHIPS AND CASE STUDIES

Architecture and features of TMS 320F2400 signal processing chip - Quantization effects in designing digital filters. DSP based Electrical drives - Induction Motors and special Electrical machines - DSP controllers for Non- conventional energy sources.

FOR FURTHER READING

Interconnection of LTI systems-Discrete-Time Fourier transform (DTFT) and it's properties-Discrete Fourier Series-Hanning and Hamming windows-Instruction sets and simple programs for TMS320F2400.

Total: 45 Hours

Reference(s)

1. J. G. Proakis and D. G. Manolakis, "Digital Signal Processing Principles, Algorithms and Applications", Pearson Education, New Delhi, 2013
2. S. K. Mitra," Digital Signal Processing - A Computer Based Approach", McGraw Hill Education, 4th Edition,New Delhi, 2013
3. Alan V. Oppenheim, Ronald W. Schafer and John R. Buck, "Discrete - Time Signal Processing", Pearson Education, New Delhi, 2013
4. Emmanuel C Ifeachor and Barrie W Jervis, "Digital Signal Processing - A Practical approach", Pearson Education, 2002
5. B. Venkataramani, M. Bhaskar, "Digital Signal Processors, Architecture, Programming and Applications", Tata McGraw Hill, New Delhi, 2013

Assessment Pattern

Unit/RBT	Remember				Understand				Apply				Analyse				Evaluate				Create				Total
	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	
1	2					6					8														16
2		4												6					12						22
3						4					12				6										22
4		4					8																12		24
5	2					8				6															16
																								Total	100

Assessment Questions

Remember

1. Define signals
2. Define analog signal.
3. Define digital Signal
4. Define a system
5. State the term Digital Signal Processing?
6. List different types of discrete time system
7. State Sampling theorem
8. What is aliasing effect?
9. List any three properties of Z transform.
10. Sate the convolution property of Z transform.
11. State Pareseval's relation of Z-transform.
12. Define FIR filter.
13. State the initial and final value theorem of Z transform.
14. State the advantages of FIR filters?
15. Define ROC.

Understand

1. Interpret the architecture of TMS 320F2400 digital signal processor
2. Classify the different types of signals
3. Compare Analog Signal Processing and Digital Signal Processing.
4. Explain the Linearity property of Z-transform.
5. Illustrate the properties of ROC of Z transform
6. Explain the basic butterfly diagram or flow graph of DIT radix-2 FFT.
7. Define DFT of a discrete time sequence.
8. Define discrete signal
9. Exemplify the basic butterfly diagram or flow graph of DIF radix-2 FFT
10. Summarize the properties of Z transform

Apply

1. Find whether the given system is causal and stable. Y(n)=3x(n-2)+3x(n+2).
2. Find whether the given system is time invariant or not. y(t)=x(2t)
3. Determine whether the following continuous time system are linear or not
   y(t) =tx(t)-3tx(t-2)
4. Determine the Z- transform of (a) Impulse b) Unit step
5. Compute the DFT of the Sequence, x(n)={ 0,1,2,3 }. Sketch the magnitude and phase spectrum.
6. Given x(n)= n+1. Find 8 Point DFT using radix-2 DIT FFT algorithm. Also Draw the magnitude and phase spectrum.
7. Find the z-transform of $x_1(n)$={3,5,7} and $x_2(n)$={3,0.5,0.7}. show the relation between $x_1(z)$ and $x_2(z)$.
8. Find the inverse z-transform of H(z)=z(z+2)/(z-0.2)(z+0.6)
9. Compute 4- point DFT of a causal three sample sequence is given by,x(n)=1/3, $0 \leq n \leq 2$ and x(n)=0 , else
10. Implement the procedural steps in the design of low pass digital Butterworth filter and list its properties.
11. Implement impulse invariant transformation to H(s) = (s +1) (s + 2) with T =1sec and find H(z)

Analyse

1. Compare causal and non causal signals.
2. Differentiate static and dynamic system
3. Compare FIR and IIR filters.
4. Conclude the properties of ROC of Z transform
5. Distinguish between Linear convolution and circular convolution
6. Outine any two properties of z-transform.

7. Justify the following properties of z-transform:Time shifting,Time reversal,Differentiation.
8. Draw the 8-point flow diagramof radix-2 DIF-FFT algorithm.
9. Compare Butterworth and Chebyshev Filter
10. Justify why rounding is preferred to truncation in realizing digital filter?
11. State and prove that the product of the two sequences x1(n) and x2(n) is equivalent to the convolution of their respective z-transforms. i.e. X1(z) * X2(z)

Evaluate

1. Determine the one sided Z-transform and ROC of the discrete signal is given below x(n)= {1,2,3,8,5}
2. Determine the direct form-I,direct form-II,cascade and parallel realization for following system y(n)=-0.1y(n-1)+0.2y(n-2)+3x(n)+3.6x(n-1)+0.6x(n-2).
3. Given x(n)={ 1,1,1,1,2,2,2,2 }. Determine the 8 point DFT using radix-2 DIF FFT algorithm.

Create

1. Develop the program to perform addition of two 64 bit numbers.
2. Design a band stop filter to reject frequency in the range 1.2 to 2.4 rad/sec using hamming window With N=15. Sketch the magnitude response and also find the digital transfer function H(z).
3. Generation of Firing Pulses for Single phase Inverter and single phase converter with R load usingTMS320C54

15EE024 ORGANIZATIONAL BEHAVIOR AND MANAGEMENT 3 0 0 3

Course Objectives

- To understand the perspectives of management.
- To give an insight about the functions of management like planning, organizing, staffing, leading, controlling.
- To familiarize the students with organizational culture and help them to manage change.

Programme Outcomes (POs)

f. **The Engineer and Society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

g. **Environment and Sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

i. **Individual and Team Work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

j. **Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, ande and receive clear instructions.

Course Outcomes (COs)

1. Explain the basic functions of managers.
2. Analyze the culture and performance appraisal of the organization.
3. Apply Motivation -theories to improve the creative,a innovative and leadership skills
4. Asses the oppturnities of organizational Behavior in business settings
5. Analyze the organizational culture in business settings

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1						2				1			1	
2						3	1						1	

3						3	1		1				1	
4						2	1						1	
5						3	2						1	

UNIT I **10 Hours**

MANAGEMENT OVERVIEW MANAGEMENT OVERVIEW

Management - Definition, nature and purpose, Evolution of management, Functions of managers, management and society - Operation in a pluralistic society, Social responsibility of managers, Ethics in managing.

UNIT II **9 Hours**

MANAGEMENT FUNCTIONS - I MANAGEMENMANAGEMENT FUNCTIONS - I

Planning: Objectives, Types, Steps, Process, policies. Organizing - Nature and purpose, Departmentation, Line and staff, Decentralization. Staffing - Selection, performance appraisal, career strategy.

UNIT III **8 Hours**

MANAGEMENT FUNCTIONS-II

Leading - Human Factor in managing, Behavioral models, Creativity and innovation. Motivation - theories. Leadership - Ingredients of Leadership, Styles. Communication. Controlling - control Techniques.

UNIT IV **10 Hours**

ORGANIZATIONAL BEHAVIOUR

Meaning and importance of Organizational Behaviour, challenges and opportunities for Organizational Behaviour, Attitudes Job satisfaction, personality and values. Perception, Groups and Teams, conflict management.

UNIT V **8 Hours**

ORGANIZATIONAL CULTURE AND DYNAMICS

Organizational Culture - Definition, Functions, creating and sustaining culture, creating an Ethical Organizational culture. Organizational change - forces for change, managing change, change agents, resistance to change, approaches to managing organizational change, Organizational Development in intervention.

FOR FURTHER READING

Ethics in managing- Performance appraisal- Ingredients of Leadership- Attitudes Job satisfaction-Organizational Development in intervention

Total: 45 Hours

Reference(s)

1. Herold Koontz and Heinz Weihrich, Essentials of Management, Mc Graw Hill, New Delhi, 2014.
2. Robbins, Judge, Sanghi, Organizational Behaviour, Pearson, 2009
3. Fred Luthans, Organizational Behaviour, Tata McGraw Hill, 2009
4. R. D. Miles, Techniques of Value analysis & Engineering, McGraw Hill, 2000
5. Zimmerman, Value Engineering - A Practical Approach, CBS Publishers & Distributors, New Delhi, 2000

Assessment Pattern

Unit/RBT	Remember				Understand				Apply				Analyse				Evaluate				Create				Total
	F	**C**	**P**	**M**	**F**	**C**	**P**	**M**	**F**	**C**	**P**	**M**	**F**	**C**	**P**	**M**	**F**	**C**	**P**	**M**	**F**	**C**	**P**	**M**	
1	2					2			1	3					12										20
2		2								2	2								14						20
3		2				2					4								12						20
4		2							1	3									14						20
5	2					2			2	2									12						20
																								Total	100

Assessment Questions

Remember

1. Define management.
2. List the functions of managers.
3. State the functions of attitude.
4. Recall Leading.
5. Recognize that leadership can be seen as a continuum.
6. Recall group dynamics.
7. State the important rules for effective communication.
8. Define the term scalar chain.
9. State the importance of study of organizational behaviour.
10. Recall the important rule for effective communication.

Understand

1. Compare Maslow’s and Herzberg’s motivation theory.
2. Explain patterns of management Analysis.
3. Illustrate with an example, why change is an ongoing activity in an organization.
4. Indicate the role of change agent.
5. Exemplify the process of formulating career strategy of an employee.
6. Compare theory X and theory Y.
7. Indicate the importance of motivation.
8. Exemplify the various leadership styles based on the use of authority.
9. Compare traits approaches and charismatic leadership approach.
10. Identify the flow of communication in an organization.

Apply

1. Predict the problems involved in creating and sustaining an organizational culture.
2. Design a performance appraisal matrix for a production Engineer.
3. Select the motivational techniques ,which emphasis on the role of money,participation,quality of working life,and job enrichment.
4. Show the purpose of communication and basic communication process.
5. 'Human behaviour has cause -effect relationship' -justify.
6. Determine the problems in upward communication.
7. Show why real-time information is not good enough for effective control.
8. Compute the steps involved in the process of controlling.
9. Show why values are important in understanding behaviour of people.
10. If you were the chief executive officer of a large corporation, how would you ‘institutionalize’ ethics in the organization.

Analyse

1. Analyze Henry Fayol's 14 principles of management.
2. Differentiate personal ethics and business ethics.
3. Compare authority and responsibility.

4. Contrast the essential characteristics required for good manager in the present economic recession.
5. Differentiate between productivity,Effectiveness and efficiency.
6. Analyze different types of planning.
7. Outline the steps involved in the formulation of career strategy.
8. Analyze the McClellands needs theory of motivation.
9. Analyze the strengths and weakness of various theories of motivation.
10. Outline the barriers involved in effective communication. Explain few suggestions to overcome them.

Create

1. Plan an advertisement for “The Hindu” opportunity column inviting application from potential candidates for the post of Director – Information Technology.
2. Your boss has got the impression that “satisfied workers are productive workers” and has asked you to study this out. In this regard, generate a short report with your recommendations for your boss, based on your study.

15EE025 TOTAL QUALITY MANAGEMENT

3 0 0 3

Course Objectives

- To understand the Total Quality Management concept and principles and the various tools available to achieve Total Quality Management.
- To understand the application of statistical approach for quality control.
- To create an awareness about the ISO and QS certification process and its need for the industries.

Programme Outcomes (POs)

e. **Modern Tool Usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

f. **The Engineer and Society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

g. **Environment and Sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

j. **Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, ande and receive clear instructions.

Course Outcomes (COs)

1. Explain the quality management philosophies and frameworks.
2. Asses the principles of quality management systems
3. Evaluate the uses of Statistical Process Control and its application.
4. Implement the various tools and techniques of quality management
5. Check the ISO standards and auditing methods

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1						2							1	
2							3						2	
3										2			2	
4					1								1	
5							3						1	

UNIT I **8 Hours**

INTRODUCTION

Definition of Quality - Dimensions of Quality - Quality Planning - Quality costs - Analysis Techniques for Quality Costs - Basic concepts of Total Quality Management - Historical Review - Quality Statements - Strategic Planning, Deming Philosophy - Crosby philosophy - Continuous Process Improvement - Juran Trilogy, PDSA Cycle, 5S, Kaizen - Obstacles to TQM Implementation

UNIT II **10 Hours**

TQM PRINCIPLES

Principles of TQM, Leadership - Concepts - Role of Senior Management - Quality Council, Customer satisfaction - Customer Perception of Quality, Customer Complaints, Service Quality, Customer Retention, Employee Involvement - Motivation, Empowerment, Teams, Recognition and Reward, Performance Appraisal, Benefits - Supplier Partnership - Partnering, sourcing, Supplier Selection, Supplier Rating, Relationship Development, Performance Measures - Basic Concepts, Strategy, Performance Measure

UNIT III **10 Hours**

STATISTICAL PROCESS CONTROL (SPC)

The seven tools of quality - Statistical Fundamentals - Measures of central Tendency and Dispersion, Population and Sample, Normal Curve, Control Charts for variables X bar and R chart and attributes P, nP, C, and u charts, Industrial Examples, Process capability, Concept of six sigma - New seven Management tools - Case studies

UNIT IV **8 Hours**

TQM TOOLS

Benchmarking - Reasons to Benchmark - Benchmarking Process, Quality Function Deployment (QFD) - House of Quality, QFD Process, and Benefits - Taguchi Quality Loss Function - Total Productive Maintenance (TPM) - Concept, Improvement Needs, and FMEA - Stages of FMEA- Case studies.

UNIT V **9 Hours**

QUALITY SYSTEMS

Need for ISO 9000 and Other Quality Systems - ISO 9000:2000 Quality System - Elements, Implementation of Quality System, Documentation, Quality Auditing, ISO 9000:2005 (definitions), ISO 9001:2008 (requirements) and ISO 9004:2009 (continuous improvement), TS 16949, ISO 14000, AS9100 - Concept, Requirements and Benefits- Case studies.

FOR FURTHER READING

Obstacles to TQM Implementation - Benefits of supplier partnership- Application of concept of six sigma - Benchmarking process - Concepts and requirements of AS9100

Total: 45 Hours

Reference(s)

1. Dale H. Besterfiled, Total Quality Management, Pearson Education Inc, New Delhi, 2014(Revised fifth Edition)
2. N. Gupta and B. Valarmathi, Total Quality Management, Tata McGraw-Hill Publishing Company Pvt Ltd., New Delhi, 2009
3. James R. Evans and William M. Lidsay, The Management and Control of Quality, South-Western 2002.
4. Dr S. Kumar, Total Quality Management, Laxmi Publications Ltd., New Delhi 2006.
5. P. N. Muherjee, Total Quality Management, Prentice Hall of India, New Delhi,2006.
6. http://nptel.iitm.ac.in/courses/Webcourse-contents/IIT-roorkee/industrial enginerring/index.html

Assessment Pattern

Unit/RBT	Remember				Understand				Apply				Analyse				Evaluate				Create				Total
	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	
1	2					2	4		2	3								7							20
2		2				6					2				5				5						20
3		2				6				5					7										20
4		2	4				7			1	3	3													20
5	2	8				6				4															20
																								Total	100

Assessment Questions

Remember

1. Define the term Total Quality Management.
2. Recall the basic concepts of Total Quality Management.
3. List any four gurus of Total Quality Management.
4. Define the term Quality.
5. Recognise the means how the quality can be quantified?
6. List the 3 obstacles for TQM implementation.
7. Define the term leadership.
8. List the characteristics of quality leaders.
9. Reterive the functions of quality council.
10. Reproduce the general equation for Taguchi Quality Loss function.

Understand

1. Indicate how the suppliers are rated?
2. Explain the three stage process for establishing a quality-cost system.
3. Compare goal and obiective.
4. Explain in detail about the customer perception of quality.
5. Compare the difference between a document and a record?
6. Compare X Bar & R charts based on their attributes.
7. Summarise the use of scatter diagram?
8. Infer about the use of poission distribution curve in preparing c-chart?
9. Exemplify the characteristics of a successful team.
10. Interpret the best approach in resolving Complaints.

Apply

1. Show the usage of an effective recognition and reward system?
2. Assess the means to improve the performance appraisal system.
3. Show the control chart for variables and attributes.
4. Implement the concepts of Six Sigma in Engineering enterprises.

5. Use the hierarchy-of-needs, two-factor, and achievement motivation theories, and assess their value to international human resource management
6. Show the value of process theories in motivating employees worldwide.
7. Show the importance of job design, work centrality, and rewards to understanding how to motivate employees in an international context.
8. Demonstrate the losses to society because of poor quality as per Taguchi.
9. Compute the target value in equipment effectiveness.
10. Assess the purpose of Supplier Rating for engineering products.

Analyse

1. Justify how customer complaints are the source for corrective actions.
2. Consider a company involved in testing the strengths of components. Currently 50 engineers are working in the company. Outline the steps that the company should take to implement ISO 9000:2000 based quality system and obtain the certificate from a certifying agency.
3. Differentiate the Juran's Trilogy and the PDSA cycle based on their principles.
4. Structure the steps involved in failure mode effect analysis with a case study.

Evaluate

1. Assuming that the life in hours of an electric bulb is a random variable following normal distribution with a mean of 2000 hrs and standard deviation of 840 hrs. Determine the expected number of bulbs from a random sample of 2000 bulbs having life I. More than 3000 hrs II. Between 2600 and 2800 hrs.
2. The mean weight of 500 male students at a certain college is 65.6 kg and tile standard deviation is 10 kg. Assuming tl1at the weights are normally distributed, determine how many students, weigh (i) more than 75.5 kg, and (ii) between 55.5 and 75.5 kg 8. At a certain examination 10% of the students who appeared for the paper in statistics got less than 30 marks and 97% of the students got less than 62 marks. Assuming tire distribution is normal, find the mean and tile standard deviation of the distribution
3. Judge the role of Management in an organization.
4. Justify the need for good relationship to be maintained between customers and suppliers.
5. Support the implementation of TQM with a case study from the manufacturing industry.
6. Criticise on adopting benchmarking technique in the organisations.

Create

1. Plan the stages in building the house of quality.
2. Argue the ways by which an organisation can make use of customer feedback.
3.

15EE026 CONCEPTS OF ENGINEERING DESIGN

3 0 0 3

Course Objectives

- To understand the basic concepts of engineering design and finding solution towards emerging social issues
- To analyze the various factors to be considered in design and planning for manufacture
- To explain the fundamentals of Intellectual property rights.

Programme Outcomes (POs)

b. **Problem Analysis:** Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
c. **Design/ Development of Solutions**: Design solutions for complex engineering problems and design system components or processes that meet the consideration for thepublic

health and safety, and the cultural, societal, and environmental considerations.cultural, societal, and environmental considerations.

d. **Conduct Investigations of Complex Problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

f. **The Engineer and Society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

g. **Environment and Sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

h**.** **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

j. **Communication**: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, ande and receive clear instructions.

k. **Project Management and Finance**: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one’s own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

Course Outcomes (COs)

1. Explain the interfaces and principles of engineering design.
2. Compare the different performance parameters for creativity and quality of a product.
3. Classify the various manufacturing process and design techniques.
4. Apply the principles of Quality Control Tools in design process.
5. Analyze the concepts of Intellectual Property Rights.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1		1	3	2		1							1	
2			2			2	3	1					2	
3			2	1		2	3				1		3	
4				3		2		1			1		2	
5				3		1				2	1		1	

UNIT I **8 Hours**

PRINCIPLES AND PROBLEM IDENTIFICATION

Engineering design introduction and definition, Considerations of a good design, Engineering design interfaces, Principles of engineering design, Problem identification, Design process, simplified approach and detailed description

UNIT II **9 Hours**

TECHNOLOGICAL INNOVATION AND CONCEPT GENERATION

Introduction, Product and process cycle, Societal considerations in engineering, Creativity and problem solving, Creativity methods, Identifying customer needs, Marketing, Benchmarking.

UNIT III **10 Hours**

CONCEPT EVALUATION AND DESIGN PROCESS

Evaluation methods, Decision making, Classification of manufacturing process, Design for manufacturing (DFM), Design for Assembly (DFA), Industrial design, Human factors design, Design for environment.

UNIT IV **10 Hours**

PLANNING FOR MANAGEMENT AND MANUFACTURE

Production design specification (PDS), Quality function deployment (QFD), Design review, Value engineering, Detail design, Role of processing in design, Materials selection.

UNIT V **8 Hours**

INTELLECTUAL PROPERTY RIGHTS AND CASE STUDIES

Introduction, Study prior inventions, Patent, Patent literature, Expert system, Presentation Techniques, Design report, Case studies

FOR FURTHER READING

TRIZ- Design for X- Finite Element Analysis- FMEA- Life cycle costing- TORT law- Environmental standards- Geographical indication.

Total: 45 Hours

Reference(s)

1. George E. Dieter, Engineering Design, McGraw - Hill International,2013.
2. Ken Hurst, Engineering Design Principles, Elsevier Science and Technology Books, May 1999.
3. Richard Birmingham, Graham Cleland, Robert Driver and David Maffin, Understanding Engineering Design, Prentice Hall of India
4. G. Pahl, W. Beitz, J. Feldhusan and K.H. Grote, Engineering Design, Springer, 2007
5. Yousef Haik and Tamer M. Shahin, Engineering Design Process, Cengage Learning, 2010
6. John Chris Jones, Design Methods, John Wiley & Sons, 2002.

Assessment Pattern

Unit/RBT	Remember				Understand				Apply				Analyse				Evaluate				Create				Total
	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	
1		3			12	2							1	1			1								20
2		1				1			2				12	1	1		1	1							20
3	2				12								1	1	2		1	1							20
4	2	1							1	1			2				12	1							20
5	1				1	1				12			2				1	2							20
																								Total	100

Assessment Questions

Remember

1. List out the criteria of fluid documents.
2. Define engineering design.
3. Recall optimization?
4. List the places where patent offices located in India.
5. Define iteration.
6. List out the characteristics of creative person.
7. Recall Pahl and Beitz’s model of design process.
8. What are all the four stages are recommended in morphological analysis?
9. Recognise PDS interfaces
10. Recall provisional materials and process determination.

Understand

1. Explain about patent and its registration.
2. Explain in detail concept sketches and scheme drawing.
3. Explain the relationship between QFD and PDS
4. Classify ergonomics and aesthetic needs.
5. By using Pahl and Beitz's model of design process, briefly explain the design of domestic car.
6. Explain the term ergonomics in performance requirement of PDS criteria?
7. Explain Pugh's model of design process
8. Compare convergence and divergence thinking
9. Discuss the various types of creativity methods
10. Find the analogy for the given two statements a) Bat uses sonar b) Squid uses the jet propulsion

Apply

1. "Quantity breeds quality"- Support this statement with the help of suitable concept generation method.
2. Construct the sequence of engineering drawing.
3. Find the various sections in design report.
4. Use the analogy for the given two statements a) Bat uses sonar b) Squid uses the jet propulsion
5. Show the term ergonomics is included in performance requirement of PDS criteria?
6. By using Pahl and Beitz's model of design process, briefly explain the design of domestic car.
7. If the no. of criteria are 8 how many no. of 1's should be given in criteria ranking table?
8. Demonstrate the morphological chart for the design of a fan.
9. Demonstrate Morphological chart for the design of a CD case.
10. Prepare the table which contains the materials to be used for manufacturing TV and compare its various features.

Analyse

1. Use Pugh's model of design process to explain the design process of generator.
2. Structure the materials can be used for manufacturing TV.
3. Execute a design report for any innovative product and analyze it.
4. Compare convergence and divergence thinking.
5. Choose the example for analogy.
6. Compare the concept sketches and scheme drawing.

Evaluate

1. Consider the wide variety of devices available for assisting the removal of a cork from the neck of wine bottle. Choose the optimum using the recommended decision making process.
2. A survey has been conducted which indicates a sizeable market for a power driven mini trencher. The use would be mainly for services on new housing estates, where a trench 100 mm wide by 450 mm deep is the minimum requirement and for digging drainage channels in lawns. It is envisaged that sales would be almost solely through contractors/ dealers who would then hire the device out.Implement a PDS generate concepts and select the optimum concept for the mini trencher.
3. Distinguish psychological set and technological advances.
4. Choose the example for inversion.

Create

1. Assume that you are a design engineer and generate a PDS with specific format for solar water heater.
2. Generate the concepts for replacing the traditional type of scarecrow with alternative methods of bird scaring.

15EE027 ENTREPRENEURSHIP DEVELOPMENT

3 0 0 3

Course Objectives

- To explain the fundamentals of Entrepreneurship
- To understand the business entity, source of capital and to evaluate the project financially
- To analyze the human resources management techniques and methods of taxation

Programme Outcomes (POs)

f. **The Engineer and Society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

k. **Project Management and Finance**: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

l. **Life-long Learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Course Outcomes (COs)

1. Apply the essential, types and value of entrepreneurship with case studies.
2. Analyze statutory bodies of business with articles, act and rules and infer the importance of taxation and negotiable instruments
3. Analyze the human resource policies, information and act with various decision making process
4. Evaluate the effectiveness of different marketing strategies in marketing management.
5. Construct a business plan by considering legal and financial conditions and analyze its viability.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1						1						2	1	
2						2							2	
3						2						3	3	
4											3	2	2	
5						3							1	

UNIT I **7 Hours**

BASICS OF ENTREPRENEURSHIP

Entrepreneurship Competence, Entrepreneurship as a career, Entrepreneurship, Social entrepreneurship, Serial entrepreneurship (Cases), Technopreneurship.

UNIT II **10 Hours**

LEGAL ASPECTS OF BUSINESS

Sole proprietor, HUF, Partnership, Companies Act - Kinds, Formation, Memorandum of Association, Articles of Association , Cooperative societies act, Direct Taxation, Indirect Taxation, Contract Act, Sale of Goods Act, Negotiable Instruments - Promissory Note, Bills and Cheques.

UNIT III **9 Hours**

HUMAN RESOURCE MANAGEMENT

Human Resource Planning (Cases), Recruitment, Selection, Training and Development, HRIS, Factories Act 1948 (an over view), Fractionation, Reversal Method, Brain storming

UNIT IV **10 Hours**

MARKETING MANAGEMENT

Formulating Marketing strategies, The marketing plan, Deciding on the marketing mix (Cases), Interactive marketing, Marketing through social networks, Below the line marketing, International marketing - Modes of Entry, Strategies (Cases). Creativity and Innovation (Cases), Lateral thinking, Generation of alternatives (Cases)

UNIT V **9 Hours**

BUSINESS PLAN PREPARATION

Purpose of writing a business plan, Capital outlay, Technical feasibility, Production plan, HR plan, Market survey and Marketing plan, Financial plan and Viability, Government approvals, SWOT analysis

FOR FURTHER READING

Industrial policies of Central and State Government, Financial Institution, MSME, Equity, Mutual funds.

Total: 45 Hours

Reference(s)

1. S. S. Khanka, Entrepreneurial Development, S. Chand & Co, New Delhi, 2010
2. Hisrich, Entrepreneurship, Tata McGraw Hill, New Delhi, 2005.
3. Philip Kotler, Marketing Management, Prentice Hall of India, New Delhi, 2003.
4. K. Aswathappa, Human Resource and Personnel Management, Text and Cases, Tata McGraw Hill,2007.
5. P. C. Jain, Handbook for New Entrepreneurs, EDII, Oxford University Press, New Delhi, 2002.
6. Akhileshwar Pathak, Legal Aspects of Business, Tata McGraw Hill, 2006.

Assessment Pattern

Unit/RBT	Remember				Understand				Apply				Analyse				Evaluate				Create				Total
	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	
1	1		2			1			1		2				12		1								20
2		1			1	2				1	2		1						12						20
3		2	1				1		1					1	2								12		20
4			2	1		12			1		1							2	1						20
5	1					1			12	2	1						1			2					20
																								Total	100

Assessment Questions

Remember

1. List the three functions of NSIC?
2. RecallÂ the Project Objectives?
3. List the stages in a Project Lifecycle?
4. RecallÂ the objective of Entrepreneurial Training?
5. Recognise Fabian Entrepreneur?
6. RecallÂ the Views on Schumpeter on Entrepreneurship?
7. State the role of IDBI in the development of Entrepreneurship?
8. Define the term Feasibility Report?
9. Define Small Scale Entrepreneur?

10. List the Social Problems of Women Entrepreneur?

Understand

1. Explain briefly various types of Entrepreneur?
2. Exemplify any three programmes supporting women entrepreneurs.
3. Explain the different merchant castes in India.
4. Classify the target groups of EDP?
5. Exemplify the stages in project Formulation?
6. Compare the qualities of a Manager and an Entrepreneur?
7. Summarise the role played the commercial banks in the development of Entrepreneur?
8. Illustrate the role of NISIET.
9. Compare entrepreneur and entrepreneurship.
10. Explain the steps involved in Motivating Training?

Apply

1. Demonstrate the various functions performed by Entrepreneurs?
2. Implement the role of different agencies in the development of Entrepreneur?
3. Construct the criteria for selecting a particular project?
4. Justify the role of Entrepreneur in the Development of Country?
5. Find the problems and opportunities for an entrepreneur.
6. Demonstrate the schemes offered by Commercial banks for development of entrepreneurship.
7. Find the significant role played by DIC & SISI for the development of entrepreneurship.
8. Design a short Entrepreneurship development programme for farmer.
9. Assess the role and importance of the following institutions in promoting,training and developing entrepreneurs in India.
10. Predict the role of Entrepreneur in the developing countries?

Analyse

1. "All economy is the effect for which entrepreneurship is the cause"- Justify it.
2. Integrate the problems of Women entrepreneurs and Evaluate the ways to overcome these barriers?
3. "Developing countries like India need imitative entrepreneurs rather than innovative entrepreneurs". Do you agree? Justify your answer with examples.
4. Justify the recommendation and policy implication for survival of SME's.
5. Compare the reasons of very few women becoming entrepreneurs in a developing country like India? Whether Indian women entrepreneurs have now made an impact and shown that they too can contribute in economic development of the country?

Evaluate

1. Criticise entrepreneurial growth by the communities of south India.
2. Determine the importance of small scale industries in India.
3. Criticise the growth and development of ancillarisation in India.
4. Compare various sources and collection of credit information of entrepreneurs.
5. Determine the role of the Government both at the Central and State level in motivating and developing entrepreneurship in India.

Create

1. Generate new ideas for Digital India.
2. Design a new theme for entering International marketing.

15EE028 ELECTRIC TRACTION

3 0 0 3

Course Objectives

- To understand the latest trends in traction system
- To analyze the speed time curves for main line, suburban and urban services.
- To study the basics of electric locomotive and distribution system.

Programme Outcomes (POs)

a. **Engineering Knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

b. **Problem Analysis:** Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

Course Outcomes (COs)

1. Explain the latest trends used in traction system and select the suitable traction system for particular application.
2. Examine the speed time curves of suburban and urban services, requirements and factors influencing electric traction systems.
3. Analyze the performance characteristics of different types of traction motors and their control for traction systems
4. Analyze the operation of various electric locomotives for power conversion and transmission system.
5. Analyze the requirements, selection and method of feeding the distribution system for electric traction.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3												2	
2		2											2	
3		1												2
4		3												3
5		1											2	

UNIT I **10 Hours**

TRACTION SYSTEMS AND LATEST TRENDS

Present scenario of Indian Railways, High speed traction, Metro, Monorail, Magnetic levitation Vehicle, Steam, diesel, diesel-electric, Battery and electric traction systems, General arrangement of D.C.,A.C.single phase, three-phase,Composite systems,Choice of traction system.

UNIT II **8 Hours**

MECHANICS OF TRAIN MOVEMENT

Analysis of speed time curves for main line, suburban and urban services, Simplified speed time curves. Relationship between principal quantities in speed time curves, Requirement of tractive effort, Specific energy consumption and influencing factors.

UNIT III **10 Hours**

TRACTION MOTORS AND CONTROL

Features of traction motors,Significance of D.C. series motor as traction motor, A. C. Traction motors-single phase, Three phase, Linear Induction Motor, Comparison between different traction motors, Series-parallel control, Open circuit, Shunt and bridge transition, Pulse Width Modulation control of induction motors, Types of electric braking system.

UNIT IV **9 Hours**

ELECTRIC LOCOMOTIVES AND AUXILIARY EQUIPMENT

Important features of electric locomotives, Different types of locomotives, Current collecting equipment, Coach wiring and lighting devices, Power conversion and transmission systems, Control and auxiliary equipment.

UNIT V **8 Hours**

FEEDING AND DISTRIBUTION SYSTEM

Distribution systems pertaining to traction (distributions and feeders), Traction sub-station requirements and selection, Method of feeding the traction sub- station.

FURTHER READING

Bullet train, Hyper loop locomotive systems, Batteries and Solar train

Total: 45 Hours

Reference(s)

1. H. Partab Modern Electric Traction DhanpatRai and Sons, New Delhi
2. J. Upadhyay S. N. Mahendra Electric Traction Allied Publishers Ltd, DhanpatRai and Sons, New Delhi.
3. A.T. Dover Electric Traction Mac millan, DhanpatRai and Sons, New Delhi.
4. R. B. Brooks Electric Traction Hand Book Sir Isaac Pitman and sons ltd. London.
5. P. C. Jain, Handbook for New Entrepreneurs, EDII, Oxford University Press, New Delhi, 2002.
6. Akhileshwar Pathak, Legal Aspects of Business, Tata McGraw Hill, 2006.

15EE029 INDUSTRIAL AUTOMATION 3 0 0 3

Course Objectives

- To enable the students to learn and understand the DCS and PLC concepts.
- To explain the generation of DCS feedback control functions operator station display functions, sequence control functions, sequence logic functions and graphic panels using DCS system.
- To explain the instrumentation basics/standards along with the field instruments used for measuring different process parameters.

Programme Outcomes (POs)

a. **Engineering Knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

b**. Problem Analysis:** Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

e. **Modern Tool Usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

m. **PSO1:** Modeling , design and Analysis of Electrical and Electronic Systems using design principles and software tools

n. **PSO2**: Develop electrical machineries/Appliances for various Domestic and industrial needs

Course Outcomes (COs)

1. Explain the architecture of industrial automation system.
2. Summarize the architecture and interfacing of CENTUM VP system.
3. Aanlyze the various configuration of MC-2 block.
4. Execute the suitable PLC Programming languages
5. Design SCADA graphics by interfacing with PLC.

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3												2	
2		2											2	
3		1												2
4		3												3
5		1											2	

UNIT I **8 Hours**

INTRODUCTION TO INSTRUMENTATION BASICS

Instrumentation Standards- Introduction to Industrial Measurement techniques-Pressure Measurement, Temperature Measurement, Flow Measurement, Level Measurement- Basic Control Loops and Tuning Introduction to Field Instruments- Principle and Operation of Transmitters-Principle and Operation of Flow meters- Principle and Operation of Control Valves- Single Loop Controllers and Operation- Principle and Operation of Data acquisition System.

UNIT II **8 Hours**

INTRODUCTION TO CENTUM VP ENGINEERING

CENTUM VP overview,CENTUM VP system architecture,FCS hardware configuration,HIS configuration,Network details,Address settings, Project creation, Project attribute utility,IOM creation/ IOM builder settings,Practice session, Creation of open loop,Creation of closed loop-Introduction to FCS simulation-Concept of download:Offline download,Online download, IOM load ,System defined windows, Faceplate, Tuning ,System defined windows-Practice session

UNIT III **8 Hours**

INTRODUCTION TO CENTUM VP ENGINEERING

Creation of cascade loop-Signal selectors-Configuration of FOUT block-Configuration of SPLIT block-Creation of control group window-Creation of trend window-HIS setup window-SchedulerPractice session-ncept of discrete I/Os, switches-Concept of interlocks-Configuration of sequence table-configuration of logic chart-Configuration of MC-2 block-Configuration of MC-2 in logic chart TPCFL block-CALCU block-Overview window-Graphics window Practice session

UNIT IV **8 Hours**

INTRODUCTION PLC CONCEPTS

Types of PLCs -Difference between DCS and PLC-PLC System Configuration-PLC Hardware Configuration-Prosafe-RS safety PLC-features, hardware details.Introduction to Work bench-Project Creation-Screens of Workbench - Link Architecture - Hardware Architecture-- I/O Wiring-=-Dictionary-I/O Variable Creation and Wiring-Introduction to FBD-FBD logic using digital signal-Configuration of SCALER Block-Configuration of FILTER Block-Configuration of MUXREAL4 Block-Configuration of SEL_R Block-Configuration of ANLG_S Block-Offline Download/Online download-I/O Lock Window/Forcing Function

UNIT V

INTRODUCTION TO INTEGRATION WITH CENTUM VP FOR IMPLEMENTING

SCADA -Engineering on SENG Side-Engineering on CENTUM VP Side-Function Blocks for Integration-Introduction to Ladder diagrams-Introduction to Structured text-SOE Viewer

15EE030 POWER SYSTEM DEREGULATION 3 0 0 3

Course Objectives

- To interpret the need for restructuring of Power Systems, different market models, and market power.
- To analyze the market model, operations and challenges faced in deregulation environment.
- To infer the transmission open access and congestion management methods.
- To apply the concepts and terminologies in pricing methodology and available transfer capability.
- To explain the deregulation process in Indian and International market.

Programme Outcomes (POs)

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
e. Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
m. PSO1: Modeling , design and Analysis of Electrical and Electronic Systems using design principles and software tools
n. PSO2: Develop electrical machineries/Appliances for various Domestic and industrial needs

Course Outcomes (COs)

1. Analyze the restructuring process, new entities in power market and benefits
2. Explain the challenges faced in deregulation environment with their market model and operations.
3. Analyze the transmission open access and congestion management methods.
4. Compute the pricing of power transaction and available transfer capability in deregulation environment.
5. Elaborate the deregulation process in Indian and International market.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3	2											3	
2	3	2											3	1
3	2				3								3	2
4	2				3								3	2
5	3	2											3	

UNIT I **8 Hours**

POWER SYSTEM DEREGULATION: AN OVERVIEW

Introduction- Motivation for Restructuring of Power System- Electricity Market Entities and Model-Milestones of Deregulation-International Scenario - Benefits of deregulation- Basic Terminologies.

UNIT II **10 Hours**

COMPETITIVE WHOLESALE ELECTRICITY MARKET

Introduction - Restructuring models - Role of Independent system operator - Power exchange (PX) - Market Clearing Price (MCP) - Market operations - Whole sale electricity market characteristics - Challenges in wholesale electricity market.

UNIT III **9 Hours**

TRANSMISSION OPEN ACCESS

Introduction - Transmission open access- Types of Transmission services in open access - FERC order 889 - Structure of OASIS: Functionality and Architecture of OASIS - Congestion management - congestion management methods: An overview: Rescheduling of generation-Power World Simulation model.

UNIT IV **10 Hours**

PRICING AND AVAILABLE TRANSFER CAPABILITY

Introduction - Transmission cost components - Transmission pricing methods - Postage stamp method - contract path method-MW Mile method - Marginal participation method - Available Transfer Characteristics (ATC): Introduction -Definition - Methods of Static ATC Determination - Method based on multiple load flow and continuation power flow - method based on linear sensitivity factors - Power World Simulation model.

UNIT V **8 Hours**

INTERNATIONAL AND INDIAN POWER MARKET

Introduction - California Markets - New York Markets - PJM interconnection - Indian power sector past and present status-growth of power sector in India - overview - Time line of Indian power sector-Players in the Indian power sector.

FOR FURTHER READING

Electric Energy Trading, Electricity Price Forecasting, Demand Side Management

Total: 45 Hours

Reference(s)

1. M.Shahidepour, Hatim Tamin and Zuyi Li, "Market operations in electric power system forecasting, scheduling and risk management", John Wiley sons, 2002.
2. M.Shahidepour and M. Alomoush, "Restructured Electrical Power Systems: Operation: Trading, and Volatility", Marcel Dekker, Inc., 2001.
3. P.Venkatesh, B.V.Manikandan, S.Charles Raja and A.Srinivasan, "Electrical power systems analysis, Security and Deregulation", PHI 2012.
4. Loi Lei Lai, "Power system Restructuring and Deregulation" John Wiley sons, 2001.
5. Kankar Bhattacharya Maath H.J. Bollen and Jaap E.Daalder, "Operation of restructured power systems", Kluwer academic publishers, USA, first edition, 2001.

15GE001 ENTREPRENEURSHIP DEVELOPMENT I **3 0 0 3**

Course Objectives

- Study of this subject provides an understanding of the scope of an entrepreneur, key areas of development, financial assistance by the institutions, methods of taxation and tax benefits, etc.,

Programme Outcomes (POs)

h. **Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
i. **Individual and Team Work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
j. **Communication**: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
k. **Project Management and Finance**: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

Course Outcomes (COs)

1. Able to gain Knowledge about entrepreneurship, motivation and business.
2. Able to develop small scale industries in different field.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
1								1	1	2	2	
2								2	3	3	3	

UNIT I

BASICS OF ENTREPRENEURSHIP

Nature, scope and types of Entrepreneurship, Entrepreneur Personality Characteristics, Entrepreneurship process. Role of entrepreneurship in economic development

UNIT II **9 Hours**

GENERATION OF IDEAS

Creativity and Innovation, Lateral Thinking, Generation of Alternatives, Fractionation, Reversal Method, Brain Storming, Analogies

UNIT III **9 Hours**

LEGAL ASPECTS OF BUSINESS

Contract act-Indian contract act, Essential elements of valid contract, classification of contracts, sale of goods act- Formation of contract of sale, negotiable instruments- promissory note, bills and cheques, partnership, limited liability partnership (LLP), companies act-kinds, formation, memorandum of association, articles of association.

UNIT IV **9 Hours**

BUSINESS FINANCE

Project evaluation and investment criteria (cases), sources of finance, financial statements, break even analysis, cash flow analysis.

UNIT V **9 Hours**

OPERATIONS MANAGEMENT

Importance- functions-deciding on the production system- facility decisions: plant location, plant layout (cases), capacity requirement planning- inventory management (cases)-lean manufacturing, Six sigma.

Total: 45 Hours

Reference(s)

1. Hisrich, Entrepreneurship, Tata McGraw Hill, New Delhi: 2005
2. Prasanna Chandra, Projects Planning, Analysis, Selection, Implementation and Reviews, Tata McGraw-Hill Publishing Company Limited, New Delhi: 2000.
3. Akhileshwar Pathak, Legal Aspects of Business, Tata McGraw Hill: 2006.

Assessment Pattern

Unit/RBT	Remember				Understand				Apply				Analyse				Evaluate				Create				Total
	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	
1	3							2	2			1		2			2		2		2		4		20
2		3					2			2		2		2		2			3			4			20
3			3			2					2				2			4		3			4		20
4				3			2			2			2			3		4						4	20
5		1		2				2		2		2			2				5			4			20
																								Total	100

Assessment Questions

Remember

1. What is entrepreneurship?
2. What are the factors that motivate people to go into business?
3. Define a small-scale industry
4. Who is an intrapreneur?
5. State functions of SISI
6. What is serial entrepreneur?
7. What is Technopreneurship?
8. What is reversal method?
9. What is brainstorming?
10. What do you mean by term business idea?
11. Mention any two schemes Indian government provides to the development of entrepreneurship
12. What is a project report?
13. What is project scheduling?
14. Mention any four techniques available for project scheduling.
15. What is contract act?
16. Define MOU.
17. Mention any five external sources of finance to an entrepreneur.
18. Classify the financial needs of an organization
19. Why is motivational theories important for an entrepreneur?

Understand

1. Why is entrepreneurship important of growth of a nation?
2. Mention the essential quality required for someone to be an entrepreneur.
3. How is network analysis helpful to the development of an entrepreneur?
4. Mention the essential requirements for a virtual capital.

5. How under-capitalization affects an entrepreneur
6. Mention the causes of dissolution of a firm.
7. How important is the support of IDBI to an entrepreneur?
8. What are the salient features of New Small Enterprise Policy, 1991?
9. Why scheduling is very important for a production design?

Apply

1. If you want to become as an entrepreneur, what will be your idea?
2. Select any one of the creative idea generation method and suggest an innovation that you can implement in your business.
3. Write a short notes on various legal aspects that you have to consider to run you business.
4. How will you generate your capital and other financial supports?
5. In case of getting enough financial support, plan your business and plot the various stages using any of the tools or techniques

Create

1. Draft a sample project report for your business
2. Do a network analysis using PERT and CPM for your business plan.
3. Write a brief report to apply to a financial organization for seeking financial support to your business

15GE002 ENTREPRENEURSHIP DEVELOPMENT II

3 0 0 3

Course Objectives

- Evolve the marketing mix for promoting the product / services
- Handle the human resources and taxation
- Understand Government industrial policies / support provided and prepare a business plan

Programme Outcomes (POs)

h. **Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

i. **Individual and Team Work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

j. **Communication**: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

k. Project Management and Finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one’s own work, as a member and leader in a team, to manage projects and in multidisciplinary environments

Course Outcomes (COs)

1. Increase in awareness of the entrepreneurship Development for engineering decisions.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
1								2	2	3	3	

UNIT I

MARKETING MANAGEMENT

Marketing environment,Segmentation, Targeting and positioning, Formulating marketing strategies,Marketing research, marketing plan, marketing mix (cases)

UNIT II **9 Hours**

HUMAN RESOURCE MANAGEMENT

Human Resource Planning (Cases), Recruitment, Selection, Training and Development, HRIS, Factories Act 1948 (an over view)

UNIT III **9 Hours**

BUSINESS TAXATION

Direct taxation, Income tax, Corporate tax, MAT, Tax holidays, Wealth tax, Professional tax (Cases).Indirect taxation, Excise duty, Customs, Sales and Service tax, VAT, Octroi, GST (Cases)

UNIT IV **9 Hours**

GOVERNMENT SUPPORT

Industrial policy of Central and State Government, National Institute-NIESBUD, IIE, EDI. State Level Institutions-TIIC, CED, MSME, Financial Institutions

UNIT V **9 Hours**

BUSINESS PLAN PREPARATION

Purpose of writing a business plan, Capital outlay, Technical feasibility, Production plan, HR plan, Market survey and Marketing plan, Financial plan and Viability, Government approvals, SWOT analysis.

Total: 45 Hours

Reference(s)

1. Hisrich, Entrepreneurship, Tata McGraw Hill, New Delhi: 2005.
2. Philip Kotler., Marketing Management, Prentice Hall of India, New Delhi: 2003
3. Aswathappa K, Human Resource and Personnel Management - Text and Cases, Tata McGraw Hill: 2007.
4. Jain P C., Handbook for New Entrepreneurs, EDII, Oxford University Press, New Delhi: 2002.
5. Akhileshwar Pathak, Legal Aspects of Business, Tata McGraw Hill: 2006.
6. http://niesbud.nic.in/agencies.html

Assessment Pattern

Unit/RBT	Remember				Understand				Apply				Analyse				Evaluate				Create				Total
	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	
1	2	2			2	2			2	2					2	2				2				2	20
2	2									6					6							6			20
3		3				2					3			3					3		3			3	20
4			3				3			3					3		3		3				2		20
5			3				3					3			3						3	2		3	20
																								Total	100

Assessment Questions
Remember

1. Who are Fabian Entrepreneur?
2. Mention the three functions of NSIC?
3. Narrate the role of IDBI in the development of Entrepreneurship?
4. What are the stages in a Project Lifecycle?
5. Give the meaning of Feasibility Report
6. What is Motivating Training?
7. Who is a Small Scale Entrepreneur?
8. How to develop Rural Entrepreneur?
9. What are the Social Problems of Women Entrepreneur?
10. What are the types of entrepreneurs?
11. List the various qualities of entrepreneur.
12. What is entrepreneurship training?
13. State the role of NISIET.
14. List the challenges and opportunities available in SSI's?

Understand
1. What are the elements of EDP?
2. How would you Classify Projects?
3. What is the role played by commercial banks in the development of entrepreneur?
4. What are the target groups of EDP?
5. What are the major problems faced by Small Entrepreneur?
6. What are the problems & prospects for women entrepreneur in India?

Apply
1. Describe the various functions performed by Entrepreneurs?
2. Explain the role of different agencies in the development of Entrepreneur?
3. Discuss the criteria for selecting a particular project?
4. Describe the role of Entrepreneur in the Development of Country?
5. Define business idea. Elaborate the problems and opportunities for an entrepreneur.
6. Elaborate the schemes offered by commercial banks for development of entrepreneurship.
7. Explain the significant role played by DIC & SISI for the development of entrepreneurship.

Analyse
1. Differentiate between entrepreneur and entrepreneurship
2. What are the problems of Women entrepreneurs and discuss the ways to overcome these barriers?
3. Discuss the importance of small scale industries in India

Evaluate

1. Review the entrepreneurial growth by the communities of south India.
2. Critically examine the growth and development of ancillarisation in India.

Create
1. Design a short entrepreneurship development programme for farmer.
2. "All economy is the effect for which entrepreneurship is the cause"-Discuss.
3. Discuss the various sources and collection of credit information of entrepreneurs
4. Discuss the role of the government both at the Central and State level in motivating and developing entrepreneurship in India.

5. Briefly explain the recommendation and policy implication for survival of SME's.
6. Developing countries like India need imitative entrepreneurs rather than innovative entrepreneurs". Do you agree? Justify your answer with examples.
7. Discuss the "Culture of Entrepreneurship" and its role in economic development of a nation. What factors contribute to nurturing such a culture?

15GE0P1 NANOMATERIALS SCIENCE **3 0 0 3**

Course Objectives

- Understand the fundamentals of physics of nanomaterials
- Correlate on multidisciplinary branch
- Acquire the knowledge in nanomaterials synthesis, compile and analyze data and draw conclusions at nano level

Programme Outcomes (POs)

a. **Engineering Knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. **Problem Analysis**: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

Course Outcomes (COs)

1. Classify the size dependant properties of different nanomaterials
2. Explain different experimental methods used for the preparation of nanomaterials
3. Analyse the data using different characterization techniques
4. Illustrate the different techniques to synthesize semiconductor nanostructures and utilize them for application
5. Identify the impact of nanomaterials and their applications in Nano devices

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
1	3	2										
2	3	1										
3	3	2										
4	3	2										
5	3	1										

UNIT I **9 Hours**

NANO SCALE MATERIALS

Introduction-Feynman's vision-national nanotechnology initiative (NNI) - past, present, future - classification of nanostructures,nanoscale architecture - effects of the nanometer length scale - changes to the system total energy, and the system structures- effect of nanoscale dimensions on various properties -magnetic properties of nanoscale materials -differences between bulk and nanomaterials and their physical properties.

UNIT II **9 Hours**

NANOMATERIALS SYNTHESIS METHODS

Top down processes - mechanical milling, nanolithography and types based on radiations - Bottom up process - chemical vapour deposition, plasma enhanced CVD, colloidal and sol-gel methods - template based growth of nanomaterials - ordering of nanosystems, self-assembly and self-organization - DC sputtering and RF sputtering process.

UNIT III **9 Hours**

CHARACTERIZATION TECHNIQUES

General classification of characterization methods - analytical and imaging techniques - microscopy techniques - electron microscopy, scanning electron microscopy, transmission electron microscopy, atomic force microscopy - diffraction techniques - X-ray spectroscopy - thermogravimetric analysis of nanomaterials.

UNIT IV **9 Hours**

SEMICONDUCTOR NANOSTRUCTURES

Quantum confinement in semiconductor nanostructures - quantum wells, quantum wires, quantum dots, super lattices-epitaxial growth of nanostructures-MBE, metal organic VPE, LPE - carbon nano tubes- structure, synthesis and electrical properties -applications- fuel cells - quantum efficiency of semiconductor nanomaterials.

UNIT V **9 Hours**

NANOMACHINES AND NANODEVICES

Microelectromechanical systems (MEMS) and Nanoelectromechanical systems (NEMS)-fabrication, actuators-organic FET- principle, description, requirements, integrated circuits- organic LEDÃ¢??s - basic processes, carrier injection, excitons, optimization - organic photovoltaic cells- nano motors -bio nano particles-nano - objects - applications of nano materials in biological field.

FOR FURTHER READING

Application of graphene in various field - supercapacitors - third generation solar cell-dye sensitized solar cell (DSSC) -fuel cells.

Total: 45 Hours

Reference(s)

1. Willam A. Goddard, Donald W.Brenner, Handbook of Nanoscience, Engineering, and Technology, CRC Press, 2012.
2. Charles P. Poole Jr and. Frank J. Owens, Introduction to Nanotechnology, Wiley Interscience, 2007.
3. Guozhong Cao, Y. Wang, Nanostructures and Nanomaterials-Synthesis, Properties & Applications, Imperials College Press, 2011.
4. T. Pradeep, NANO: The Essentials Understanding Nanoscience and Nanotechnology, McGraw - Hill Education (India) Ltd, 2012.
5. Robert W. Kelsall, Ian W. Hamley, Mark Geoghegan, Nanoscale Science and Technology, John Wiley and Sons Ltd, 2006
6. Viswanathan B, AuliceScibioh M, Fuel cells: Principles and Applications, University Press, 2009.

Assessment Pattern

Unit/RBT	Remember				Understand				Apply				Analyse				Evaluate				Create				Total
	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	
1	3	4	4		2					4				3					4						24
2	2	3	4		4	4				3				4											24
3	2	4	2			2	2				2			2											16
4		2			2	4				2				4					3						17
5	2	4				3	2				4				4										19
																								Total	100

Assessment Questions
Remember

1. Explain the term nano
2. List three types of classifications of nanomaterials.
3. Recall the principle behind lithography.
4. Define top-down and bottom-up approach.
5. Name two types of nanoarchitecture
6. Define nanocomposites.
7. Recall the principle of electron microscopy.
8. List 5 characterization techniques in nanotechnology.
9. Define quantum well and quantum wire.
10. Write the allotropy of carbon.

Understand

1. Explain the effect of nanometer length scale.
2. Can affect the system total energy when particle size reduced? Justify.
3. Explain plasma enhanced CVD.
4. Identify the difference between self-assembly and self-organization.
5. Name 3 synthesis process under bottom-up approach.
6. Explain contact mode in AFM.
7. Is it possible to explain the entire details of the sample by taking one characterization technique? if no, justify.

Apply

1. Find three day to day live commercial application of nanotechnology?
2. Choose two template methods used to obtain nanowire or nanorods.
3. Construct the experimental setup for organic LED.
4. Find 4 industrial applications of CNT.

Analyse

1. Differentiate between bulk and nanomaterials.
2. Identify the roll of nanoparticles in biological field.
3. Distinguish between glow discharge and RF sputtering.
4. Criticize the future challenges for nanotechnology?

Evaluate

1. Nanomaterials, do they exist in nature? If yes, Identify the nanomaterials and recognize.

15GE0P2 SEMICONDUCTOR PHYSICS AND DEVICES

3 0 0 3

Course Objectives

- Impart knowledge in physical properties of semiconducting materials
- Analyze the factors affecting the operation of semiconductor devices
- Apply the physics of semiconductors to develop semiconductor devices

Programme Outcomes (POs)

a. **Engineering Knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

b. **Problem Analysis:** Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

Course Outcomes (COs)

1. Exemplify the drift and diffusion current densities due to carrier transport in semiconductors
2. Analyze the electric field and space charge width of PN junction under different biasing
3. Explain the charge flow, temperature effects, turn on and turn off transients in PN junction diode
4. Illustrate the operation of Bipolar Junction transistor at different modes and different configurations.
5. Represent the working mechanism of opto-electronic devices

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
1												
2	2	1										
3	2	1										
4	2	1										
5												

UNIT I **9 Hours**

CARRIER TRANSPORT IN SEMICONDUCTORS

Carrier drift - drift current density - mobility effects on carrier density - conductivity in semiconductor - carrier transport by diffusion - diffusion current density - total current density - breakdown phenomena - avalanche breakdown.

UNIT II **9 Hours**

PHYSICS OF P-N JUNCTION

Basic structure-Built in potential barrier, Electric field and space charge width of P-N junction under zero, forward and reverse bias- Diffusion capacitance - one sided and linearly graded junctions.

UNIT III **9 Hours**

P-N JUNCTION DIODE

Qualitative description of charge flow in p-n junction - boundary condition - minority carrier distribution - ideal p-n junction current - temperature effects - applications - the turn on transient and turn off transient.

UNIT IV **9 Hours**

BIPOLAR JUNCTION TRANSISTOR

Introduction to basic principle of operation - the modes of operation - amplification - minority carrier distribution in forward active mode - non-ideal effects - base with modulation - high injection emitter band gap narrowing - current clouding - breakdown voltage - voltage in open emitter configuration and open base configuration.

UNIT V **9 Hours**

OPTO ELECTRONIC DEVICES

Optical absorption in a semiconductor, photon absorption coefficient - electron hole pair generation - solar cell - homo junction and hetero junction - Photo transistor - laser diode, the optical cavity, optical absorption, loss and gain - threshold current.

FOR FURTHER READING

Organic semiconductors- diodes - transistors-working and applications

Total: 45 Hours

Reference(s)

1. Donald A Neamen, Semiconductor Physics and Devices, Tata McGraw Hill, 2012.
2. S. M. Sze and M. K. Lee, Semiconductor Devices, Physics and Technology, John-Wiley & Sons, 2015.
3. Ben. G. Streetman and S. K. Banerjee , Solid State Electronic Devices, Pearson Education Ltd, 2015.
4. C. Kittel, Introduction to Solid State Physics, John-Wiley & Sons, 2012.
5. J. Millman and C. Halkias, Electronic Devices and Circuits, Tata McGraw Hill, 2010.
6. Hagen Klauk, Organic Electronics: Materials, Manufacturing and Applications, Wiley-VCH, 2006.

Assessment Pattern

Unit/RBT	Remember				Understand				Apply				Analyse				Evaluate				Create				Total
	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	
1	3	4	4		2					2				3					2						20
2	2	3	4		4	4				3				4											24
3	2	4	2		2	2					4			4											20
4		2			2	4				2				4					4						18
5	2	4				2	2				4				4										18
																								Total	100

Assessment Questions

Remember

1. Define drift current density
2. Recall diffusion capacitance
3. Write the ideal diode equation
4. List the three modes of transistor operation
5. State the principle of solar cell

Understand

1. Identify the two scattering mechanisms that affect mobility of charge carriers in semiconductors
2. Sketch the energy band diagram of a P-N junction under thermal equilibrium
3. Exemplify the boundary conditions used to calculate minority carrier distribution in a junction diode

4. Explain the base width modulation occur in transistors
5. Illustrate the working mechanism of a phototransistor

Apply

1. By applying the concept of scattering, explain the mobility of holes in a semiconductor.
2. Apply Poission equation to space charge region and hence derive the electric field under zero bias
3. Show that the minority carrier concentrations in a diode decay exponentially with distance away from the junction to their thermal-equilibrium values.
4. Derive an expression for excess minority current in the emitter region under forward action mode by applying the ambipolar transport equation.
5. Show that the minority carrier concentrations in a diode decay exponentially with distance away from the junction to their thermal-equilibrium values.

Analyse
1. Differentiate drift current and diffusion current
2. Space charge width increases upon reverse bias. Justify
3. Silicon is preferred over germanium for the manufacture of semiconductor devices. Justify
4. Compare emitter bandgap narrowing and current crowding.
5. Differentiate homojunction and heterojunction laser

15GE0P3 APPLIED LASER SCIENCE

3 0 0 3

Course Objectives
- Impart knowledge on laser science
- Explore different strategies for producing lasers
- Create expertise on the applications of lasers in various fields

Programme Outcomes (POs)
a. **Engineering Knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. **Problem Analysis**: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

Course Outcomes (COs)
1. Illustrate the transition mechanisms and the components of a laser system
2. Compare the different types of lasers based on pumping method, active medium and energy levels
3. Compute the rotation of earth, velocity and distance using lasers and apply the same for day today applications
4. Analyze the role of lasers in surgical and endoscopy applications
5. Apply the laser techniques in industrial applications

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
1	2	1										
2	2	1										
3	2											
4	2											
5	2											

UNIT I **9 Hours**

LASER FUNDAMENTALS

Introduction - principle - Einstein's prediction - spontaneous emission - stimulated emission - Einstein's relations - A and B coefficients - population inversion - condition for large stimulated emission - spontaneous and stimulated emission in optical region - light amplification. Components of lasers: active medium - pumping - pumping mechanisms - resonant cavity.

UNIT II **9 Hours**

CHARACTERISTICS AND TYPES OF LASERS

Introduction - directionality - intensity - coherence - monochromaticity. Classification of lasers - principle, construction, working, energy level diagram and applications of CO2 laser - dye laser - excimer laser - Nd:YAG laser - semiconductor laser.

UNIT III **9 Hours**

LASERS IN SCIENCE

Harmonic generation - stimulated Raman emission - lasers in chemistry - laser in nuclear energy - lasers and gravitational waves - LIGO - rotation of the earth - measurement of distance - velocity measurement - holography.

UNIT IV **9 Hours**

LASERS IN MEDICINE AND SURGERY

Eye laser surgery - LASIK - photocoagulations - light induced biological hazards: Eye and skin - homeostasis - dentistry - laser angioplasty - laser endoscopy - different laser therapies.

UNIT V **9 Hours**

LASERS IN INDUSTRY

Applications in material processing: laser welding - hole drilling - laser cutting. Laser tracking: LIDAR. Lasers in electronics industry: ranging - information storage - bar code scanner. Lasers in defence: laser based military weapons - laser walls.

FOR FURTHER READING

Q-switching - mode locking - thermo-optic effects - astronomy lasers - fighting crime with lasers - laser engraving.

Total: 45 Hours

Reference(s)

1. K. Thiyagarajan and A. K. Ghatak, LASERS: Fundamentals and Applications, Springer, USA, 2015.
2. M. N. Avadhanulu, An Introduction to Lasers Theory and Applications, S. Chand Publisher, 2013.
3. W. Koechner, M. Bass, Solid State Lasers: a graduate text, Springer Verlag, New York, 2006.
4. K. P. R. Nair, Atoms, Molecules and Lasers, Narosa Publishing House, 2009.
5. K. R. Nambiar, Lasers: Principles Types and Applications, New Age International Publications, 2006.
6. A. Sennaroglu, Solid-State Lasers and Applications, CRC Press, 2006.

Assessment Pattern

Unit/RBT	Remember				Understand				Apply				Analyse				Evaluate				Create				Total
	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	
1	2	2			2	2	1		2	3	1			2			1	2							20
2	2	2			3	2	2		2	2			1	1			1		2						20
3	3				2	2	1		2		3		2	1	1			1	2						20
4	2	2			2	1	1		2	2	1		2	2	1			1	1						20
5	2	1			1		3		2		2		2	1			1	2	3						20
																								Total	100

Assessment Questions
Remember

1. Recognise the term LASER
2. Define stimulated absorption
3. Define spontaneous emission
4. Define stimulated emission
5. Distinguish between spontaneous and stimulated emission
6. State population inversion
7. List the four characteristics of lasers
8. Mention the five medical applications of lasers
9. State the principle behind the holography
10. Recall the term resonant cavity

Understand
1. Identify the condition needed for laser action
2. Interpret the pumping of atoms
3. Exemplify the optical excitation occurs in three level laser systems
4. Explain the determination of rotation of earth using laser
5. Summarize the application of lasers in welding and cutting
6. Explain the term LASIK
7. Classify the different types of lasers based on materials
8. Illustrate the working of laser in material processing

Apply
1. Predict the condition for laser action
2. Derive the Einstein's A and B coefficients
3. Deduce the expression for large stimulated emission
4. Construct the experimental setup for distance measurement
5. Find the applications of lasers in stimulated Raman
6. Assess the wavelength of emission of GaAs semiconductor laser whose bandgap energy is 1.44 eV.

Analyse

1. Laser beam should be monochromatic, Justify?
2. Differentiate ordinary light source from laser source
3. Compare the working of gas lasers with excimer laser
4. Four level laser systems are more efficient than three level laser systems. Justiify**?**

Evaluate

1. Determine the intensity of laser beam be focused on an area equal to the square of its wavelength. For He-Ne laser wavelength is 6328 A^0 and radiates energy at the rate of 1mW.
2. Choose the appropriate lasers for the materials processing in industry

15GE0C1 CORROSION SCIENCE

3 0 0 3

Course Objectives

- Recognize the terminologies used in corrosion science.
- Impart knowledge about the various types of corrosion and its mechanism.
- Understand the various methods of corrosion control, corrosion testing and monitoring.

Programme Outcomes (POs)

a. **Engineering Knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. **Problem Analysis:** Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
g. **Environment and Sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

Course Outcomes (COs)

1. Evaluate if corrosion can occur under specific operating conditions in a given equipment or construction and indicate regions of immunity, corrosion and passivity of a metal
2. Compare different corrosion types on metals when exposed to air, water and at high temperatures (> 100 C)
3. Identify the corrosion mechanism on steel, iron, zinc and copper metal surfaces
4. Calculate the rate of corrosion on metals using electrochemical methods of testing
5. Propose the correct materials, design and operation conditions to reduce the likelihood of corrosion in new equipment and constructions

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
1	2	1										
2	2						1					
3	1	3										
4	2	2										
5	3	3										

UNIT I **9 Hours**

CORROSION

Importance of corrosion - spontaneity of corrosion - passivation - direct and indirect damage by corrosion - importance of corrosion prevention in industries - area relationship in both active and passive states of metals - Pilling Bedworth ratio and its significance - units of corrosion rate (mdd and mpy) - importance of pitting factor - Pourbaix digrams of Mg, Al and Fe and their advantages and disadvantages.

UNIT II **7 Hours**

TYPES OF CORROSION

Eight forms of corrosion: uniform, galvanic, crevice corrosion, pitting, intergranular corrosion, selective leaching, erosion corrosion and stress corrosion. High temperature oxidation, kinetics of protective film formation and catastrophic oxidation corrosion.

UNIT III **9 Hours**

MECHANISM OF CORROSION

Hydrogen embrittlement - cracking - corrosion fatigue - filliform corrosion - fretting damage and microbes induced corrosion - corrosion mechanism on steel, iron, zinc and copper metal surfaces - thick layer and thin layer scale formation - in situ corrosion scale analysis.

UNIT IV **10 Hours**

CORROSION RATE AND ITS ESTIMATION

Rate of corrosion: factors affecting corrosion - electrochemical methods of polarization - Tafel extrapolation polarization, linear polarization, impedance techniques - weight loss method - susceptibility test - testing for intergranular susceptibility and stress corrosion. Visual testing - liquid penetrant testing - magnetic particle testing - eddy current testing.

UNIT V **10 Hours**

CORROSION CONTROL METHODS

Fundamentals of cathodic protection - types of cathodic protection. Stray current corrosion problems and its prevention. Protective coatings: anodic and cathodic coatings - metal coatings: hot dipping (galvanizing, tinning and metal cladding) - natural inhibitors. Selection of sacrificial anode for corrosion control.

FOR FURTHER READING

Corrosion issues in supercritical water reactor (SCWR) systems.

Total: 45 Hours

Reference(s)

1. Mouafak A. Zaher, Introduction to Corrosion Engineering, CreateSpace Independent Publishing Platform, 2016.
2. E.McCafferty, Introduction to Corrosion Science, Springer; 2010 Edition, January 2010.
3. R. Winstone Revie and Herbert H. Uhlig, Corrosion and Corrosion Control: An Introduction to Corrosion Science and Engineering, 4th Edition, John Wiley & Science, 2008.
4. Mars G. Fontana, Corrosion Engineering, Tata McGraw Hill, Singapore, 2008.
5. David E.J. Talbot (Author), James D.R. Talbot, Corrosion Science and Technology, Second Edition (Materials Science & Technology), CRC Press; 2nd Edition, 2007.
6. http://corrosion-doctors.org/Corrosion-History/Eight.htm

Assessment Pattern

Unit/RBT	Remember				Understand				Apply				Analyse				Evaluate				Create				Total
	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	
1	1	2	2		1	2	1		1	1	1		1	1	2		2	1			1				20
2	1	3			2	1	1			2			1	2			1	1					1		16
3	2	1			1	4	1			3				2			2	2				2			20
4	1	1	1		2	3	1		2	2	1		2	1	1		1	2					1		22
5	1	2			1	2			2	3			2	3			1	2			1	2			22
																								Total	100

Assessment Questions
Remember

1. Define Corrosion
2. Mention the five types of corrosion
3. Define dry corrosion. Explain the mechanism.
4. What are corrosion inhibitors? Give two examples.
5. What are corrosion inhibitors? Give two examples.
6. Write the working principle of Tafel polarization techniques.
7. How polarization and impedance techniques are used to measure the corrosion products?
8. Define cathodic protection.
9. ellaborate non-electrochemical and electrochemical methods of corrosion testing and monitoring.
10. What is Tafel linear polarization?
11. What is Tafel linear polarization?
12. In corrosion, which criteria involves nature of the metal
    a. Temperature
    b. Humidity
    c. pH
    d. Purity of the metal
13. An example of corrosion measurement technique is
    a. Tribometer
    b. non-destructive testing
    c. rupture testing
    d. Charpy test

14. In the weight loss method, the preferred duration of exposure of test samples to corrosive media is

    a. 10 days
    b. 1 month
    c. 1 year
    d. 1 day

15. The long term corrosion protection method is

    a. Impressed current method
    b. Proper choice of metal for the designing
    c. Cathode protection
    d. Sacrificial anode method

16. Indicate two purposes of corrosion testing.
17. Write the principal of anodic protection method.

Understand

1. Explain the mechanism of electrochemical corrosion.
2. Identify the relation between the two units used to measure corrosion rate.
3. Illustrate the Pourbaix digrams of Mg/Al/Fe and their limitations.
4. List the eight forms of corrosion. Explain each type with an example.
5. What are the factors influencing the corrosion rate? Explain.
6. Discuss the Pilling-Bedworth rule.
7. Differentiate between electrochemical and dry corrosion.

8. How inhibitors are used to protect the corrosion rate of the metal? Explain.
9. What are consequences of Pilling-Bedworth ratio?
10. List the difference between filliform corrosion and pitting corrosion.
11. By which method can we prevent corrosion in ship hulls?
    a. Sacrificial anode method
    b. Impressed current method
    c. Deaeration method
    d. Deactivation method
12. In order to form a protective oxide layer, the ratio of the volume of oxide formed to that of metal consumed should be
    a. greater than one
    b. less than one
    c. much greater than one
    d. none of the above

13.Stress corrosion is often observed in
    a. Welding
    b. Boilers
    c. Alloys
    d. Quenching of metals

14**.**A very dangerous form of corrosion which is difficult to monitor is
    a. Galvanic
    b. Pitting
    c. Crevice
    d. Stress

15.The method to overcome the disadvantages of Tafel plot is
    a. Weight loss method
    b. linear polarization
    c. organic coating
    d. non-destructive test

16.In sacrificial anodic protection
    a. an artificial cathode is connected to the metal to be protected
    b. an anodic metal is coated on the surface of the metal to be protected
    c.protection of the metal given by galvanizing the metal
    d. an artificial anode is connected to the metal to be protected

17.…………..is mostly used in sacrificial anode method.
    a. Zinc
    b. Magnesium
    c. Copper
    d. Platinum

18.Corrosion can be prevented by
    a. Alloying
    b. Tinning
    c. Galvanizing
    d. all of above

19.Which of following metals could provide cathodic protection to Fe?
    a. Al & Cu
    b. Al & Zn
    c. Zn & Cu
    d. Al & Ni

20. Galvanization is
    a. acoating Zn on steel
    b. coating steel on steel
    c. coating SiC on steel

   d. coating rubber on steel

21. .What is Tafel equation? Mention its application.
22. How is corrosion minimized by proper designing of equipment?
23. Mention the three visual corrosion testing methods.
24. Indicate the principles of cathodic protection.
25. Describe sacrificial anode with two examples.
26. What is a sacrificial anode? How does it protect a submerged pipeline?
27. Discuss the susceptibility tests for intergranular corrosion.
28. With a neat sketch of diagram, explain the principal and applications of impressed current method.

Apply

1. Area relationship between the anodic and cathodic part in galvanic corrosion. Discuss.
2. Describe alternatives to protective coatings.
3. How Tafel polarization and impedance techniques used to measure the corrosion products?
4. Name any two polarization methods for corrosion testing and monitoring.
5. Mention any two applications of susceptibility test.
6. Differentiate corrosion measurement from corrosion monitoring
7. Define cathodic protection? Under what conditions is this protection more useful?
8. Illustrate Tafel extrapolation polarization for the determination of corrosion rate.
9. Illustrate Tafel extrapolation polarization for the determination of corrosion rate.
10. Illustrate Tafel extrapolation polarization for the determination of corrosion rate.
11. Discuss the determination of corrosion rate by weight loss method.
12. Explain the control of corrosion by the use of sacrificial anodes and by impressed current cathodic protection.

Analyse

1. Explain why corrosion rate of metal is faster in aqueous solution than atmosphere air?
2. Why pitting corrosion is localized corrosion? Explain.
3. Compare the effects of corrosion products.
4. Identify different forms of corrosion in the metal surface.
5. What are the major implications of enhanced techniques of corrosion product analysis?
6. When zinc is coupled to steel and corrosion is tested in various environments, which one of the following happens?
   a. The corrosion rate of steel increases while that of zinc is decreased
   b. The corrosion rate of zinc is increased while that of steel is decreased
   c. The corrosion rates of both decrease
   d. The corrosion rates of both increase
7. Which corrosion control technique is most suitable inthe case of buried iron pipelines?
   1. Sacrificial anodic method
   2. Impressed current cathodic protection
   3. Electroplating
   4. Cathodic inhibitors
8. Outline the draw backs of cathodic protection?
9. For what purpose Mg bars are used in ships?
10. List any four corrosion inhibitors.
11. Discuss the importance of design and material selection in controlling corrosion.
12. Differentiate sacrificial anodic protection from impression current method.
13. Analyze the role of sacrificial anode method in the prevention of corrosion.
14. Explain how corrosion of metals controlled by sacrificial anode technique.
15. Compare sacrificial anode method and impressed current method.
16. List and explain the 6 design rules that should be followed to prevent corrosion.

15GE0C2 ENERGY STORING DEVICES AND FUEL CELLS **3 0 0 3**

Course Objectives

- Understand the concept, working of different types of batteries and analyze batteries used in electric vehicles.
- Identify the types of fuel cells and to relate the factors of energy and environment.
- Analyze various energy storage devices and fuel cells.

Programme Outcomes (POs)

a. **Engineering Knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. **Problem Analysis**: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
d. **Conduct Investigations of Complex Problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

Course Outcomes (COs)

1. Analyze the parameters required for operation of a cell to evaluate the capacity of energy storage devices
2. Identify the electrodes, electrolyte and cell reactions of different types of primary, secondary batteries and infer the selection criteria for commercial battery systems with respect to commercial applications
3. Differentiate fuel cells based on its construction, production of current and applications
4. Identify different methods for the production of hydrogen fuel and its environmental applications
5. Relate energy and environmental based on the importance and types of renewable energy for sustainable development

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
1	3	1										
2	2	3										
3	3	1		1								
4	2	2										
5	3	3		1								

UNIT I

6 Hours

BASICS OF CELLS AND BATTERIES

Components - classification - operation of a cell - theoretical cell voltage - capacity - specific energy - energy density of practical batteries - charge efficiency- charge rate - charge retention - closed circuit voltage, open circuit voltage current density - cycle life - discharge rate-over charge-over discharge.

UNIT II **10 Hours**

BATTERIES FOR PORTABLE DEVICES AND ELECTRIC VEHICLES

Primary batteries- zinc-carbon, magnesium, alkaline, manganous dioxide, mercuric oxide, silver oxide batteries - recycling/safe disposal of used cells. Secondary batteries - introduction, cell reactions, cell representations and applications - lead acid, nickel-cadmium and lithium ion batteries - rechargeable zinc alkaline battery. Reserve batteries: Zinc-silver oxide, lithium anode cell, photogalvanic cells. Battery specifications for cars and automobiles.

UNIT III **10 Hours**

TYPES OF FUEL CELLS

Importance and classification of fuel cells - description, working principle, components, applications and environmental aspects of the following types of fuel cells: alkaline fuel cells, phosphoric acid, solid oxide, molten carbonate and direct methanol fuel cells.

UNIT IV **10 Hours**

HYDROGEN AS A FUEL

Sources and production of hydrogen - electrolysis - photocatalytic water splitting - biomass pyrolysis -gas clean up - methods of hydrogen storage- high pressurized gas - liquid hydrogen type - metal hydride - hydrogen as engine fuel - features, application of hydrogen technologies in the future - limitations.

UNIT V **9 Hours**

ENERGY AND ENVIRONMENT

Future prospects of renewable energy and efficiency of renewable fuels - economy of hydrogen energy - life cycle assessment of fuel cell systems. Solar Cells: energy conversion devices, photovoltaic and photoelectrochemical cells - photobiochemical conversion cell.

FOR FURTHER READING

Energy conservation, Over utilization, Energy demanding activities.

Total: 45 Hours

Reference(s)

1. M. Aulice Scibioh and B. Viswanathan, Fuel Cells: Principles and Applications, University Press, India, 2009.
2. F. Barbir,PEM fuel cells: Theory and practice,Elsevier, Burlington, MA, Academic Press, 2013.
3. M. R. Dell Ronald and A. J. David, Understanding Batteries, Royal Society of Chemistry, 2001.
4. J. S. Newman and K. E. Thomas-Alyea, Electrochemical Systems, Wiley, Hoboken, NJ, 2012.
5. Shripad T. Revankar, Pradip Majumdar, Fuel Cells: Principles, Design, and Analysis, CRC Press, 2016.
6. Thomas B. Reddy, Linden's Handbook of Batteries, 4th Edition, McGraw Hill Professional, 2010

Assessment Pattern

Unit/RBT	Remember				Understand				Apply				Analyse				Evaluate				Create				Total
	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	
1	2	2			1	2	2			1			1	3				1							15
2	4	1			4	5	2			2			1	2				1							22
3	3				4	6	2		1	3			1	1				1							22
4	1	2			4	4	1			4			2	4											22
5	2	2			2	5				3			2	3											19
																								Total	100

Assessment Questions

Remember

1. How galvanic cell is differing from electrolytic cell?
2. How is the potential of an electrochemical cell calculated?
3. List any four characteristics of primary batteries.
4. Mention any two characteristics and applications of zinc-carbon battery.
5. Recognize any two applications and characteristics of primary magnesium batteries.
6. Identify the applications and characteristics of Zn/HgO primary batteries.
7. Indicate any two applications of Zn/alkaline/MnO_2 battery.
8. Mentioned any two applications of Zn/Ag_2O primary battery.
9. Define capacity of a cell
10. Define discharge rate of a battery.
11. Describe the construction, cell reaction and applications of zinc-carbon battery.
12. Explain the construction, chemistry, advantages and uses of mercuric oxide battery.
13. Explain the major components and reaction of direct methanol fuel cell. List two applications.
14. Explain the working principle, components and applications of alkaline fuel cells
15. Discus the conversion of sunlight into electrical power in photoelectrochemical cells.

Understand

1. Mention the five different types of energy storage devices
2. Define the term battery
3. List any two differences between battery and cell.
4. Mention the three major components of cell.
5. Classify the batteries based on their cell reversibility.
6. Define cycle Life of a cell.
7. Explain the construction, cell reaction and applications of silver oxide batteries.
8. With a neat sketch explain the construction and working of phosphoric acid fuel cell.
9. Explain the major components and reactions of direct methanol fuel cell
10. Explain the production of hydrogen photobiochemical conversion cell.

Apply

1. Specific gravity is an indicator of charge in lead acid battery – Justify.
2. Illustrate the process of water electrolysis for the production of hydrogen.
3. How is the potential of an electrochemical cell calculated?
4. How is the potential of an electrochemical cell calculated?

Analyse

1. In the mid-winter car battery is not working –reason out.
2. Discuss the hydrogen energy strategies for sustainable development.
3. How galvanic cell is differing from electrolytic cell?
4. How batteries are rated?
5. Differentiate between primary and secondary batteries.

15GE0C3 POLYMER CHEMISTRY AND PROCESSING **3 0 0 3**

Course Objectives

- Impart knowledge on the basic concepts of polymers and its mechanism
- Use the appropriate polymerization techniques to synthesize the polymers and its processing
- Select the suitable polymers for various applications

Programme Outcomes (POs)

a. **Engineering Knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. **Problem Analysis**: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
c. **Design/ Development of Solutions:** Design solutions for complex engineering problems and design system components or processes that meet the consideration for thepublic health and safety, and the cultural, societal, and environmental considerations.cultural, societal, and environmental cthe cultural, societal, and environmental considerations.

Course Outcomes (COs)

1. Illustrate the types of mechanism of polymerization reactions and analyze the natural and synthetic polymers
2. Identify the suitable polymerization techniques to synthesize the high quality polymers
3. Characterize the polymers to identify the structural, thermal ,mechanical and electrical features for specific applications
4. Apply the polymer processing methods to design polymer products
5. Identify and analyze the polymers used in electronic and biomedical applications

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
1	2	1										
2	1	2										
3	2	2										
4	1	1	2									
5	1	3	2									

UNIT I

10 Hours

POLYMERS AND ELASTOMERS

Classification of polymers - Mechanism: Addition polymerization - free radical polymerization - cationic, anionic and co-ordination (Ziegler-Natta) polymerization, copolymerization, condensation polymerization (nylon-6,6) ring opening polymerization (nylon-6). Elastomers: Natural rubber - vulcanization - synthetic rubber: styrene -butadiene rubber (SBR), butyl, neoprene, thiocol rubbers. High performance polymers: polyethers, polyether ether ketone(PEEK), polysulphones, polyimides.

UNIT II **8 Hours**

POLYMERIZATION TECHNIQUES

Homogeneous and heterogeneous polymerization - bulk polymerization (PMMA, PVC) solution polymerization - polyacrylic acid, suspension polymerization (ion-exchange resins) - emulsion polymerization (SBR) - advantages and disadvantages of bulk and emulsion polymerization. Melt solution and interfacial poly-condensation.

UNIT III **8 Hours**

CHARACTERIZATION AND TESTING

Characterization of polymers by Infrared Spectroscopy (IR) and Nuclear Magnetic Spectroscopy (NMR) - Thermal properties by TGA and DSC, Testing tensile strength, Izod impact, Compressive strength, Rockwell hardness, Vicot softening point. Test for electrical resistance, dielectric constant, dissipation factor, arc resistance and dielectric strength - water absorption.

UNIT IV **9 Hours**

POLYMER PROCESSING

Moulding: Compression - injection - extrusion and blow mouldings. Film casting - calendering. Thermoforming and vacuum formed polystyrene - foamed polyurethanes. Fibre spinning: melt, dry and wet spinning. Fibre reinforced plactics fabrication: hand-layup - filament winding and pultrusion.

UNIT V **10 Hours**

SPECIALITY POLYMERS

Preparation and properties of heat resistant and flame retardant polymers. Polymers for electronic applications: liquid crystalline, conducting and photosensitive polymers. Polymer for biomedical applications: artificial organs, controlled drug delivery, hemodialysis and hemofiltration.

FOR FURTHER READING

Biodegradable polymers

Total: 45 Hours

Reference(s)

1. V. R. Gowarikar, N. V. Viswanathan and Jayadev Sreedhar, Polymer Science, New Age International (P) Ltd., New Delhi, 2015.
2. Joel R. Fried, Polymer Science and Technology, Prentice Hall of India (P). Ltd., 2014
3. F. W. Billmeyer, Text Book of Polymer Science, John Wiley & Sons, New York, 2007
4. Barbara H. Stuart, Polymer Analysis, John Wiley & Sons, New York, 2008
5. George Odian , Principles of Polymerization, John Wiley & Sons, New York, 2004
6. R. J. Young and P. A. Lovell, Introduction to Polymers, CRC Press, New York, 2011

Assessment Pattern

Unit/RBT	Remember				Understand				Apply				Analyse				Evaluate				Create				Total
	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	
1	1	1	3		2	2	3		2	2	3		1	1	1										22
2	1	1	4		1	1	3		1	1	3		1	1											18
3	1	1	1		1	1			1	2	2			2			1	1	4						18
4	1				1	2	2		3	2	2		2	2	1								2		20
5	1	1	1		2	2	1		2	2	3		2	2	3										22
																								Total	100

Assessment Questions

Remember

1. Recall two factors that govern termination of cationic polymerization.
2. Identify the monomers used in styrene -butadiene rubber.
3. Give an examples for the thermosetting and thermoplastic polymers.
4. What is copolymerization? Give an example
5. Name two synthetic polymers which are used for making textile fibres.
6. Define the role of Ziegler – Natta catalysts
7. List the examples of Ziegler – Natta catalysts.
8. Identify the four types of polymerization technique.

9. List any two disadvantages of suspension polymerization.
10. Point out the advantages of bulk polymerization technique.
11. Why does natural rubber need compounding?
12. List any four applications of injection moulding process.
13. List the various additives in processing of plastics.
14. List the two properties of heat resistant polymers .
15. Mention the application of flame retardant polymers.

Understand

1. Classify the polymers based on source
2. Discuss the addition and chain growth polymerization with example
3. Compare addition and condensation polymerization reaction with example for each type .
4. Explain homogeneous and heterogeneous polymerization.
5. Explain the mechanism involved in addition polymerization of vinylChloride
6. Explain the condensation polymerization method taking nylon 6,6,nylon synthesis as a representative example.
7. Discuss the preparation method and any three properties of Polysulphone.
8. Summaries the salient features, advantages and disadvantages of bulk and emulsion polymerization techniques.
9. Compare the homogeneous and heterogeneous polymerization method.
10. With a neat sketch, discuss the functioning of melt, dry and wet spinning process.
11. Illustrate the compression and extrusion moulding of plastics with diagram neat diagram.
12. Explain the coordination polymerization mechanism using a sutable example.

Apply

1. Relate the various steps involved in anionic and cationic polymerisation using suitable examples.
2. Select the suitable polymerization techniques for synthesis of PMMA and SBR
3. Assess the characterisation techniques used to find the structure of polymer .
4. Find the method to process the composite materials with example.
5. Execute the filament – winding Technique for manufacturing of rocket motor bodies.

Analyse

1. Distinguish between addition and condensation polymerisation.
2. Natural rubber need vulcanization –Justify.
3. Compare the salient features, advantages and disadvantages of solution and suspension polymerization techniques.
4. Bring out the differences between thermoforming and vacuum-forming process.
5. Outline the applications of polymer in controlled drug delivery and artificial organs.

Evaluate

1. Judge the biomedical applications of polymers in Hemo dialysis and hemo filtration.
2. Choose the suitable moulding Technique for polyvinyl chloride.

15EE0YA ENERGY CONSERVATION AND MANAGEMENT 3 0 0 3

Course Objectives

- To understand the need for energy conservation and current trends.
- To identifying energy conservation opportunities in mechanical equipment.
- To fix the energy saving potential targets for individual cost centers.

Programme Outcomes (POs)

a. **Engineering Knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

b. **Problem Analysis:** Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

g. **Environment and Sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

i. **Individual and Team Work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

k. **Project Management and Finance**: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

Course Outcomes (COs)

1. Explain the importance of Indian energy scenario and energy conservation act features.
2. Apply the energy conservation technique in electro mechanical devices and HVAC systems
3. Choose the suitable energy audit technique using appropriate tools to improve the system efficiency
4. Analyze the different financial technique adopted in energy management system
5. Exemplify the role of energy efficiency, features, demand side management and barriers in electrical system

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	1	2					2						3	
2	2	1											2	3
3	1	2							1		2		2	1
4	2	1							1		2		3	
5	1	2					1						2	1

UNIT I **10 Hours**

ENERGY SCENARIO

Commercial and Non-commercial energy, primary energy resources, commercial energy production, final energy consumption, Indian energy scenario- energy needs of growing economy, energy intensity, energy conservation and its importance-Energy Conservation Act 2001 and its features.

UNIT II **8 Hours**

ELECTRICAL ENERGY CONSERVATION

Input electrical energy requirements in pumps, fans, and compressors-load factor estimation in the equipments - Energy conservation potential -Electrical energy conservation in refrigeration and A/C system -Operation and maintenance practices for electrical energy conservation Case examples.

UNIT III **8 Hours**

ENERGY MANAGEMENT

Definition, energy audit, need, types of energy audit. Energy management (audit) approaches-understanding energy costs- Benchmarking, energy performance, matching energy use to requirement, maximizing system efficiencies, fuel and energy substitution, energy audit instruments and metering.

UNIT IV **10 Hours**

FINANCIAL MANAGEMENT

Investment-need, appraisal and criteria, financial analysis techniques simple payback period, return on investment, net present value, internal rate of return, cash flows, risk and sensitivity analysis; financing options, and - elements of monitoring system.

UNIT V **9 Hours**

ENERGY EFFICIENCY AND DEMAND SIDE MANAGEMENT

Basic concepts-Importance of demand side managements- Efficiency gains-Estimation of energy efficiency potential-Cost effectiveness- Barriers for energy efficiency and DSM.

FOR FURTHER READING

Energy conservation and management -case studies

Total: 45 Hours

Reference(s)

1. Jose Golden Berg; Thomas Johansson, A K N Reddy ,Robert Williams - Energy for a sustainable world, Wiley Eastern.
2. BEE reference book 1/2/3/4
3. Albert Thumann,Terry Niehus, Handbook of Energy Audits, 2012 Ninth Edition
4. Charles E Brown, Springer, 2012,World Energy Resources
5. Energy Conservation In Process Industry, - W. F. Kenny
6. Energy Engineering and Management - Amlan Chakrabarti - Prentice hall India 2011

Assessment Pattern

Unit/RBT	Remember				Understand				Apply				Analyse				Evaluate				Create				Total
	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	
1		8				8					2				2										20
2		4				8					4				4										20
3		2				4				4					6				4						20
4	4					2				5					5				4						20
5						4					8				4				4						20
																								Total	100

Assessment Questions

Remember

1. Recall the need of energy audit.
2. State Faraday’s law of electromagnetic induction.
3. Recognise the features of energy policy
4. Define energy
5. List the advantages high powerfactor
6. Â List the drawbacks of low power factor.
7. State the uses of any two energy audit equipments
8. List the various losses occur in Induction machines
9. List the types of energy audit
10. Recall the concept of ROI

Understand

1. Explain the various types of energy audit in detail
2. Classify the various energy audit types
3. Infer the reason behind connecting domestic appliances in parallel
4. Summarise your inference about Â energy scenario in India.
5. Identify various measurements required in energy auditing
6. Explain the steps in an energy audit report generation
7. Explain the various components of power triangleWith relevant diagram
8. Classify the instruments required for an Energy Audit.
9. Explain in brief the following:
   (i) Renewable and nonrenewable energy.
   (ii) Commercial and Noncommercial energy
   (iii) Low grade and High grade energy
   (iv) Energy security

10. Formulate Indian energy scenario and energy intensity.

Apply

1. A load of 500KW at 0.8 of is taken by an industrial user.The tariff plan Rs 400/KVA of maximum demand per annum +Rs 1.00 per unit of energy consumed.The cost of installation of capacitor bank for pf improvement is Rs.600 per KVAR and as an annual interest and depreciation of 11%,Find
   i) Most economical power factor
   ii) Annual saving in energy bills
2. A toroidal air cored coil with 2000 turns has a mean radius of 25cm, diameter of each turn being 6cm. If the current in the coil is 10A, find mmf, flux, reluctance, flux density and magnetizing force.
3. A load of 500KW at 0.8 of is taken by an industrial user.The tariff plan Rs 400/KVA of maximum demand per annum +Rs 1.00 per unit of energy consumed.The cost of installation of capacitor bank for pf improvement is Rs.600 per KVAR and as an annual interest and depreciation of 11%,Find
   i) Most economical power factor ii) Annual saving in energy, energy saving in kWh and cost
4. An industrial undertaking has connected load of 100 KW.The maximum demand is 80KW. ON an average the plant is in operation for 60% time. Find yearly bill on electricity if the tariff is : Rs 6000 + Rs 600 per KW of maximum demand perÂ annum + Rs. 1.8 per unit of energy consumed.
5. An industrial undertaking has connected load of 1000 KW.The maximum demand is 80KW. ON an average the plant is in operation for 60% time. Find yearly bill on electricity if the tariff is : Rs 5000 + Rs 900 per KW of maximum demand perÂ annum + Rs. 3.5 per unit of energy consumed.
6. Select methodology for the study of Lighting system Energy Efficiency.
7. Predict: (1) AC & DC Current (2) Apparent power (3) Reactive power (4) Active power (5) power factor (6) kilowatt hour (7) maximum demand (8) load factor (9) time of day tariff.
8. Demonstrate the relation between energy consumpation and production using graph and bar chart method.
9. Construct the Energy conservation Act 2001 and its features
10. Compute the key elements of Energy monitoring and targeting system. Also discuss its benefits.

Analyse

1. Predict the equations for the power factor improvement used in industry
2. Structure the expressions for ROI and NPV
3. Compare preliminary audit with the detailed energy audit.
4. Attribute the account of Energy conservation Act – 2001.

5. A co-generation plant installation is expected to reduce a company's annual energy bill by Rs.24 lakhs. If the capital cost of the new cogeneration installation is Rs.90 lakhs and the annual maintenance and operating costs are Rs. 6 lakhs, What will be the expected pay back period for the project
6. A portable machine requires a force of 250 N to move it. How muchwork is done if the machine is moved 25 m and what average power isutilized if the movement takes 50s
7. Justify the following :
   (i) Reactive power and Active power
   (ii) Explain the importance of TOD (time of the day) tariff

Evaluate

1. Choose the different energy audit and the outcome of the audit
2. Determine the phase relation in pure resistor
3. Defend the rewinding effects of motors on their energy efficiency
4. Outline initiatives taken up by Bureau of Energy Efficiency
5. Critise factors affecting the energy efficiency of Refrigeration plants
6. Choose a methodology for the study of Lighting system Energy Efficiency

Create

1. Derive the expression for RMS, average value, peak and form factor of sinusoidal voltage and how will be useful in energy audit measurement.
2. Derive the various tariff option used in an industry

15EE0YB ILLUMINATION SYSTEMS

3 0 0 3

Course Objectives

- To impart knowledge on illumination.
- To determine the calculation and measurement of illumination.
- Design for interior lighting and exterior lighting .

Programme Outcomes (POs)

a. **Engineering Knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. **Problem Analysis**: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
c. **Design/ Development of Solutions**: Design solutions for complex engineering problems and design system components or processes that meet the consideration for thepublic health and safety, and the cultural, societal, and environmental considerations.cultural, societal, and environmental considerations.

Course Outcomes (COs)

1. Explain the fundamentals of illumination.
2. Analyze the characteristics of different lights.
3. Apply the basic terms in calculation of illumination and understand the accessories.
4. Design the lighting procedure for interior environments.
5. Design the lighting procedure for exterior environments.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3	1											1	
2	2	3												3
3	2	1											1	
4	2		3										3	2
5	2		3										3	2

UNIT I **10 Hours**

INTRODUCTION OF LIGHTING

Types of illumination, Day lighting, supplementary artificial lighting & total lighting, quality of good lighting, factors affecting the lighting-shadow, glare, reflection, colour rendering & stroboscopic effect, methods of artificial lighting -lighting system - direct, indirect, semi direct, semi indirect. Lighting scheme-general and localized.

UNIT II **8 Hours**

LIGHT SOURCES

Daylight, Incandescent, Electric Discharge, Arc lamps, Fluorescent , LED lamps- Luminaries.

UNIT III **10 Hours**

CALCULATIONS AND MEASUREMENTS

Definition of terminologies, laws of illumination- Inverse square law and Lambert's cosine law, illumination at horizontal and vertical plane from point source, Calculation of luminance and illumination.

UNIT IV **8 Hours**

INTERIOR LIGHTING

Lighting design procedure for Industrial, Residential, Office, Auditorium and Hospitals - Case studies.

UNIT V **9 Hours**

EXTERIOR LIGHTING

Environment and glare, Lighting Design procedure for Flood, Street, Sports lighting.

FOR FURTHER READING

Quantity and Quality of Lighting, Switching & Control circuits ,Photometry and Spectro - photometry, photocells

Total: 45 Hours

Reference(s)

1. Joseph B. Murdoch, Illumination Engineering from Edisons Lamp to the Laser, Visions Communications, Washington DC,USA, 1994.
2. Jack L. Lindsey, Applied Illumination Engineering, Prentice Hall of India, New Delhi, 2008.
3. Marc Schiler, Simplified Design of Building Lighting, John Wiley and Sons, 1997.
4. IES Lighting Handbook, 1993.
5. N. Jenkins,'Wind Energy Technology' John Wiley & Sons,1997
6. S.Heir, 'Grid Integration of WECS', Wiley 1998.

Assessment Pattern

Unit/RBT	Remember				Understand				Apply				Analyse				Evaluate				Create				Total
	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	
1	1	1			2	12			1				1				2								20
2	1	1			2	12			1				1				2								20
3	1	1			2	12			1				1				2								20
4	1	1			2				1				1				2	12							20
5	1	1			2	12			1				1				2								20
																								Total	100

Assessment Questions

Remember

1. Recall the laws of illumination
2. Define the illumination
3. Define lamp efficiency.
4. Define luminous intensity
5. Define reflection factor
6. Recall the concept of stroboscopic effect
7. Listthe advantage and disadvantage of discharge lamp over incandescent lamp
8. List the main fault in lighting system
9. Give the advantages & disadvantages of high pressure mercury vapor lamps over filament lamp
10. Define space height ratio

Understand

1. Explain the properties of light
2. Illustrate the construction and working of C.F.L.
3. Illustrate the working of fluorescent lamp.
4. Identify the importance of reflectors and refractors with reference to illumination
5. Infer Â the factors of good lighting design in detail
6. Explain plane angle and solid angle. Also derive the relation between them
7. Explain with a neat sketch the principal of working of vapor lamp and identify the Advantages and disadvantages as source of light
8. Compare the different dimmers used in illumination control. Describe the operation of any one type.
9. Compare the different dimmers used in illumination control. Describe the operation of any one type.
10. Compare the different dimmers used in illumination control. Describe the operation of any one type.
11. Discuss the type of glare and remedies over them.

Apply

1. Room 12m X 8m X 4m is to have indirect lighting giving illumination of 80 lux on working plane, 70cm above the floor. Coefficient of utilization is assumed to be 0.5 & the maintenance factor is 0.8 find out the no. of lamps & their rating lamp efficiency may be taken as 1475 lumen / watt
2. A projector lamp gives out 2000 lumens & has beam divergence of 16 degree. If the beam factor is 0.75, calculate the average illumination on the surface 60m away & normal to the source of light. What will be the illumination if the surface is rotated through 60 degrees.
3. A room 17m X 4m is to be illuminated by 16,200w lamp .The MSCP of each lamp is 250. Assume maintenance factor o
4. What is polar curve? Describe its types and How it helpful for an engine
5. A student's desk top is 2.5 m from a 1750 lm lamp. What is the illumination of the desk top?
6. A surface is illuminated by a 32 cd bulb. What is the bulb's luminous flux? If the bulb is located 2m from the surface, what is the surface's illumination?
7. A 64 cd source is 3 m above the surface of a desk. What is the illumination of the surface?

8. A photometer is used to compare the illumination of two bulbs. It is positioned until it is equally illuminated by each bulb. If it is 75 cm from a 50 cd source, how far is it from a 65 cd source?

Analyse

1. Which lamps are used for malls, supermarkets why?
2. Analyse the ways to detect and prevent glare.
3. Differtiate Incandescent lamp and fluorescent lamp
4. Differtiate LED lamps and fluorescent lamp
5. Differtiate Incandescent lamp and LED lamps
6. Compare various methods for controlling natural light
7. Compare the sodium vapor lamp and CFL Lamps on the basis ofÂ Efficiency, lumen output, cost, life span, maintenance, fittings
8. Compare the filament and fluorescent lamps on the basis of quality of light, capital and running cost, lamp efficiency, colour index
9. Analyse the ways to reduce energy consumption in ligting systems
10. Analyse the ways to reduce energy consumption in ligting systems

Evaluate

1. Evaluate the ways to correct poorly distributed light

Create

1. Design and implement of office lighting
2. Design a LED source modeling

15EE0YC VALUE ENGINEERING

3 0 0 3

Course Objectives

- To understand the concept of value engineering in order to reduce cost of product or process or service.
- To implement creative and innovative techniques using FAST diagram.
- To study benefits of Value Engineering for various industries.

Programme Outcomes (POs)

j. **Communication**: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, ande and receive clear instructions.

k. **Project Management and Finance**: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one’s own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

l. **Life-long Learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Course Outcomes (COs)

1. Apply the concepts of value and value engineering to prepare a job plan
2. Analyse the cost and worth of a product/service using the principles of economics
3. Evaluate the value of a product/service to take managerial decisions
4. Apply the softskills in understanding team building, team work and report writing
5. Asses the functions and values of product/services in industries using case studies

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1											3		1	
2										1	3		2	2
3											3		2	1
4										1	3	2	1	
5										2	3		2	1

UNIT I **8 Hours**

INTRODUCTION TO VALUE ENGINEERING

Historical perspective of Value Engineering, Aims and objectives of Value Engineering , Concept of Value, Value Engineering concerned with Economic Value , Value Engineering Job plan.

UNIT II **9 Hours**

FUNCTIONAL ANALYSIS

Function-Cost-Worth analysis: Function Analysis System Technique (FAST); Review of principles of engineering economics

UNIT III **10 Hours**

EVALUATION OF VE

Evaluation of function, Problem setting system, problem solving system, setting and solving management - decision - type and services problem, evaluation of value

UNIT IV **9 Hours**

HUMAN ASPECTS IN VALUE ENGINEERING

Team building; Life cycle costing; Managing Value Engineering Study; Value EngineeringReport writing; Presentation Skill - Individual and Team Presentations; Implementation and follow-up.

UNIT V **9 Hours**

BENEFITS OF VALUE ENGINEERING

Value Engineering Case studies in the Industries like Manufacturing; Construction; Health Care; Process.

FOR FURTHER READING

Problem identification and selection of projects- Review of principles of engineering economics- evaluation of value- Implementation and follow-up- Information Technology

Total: 45 Hours

Reference(s)

1. Anil Kumar Mukhopadhyaya, Value Engineering Mastermind - From Concepts to Certification, Response. Business Books from SAGE, Los Angeles / London / New Delhi / Singapore / Washington DC, 2014.
2. Anil Kumar Mukhopadhyaya, Value Engineering -Concepts, Techniques and Applications, Response Books, A Division of SAGE Publications, New Delhi / Thousand Oaks / London, 2003
3. R. D. Miles, Techniques of Value analysis & Engineering, McGraw Hill, 2000.
4. E. Midge Arthur, Value Engineering -A Systematic Approach, McGraw Hill Book Co., New York, 2000.
5. Zimmerman, Value Engineering - A Practical Approach, CBS Publishers & Distributors, New Delhi, 2000.

6. G.N.Tiwari, Solar Energy-Fundamentals, Design,Modeling and Applications,Narosha Publishing House Ltd.,2002

Assessment Pattern

Unit/RBT	Remember				Understand				Apply				Analyse				Evaluate				Create				Total
	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	
1	2					2			1	3					12										20
2		2								2	2								14						20
3		2				2					4								12						20
4		2							1	3									14						20
5	2					2			2	2									12						20
																								Total	100

Assessment Questions

Remember

1. Define value engineering.
2. List the key elements of Value Engineering
3. List various components of economic value.
4. Expand INVEST.
5. Remember the Aims and objectives of Value Engineering.
6. Remember the History of Value Engineering.
7. What is worth of a function?
8. What is return on investment?
9. When is the best time to perform a Value Engineering analysis? Before the Record of Decision, after the Record of Decision?
10. What is the proper team size for a Value Engineering team, and how long it should do a analysis ?

Understand

1. Distinguish between value analysis and value management.
2. Unerstand the Steps involved in Value Engineering job plan.
3. Distinguish between value gap and value index.
4. List the blocks for creative thinking.
5. Understand the Ways of transformation in team building.
6. Understand theTypes of conversation between two persons.
7. How to Calculate the pay back period?
8. Understand the Roles of Value Engineering professional societies.
9. Can a waiver or exemption be granted for the requirement to conduct a Value Engineering analysis?

Apply

1. Apply the three methods of Value Engineering to be done during the development or environmental phase without negatively impacting the environmental agreements.
2. Apply the Method of deriving life cycle cost for any product.
3. Concern about the concepts of six thinking hats in parallel thinking process.
4. What if any penalties can and should be assessed against a State DOT if an applicable project does not receive a Value engineering analysis?
5. Discuss TWO short-term tactical cost reduction initiatives and TWO longer term strategic cost reduction approaches that BCAM could have adopted to achieve a reduction in their costs.
6. Apply THREE potential benefits to Value analysis of adopting collaborative supply chain relationships.
7. Apply a range of IT/ICT tools that could have been applied by value analysis to improve the performance of its supply chain.
8. Apply the project team and senior managers with more informed decisions so that they can select ideas that fit their strategic plans?

9. Apply the human aspects in value engineering to make functional analysis of any product of your choice.
10. With a case study apply any management tool in developing a product with maximum rate of return.

Analyse

1. Does performing a Value Engineering analysis also qualify for meeting the requirement to perform a Life-Cycle Cost analysis? Likewise, does performing a life-cycle cost analysis or benefit/cost analysis qualify as a Value Engineering review?
2. Are all the different Value Engineering methods (recognized techniques) acceptable to FHWA, since no specific requirements are mentioned in the law?
3. Analyse Feature-function-matrix for a screwdriver.
4. Analyse Function-cost-worth-analysis for any one product/process/service as per your choice.
5. Analyse Value Engineering concept for any one product/process/service as per your choice

Evaluate

1. Evaluate the Steps in technically oriented FAST diagram
2. EvaluateFAST diagram for any one product/process/service as per your choice.
3. Evaluate Value Engineering steps for water bottle
4. Evaluate Function-Cost-Worth analysis for Ballpoint pen.
5. Evaluate any product of your choice using functional analysis with cost effective production.

Create

1. You are responsible for conducting a Value Engineering exercise on a *Shopping Mall* project.As part of the study, your team develops a life-cycle cost model to help them determine which elements of the shopping mall would be most productive for Value Engineering.Â Â Draw the Cost Model, and complete any one of the branches with example cost parameters.
2. A developer has a sum of money to invest in the development of a facility at a site. Using Value Engineering techniques they identify three alternative facilities that they could build at the site, which would provide a significant return on the investment. These are1. Leisure Facility 2.Shopping Mall 3.An Office Block.

15EE0YD INDUSTRIAL DRIVES AND CONTROL

3 0 0 3

Course Objectives

- To study the industrial control methods of AC and DC drives
- To Understand the theory and applications of Industrial AC and DC drive systems
- To analyze the operation of Artificial-Intelligence Based drive

Programme Outcomes (POs)

a. **Engineering Knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

b. **Problem Analysis:** Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

c. **Design/ Development of Solutions**: Design solutions for complex engineering problems and design system components or processes that meet the consideration for thepublic health and safety, and the cultural, societal, and environmental considerations.cultural, societal, and environmental considerations.

e. **Modern Tool Usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

Course Outcomes (COs)

1. Explain the operation and control techniques for industrial AC/DC Drives.
2. Apply the solid state speed control schemes for induction motor drives.
3. Compare steady state and transient performances of dc drives.
4. Apply control techniques for synchronous motor drives.
5. Compute Artificial-Intelligence Techniques for Industrial drives

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3												1	
2		2											2	3
3		2											2	1
4			2										1	
5					3								2	1

UNIT I **10 Hours**

INTRODUCTION TO MOTOR CONTROL

Motors - Load system, Dynamics, load torque, - Speed control and multi quadrant operation, Braking of series and separately excited DC motor, speed torque characteristics of induction motor and DC Motors - Control strategies for AC and DC drives.

UNIT II **9 Hours**

INDUCTION MOTOR DRIVES

Variable frequency operation of 3-phase inductions motor Drive -Scalar control - Principle of vector or field oriented control - Direct and Indirect vector control- Constant torque operations- Case study: FPGA based Industrial control of induction motor

UNIT III **8 Hours**

DC MOTOR DRIVES

Starting, Braking and Speed Control- Open and Closed loop control- Transient analysis of separately excited motor with armature and field control, Chopper Control DC drives, Case study: ARM processor based industrial DC drive system; PLC based industrial DC drive system.

UNIT IV **10 Hours**

SYNCHRONOUS MOTOR DRIVES

Principles of synchronous motor control - Adjustable frequency control - Voltage Source Inverter Drive with open loop control, Self controlled Synchronous motor with electronic commutation and load commutated thyristor inverter - Principle of Vector control. Case study: DSP processor based Synchronous Motor drives.

UNIT V **8 Hours**

ARTIFICIAL-INTELLIGENCE BASED DRIVES AND APPLICATIONSMAND SIDE MANAGEMENT

AI-Based Techniques - Applications in Electrical Machines and Drives - Neural-Network Based Drives - Commercial AI based Drives -Fuzzy Logic Concept- Applications of Fuzzy Logic to Electric Drives - Selection of drives -Steel rolling mills, Paper mills, Lifts and Cranes, Sugar mills.

FOR FURTHER READING
Neuro-fuzzy based control of DC drives, Design of AC drives using Brain Emotional Learning Based Intelligent Controller, Varialbe frequency control of multiple synchronous motor drives

Total: 45 Hours

Reference(s)

1. Bimal K Bose, "Power Electronics and Variable Frequency Drives - Technology and Application", IEEE Press, 1997.
2. Gopal K Dubey, Fundamentals of Electric Drives, Narosa Publishing House, New Delhi, 2005.
3. Peter Vas, "Vector Control of AC Machines", Oxford University Press, 1990.
4. Ned Mohan, Advanced Electric Drives: Analysis, Control and Modeling using Simulink, John Wiley and Sons Ltd, 2001
5. Peter Vas, Artificial-Intelligence-based Electrical Machines and Drives, Oxford University Press, 1999.

Assessment Pattern

Unit/RBT	Remember				Understand				Apply				Analyse				Evaluate				Create				Total
	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	F	C	P	M	
1	1	2			1	12			1					1				2							20
2	1	2			1	2			12					1				1							20
3	2	1				2			1					1				12				1			20
4	1	1			2	6			6					1				2				1			20
5	1	2			1	12			1					2				1							20
																								Total	100

Assessment Questions

Remember

1. List the typical elements of an Electric Drive
2. List the different ways of speed control in dc motors?
3. List the control strategies of DC drives
4. State the different types of electric braking.
5. Define load diagram
6. Define dynamics of motor.
7. Define scalar control and Vector Control
8. State the principle of synchronous motor
9. Define duty cycle.
10. Define DC Chopper.

Understand

1. Illutrate the functional elements of Electric drive system.
2. Clarify the Speed-Torque characteristics of three phase induction motor with neat diagrams.
3. Enlighten about the speed-torque characteristics of a DC Shunt Motor with suitable graph and equations.
4. Exemplify the working of chopper control of DC Motors.
5. Illustrate the operation of Direct and Indirect vector control of induction motor
6. Illustrate the working of Neural-Network Based induction motor speed control.
7. Illustrate the operation of Self controlled Synchronous motor with electronic commutation and load commutated thyristor inverter
8. Explain the Voltage Source Inverter Drive with open loop control of synchronous motor.
9. Illustrate the working of armature and field control of DC motor using fuzzy network
10. Classify and explain the Braking methods of DC drives

Apply

1. A 400 V, 750 r.p.m 70 A dc shunt motor has an armature of 0.3 ohm. When running under rated conditions, the motor is to be braked by plugging with armature current limited to 90A.what external resistance should be connected in series with the armatureCompute the initial braking torque and its value when the speed has fallen to 300 rpm. Neglect saturation.
2. A starter required for a 220V shunt motor. The maximum allowable current is 55 A and the minimum current is about 35 A. Find the number of starter resistance required and the resistance of each section. The armature resistance of the motor is 0.4 ohm.
3. A three phase delta connected cage type induction motor when connected directly to 400 V, 50 HZ supply takes a starting current of 100 A in each stator phase. Calculate (i).line current on direct on line starting.(ii).line and phase starting currents for star-delta starting.(iii).line and phase starting currents for a 70% tapping on autotransformer starting.
4. Choose and justify the proper motor for the following applications: steel rolling mills, paper mills, lifts, cranes and sugar mills
5. Speed of 200V series motor is 800 RPM and takes 60 A. If 1/3 of the field turns are cut out, find out the speed, assuming torque to remain constant. Armature resistance is 0.2 ohms and field winding resistance is 0.21 ohms.
6. A 200 V, 10.5 A, 2000 rpm shunt motor has the armature and field resistance of 0.50 and 400 respectively. Its drives a load whose torque is constant at rated motor torque. Calculate the motor speed if the source voltage drops to 175 V.
7. A 230V, DC shunt motor, takes an armature current at 3.33A at rated voltage and at a no load speed of 1000RPM. The resistances of the armature circuit and field circuit are 0.3 ? and 160 ? respectively. The line current at full load and rated voltage is 40A. Calculate, at full load, the speed and the developed torque in case the armature reaction weakens the no load flux by 4%.
8. Select and justify the proper artificial intelligence based control for AC and DC drives.
9. 3300V,3 phase synchronous motor running at 1500 rpm has its excitation kept constant corresponding to no-load terminal voltage of 3000V. Determine the power input, power factor and torque developed for an armature current of 250A if the synchronous reactance is 5 ? per phase and armature resistance is neglected.
10. A 3300V,10 pole ,50HZ three phase star connected induction motor has slip ring rotor resistance per phase =0.015 ohm and standstill reactance per phase =0.25 ohm .If the motor runs at 2.5 percent slip on full load ,find Speed of the motor ,Speed at which the torque will be maximumÂ and the ratio of maximum torque to full load torque

Analyse

1. Compare AC and DC drives
2. Compae the Control strategies of AC and DC drives
3. Differentiate the fuzzy and neural network based drives.
4. Compare electronic commutation and load commutated thyristor inverter for synchronous motor.
5. Compare direct and indirect vector control

Evaluate

1. Determine the Speed torque characteristics of Induction motor and DC shunt motor forÂ pumping system
2. Defend , how the vector control is better than the scalar control
3. Evaluate the performance ofÂ FPGA based induction motor speed control
4. Evaluate the performance of VSI fed synchronous motor drive.
5. Determine the performance of vector controlled Induction motor drive
6. Determine the performance of PLC based industrial DC drive system

Create

1. Create a new PLC based closed loop DC drive system by yourself for installing a DC drive at your factory.
2. Generalize the existing ARM processor based industrial DC drive system with DSP.

15EE0XA EMBEDDED CONTROL OF ELECTRIC DRIVES 1 0 0 1

Course Objectives

- To provide introduction on Electric drives and their purposes.
- To bring awareness about basic elements of automation - Sensing, Actuation and Control.

Programme Outcomes (POs)

a. **Engineering Knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

c. **Design/ Development of Solutions:** Design solutions for complex engineering problems and design system components or processes that meet the consideration for thepublic health and safety, and the cultural, societal, and environmental considerations.cultural, societal, and environmental considerations.

d. **Conduct Investigations of Complex Problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

Course Outcomes (COs)

1. Analyze the AC drives, DC drives and servo drives
2. Explain the controllers and sensing units

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	1	-	2	3									1	
2	3		2	1	-								1	1

UNIT I

Introduction to Electric Drives AC Drives, DC Drives, Servo Drives Selection of Electric Drives as per application, Basic components of Drives Control Introduction to Controllers : PLC, Microcontrollers Introduction to Sensing Circuits Basic Control Algorithms: On/Off Control, Hysteresis Control, P, PI, PID control Control of AC Drives - VFD and TRIAC Firing Angle control Control of DC Drives - PWM Control Bi-Directional Control using DIR input Position Control using Encoders Voltage and Current Control Fault Detection

Total: 15 Hours

Reference(s)

1.Vedam Subramanyam,"Electric Drives: Concepts and Applications", Tata McGraw-Hill, New Delhi, 2004.
2.Hamid A. Toliyat, "DSP Based Electromechanical Motion Control", 1st Edition, CRC Press, 2004.

15EE0XB DESIGN OF EMBEDDED SYSTEM FOR DC MOTOR CONTROL 1 0 0 1

Course Objectives

- To introduce Motor Control Applications and chip-sets available in market.
- To bring awareness about basic elements of automation - Sensing, Actuation and Control

Programme Outcomes (POs)

a. **Engineering Knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. **Problem Analysis**: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
c. **Design/ Development of Solutions**: Design solutions for complex engineering problems and design system components or processes that meet the consideration for thepublic health and safety, and the cultural, societal, and environmental considerations.cultural, societal, and environmental c
d. **Conduct Investigations of Complex Problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

Course Outcomes (COs)

1. Analyze the motor control using embedded system.
2. Acquire knowledge on selection of motor control drives.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	1		2	3									1	
2	1	2		3	-								1	

UNIT I **15 Hours**

DESIGN OF EMBEDDED SYSTEM FOR DC MOTOR CONTROL

Introduction to Motor Control Differences between DC, BLDC, Stepper and Servo MotorsMicrocontrollers – Basics Motor control Peripherals,ADC, Digital Ports, PWM, Capture Unit, Compare Unit, Comparison of Microcontrollers for Motor Control in the market,TI, ST, Atmel, Microchip Selection of External Motor Control Drivers, Importance of Optocouplers, Over Voltage / Current detection PWM control basics Current Sensing Circuit and Current Control Bi-Directional Control using H-Bridges Position Control using Encoders Fault Detection

Total: 15 Hours

Reference(s)

1. Ion Boldea and Nasar S A, "Electric Drives", CRC Press LLC, New York, 2005.
2. Bose B K,"Modern Power Electronics and AC Drives", Pearson Education, New Delhi, 2003.

15EE0XC AUTOMOTIVE ELECTRONICS

1 0 0 1

Course Objectives

- To introduce automotive mechanical system.
- To bring awareness about electronic systems and engine management systems

Programme Outcomes (POs)

a. **Engineering Knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

b. **Problem Analysis:** Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
c. **Design/ Development of Solutions**: Design solutions for complex engineering problems and design system components or processes that meet the consideration for thepublic health and safety, and the cultural, societal, and environmental considerations.cultural, societal, and environmental considerations.
e. **Modern Tool Usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

Course Outcomes (COs)

1. Explain the automotive mechanical system
2. Analyze the electronic system and engine management systems

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	1	-	2		3								1	
2	1	2	3		-								2	

UNIT I **5 Hours**

AUTOMOTIVE MECHANICAL SYSTEM

Vehicle systems, Power Train System (Air system, Fuel system (Carburetor & Diesel Fuel Injection, Ignition system, Exhaust system and other Auxiliary Systems (Cooling, Lubrications & Electrical Systems))

Transmission System (Front, Rear & 4 Wheel Drive, Manual, Automatic Transmission, Differential), Braking system (Drum, Disc, Hydraulic, Pneumatic), Steering System (Rack and Pinion, Power Steering)

UNIT II **5 Hours**

ELECTRONIC SYSTEMS

Basic electrical components and their operation in an automobile: Power train subsystem (starting systems, charging systems-Ignition systems-Electronic fuel control), Chassis subsystem(ABS,TCS &ESP)

UNIT III **5 Hours**

ENGINE MANAGEMENT SYSTEMS

Engine management systems Gasoline / Diesel systems, various sensors used in system Embedded System Applications in automotive, instrumentation and control - Automotive Control System Applications of Sensors and Actuators - Air Flow Rate Sensor - Engine Crankshaft Angular Position Sensor - Throttle Angle Sensor - Temperature Sensors - Sensors for Feedback Control - Knock Sensors - Automotive Engine Control Actuators.

Total: 15 Hours

Reference(s)

1. Tom Denton, Automobile electrical and electronic system, Edward Arnold publishers, 4th Edition , 2012
2. WilliamB.Ribbens,Understanding Automotive Electronics,Newness 7th Edition 2012.

15EE0XD QUALITY MANAGEMENT SYSTEM

1 0 0 1

Course Objectives

- To understand the quality management tools and standards.
- To analyze about product verification methods and quality cost.

Programme Outcomes (POs)

a. **Engineering Knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
e. **Modern Tool Usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
f. **The Engineer and Society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
g. **Environment and Sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
k. **Project Management and Finance**: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

Course Outcomes (COs)

1. Analyze the product verification methods and quality management tools.
2. Explain the quality standards and quality cost.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	1				2						3		1	
2						1	2				3			

UNIT I **4 Hours**

PRODUCT VERIFICATION METHODS

Inspection - Quality control - Quality Assurance - Special process - Six sigma - FMEA - Zero Defects.

UNIT II **3 Hours**

BASIC QUALITY MANAGEMENT TOOLS

Causes and Effect diagram - Check sheet- Control chart - Histogram - Pareto chart -Scatter diagram - Stratification (Flow chart or Run chart).

UNIT III **4 Hours**

QUALITY STANDARDS

ISO-9000 System - Environment Management System - 5S Work Place Management - KANBAN / JIT/ Two Bin System.

UNIT IV **4 Hours**

QUALITY COST

Cost of Quality - Rework - Rejection - Replacement - Product Failure - Warrantee - Failure Analysis - 8D Report.

Total: 15 Hours

Reference(s)

1. Besterfield D. H. Quality Control. New Jersey, 2001.
2. Goetsch D. L., Davis S. B..Introduction to TQM for production, processing and services. New Jersey: Prentice Hall, 2003.

15EE0XE PRODUCT LIFE CYCLE MANAGEMENT

1 0 0 1

Course Objectives

- To understand the Product Life Cycle Management in Industry
- To analyse the process of various process inPLM

Programme Outcomes (POs)

g. **Environment and Sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

k. **Project Management and Finance**: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

Course Outcomes (COs)

1. Explain the various features in Product life cycle management
2.To analyze the procedures in the PLM

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1							2				3			
2							2				3		1	

Total: 15 Hours

UNIT I

PLM introduction & Semiconductor industry, Agile PLM Architecture, Agile PLM Modules, Architecture,WebClient, Java client, Agile objects & classes,Character set,List,Items Object, Users, User group and Suppliers, Roles,Privilages, Practical session

UNIT II

Items object, BOM, Variant Management, Practical Session, Sites & Distributive manufacturing, AML (Approved Manufacturers List), Changes & Workflows, Affected Items, Practical Session

15EE0XFAPPLICATIONS OF SYNCHRONOUS GENERATOR IN INDUSTRIES

1 0 0 1

Course Objectives

- To understand about the various tests to be conducted in generators.
- To analyze the open circuit and short circuit characteristics of generator.

Programme Outcomes (POs)

a. **Engineering Knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
c. **Design/ Development of Solutions**: Design solutions for complex engineering problems and design system components or processes that meet the consideration for thepublic health and safety, and the cultural, societal, and environmental considerations.cultural, societal, and environmental considerations.
d. **Conduct Investigations of Complex Problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
e. **Modern Tool Usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

Course Outcomes (COs)

1. Analyze the different offline tests and online tests of generator.
2. Apply the technical standards and grid codes for generator stations.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	1		2	3									2	
2	1	-	2		3								1	1

Introduction to practical aspects of generator testing, Distinction between factory and field tests, Details of electrical tests (test procedure & analysis of results) - Off-Line Tests -Tests on Stator: Insulation Resistance (Polarization Index), Winding Resistance, Core hot-spots, Capacitance & tan-delta, Partial discharge, High voltage, Winding & core temperature detectors - Tests on Field: Insulation Resistance, Winding resistance, Winding impedance, Field short circuit & ground detectors, High voltage, Pole drop test, Magnetization.On-Line Tests - Generator Open-circuit & Short-circuit Characteristics - Step tests for excitation system - Separation tests - Factory acceptance tests - Introduction to Indian Grid Code - Power Scenario in India - Technical standards and Grid codes for generator stations.

Total: 15Hours

Reference(s)

1. Ion Boldea, Synchronous Generators, CRC Press, 2nd Edition, Taylor & Francis Group,2016.
2. M.V. Deshpande, Electrical Machines, PHI Learning, 1st Edition, 2013.
3. Dr Ravi Segal, GE- Energy, Bengaluru.

15EE0XG REACTIVE POWER MANAGEMENT AND ENERGY STORAGE DEVICES 1 0 0 1

Course Objectives

- To understand the practical aspects of reactive power problem.
- To exemplify the IEEE standards and models for Power System Stabilizers.

Programme Outcomes (POs)

a. **Engineering Knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
c. **Design/ Development of Solutions**: Design solutions for complex engineering problems and design system components or processes that meet the consideration for thepublic health and safety, and the cultural, societal, and environmental considerations.cultural, societal, and environmental considerations.
d. **Conduct Investigations of Complex Problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

Course Outcomes (COs)

1. Analyze the practical aspects of reactive power problem and sources of reactive power.
2. Explain the functions of Power System Stabilizers and Energy Storage Devices.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	1		2	3									1	1
2	1	-	3	2									1	

Introduction to the problem of VAR control-Practical aspects of reactive power problem: Voltage stability, Static & Dynamic VAR requirements, Torsional modes and Sub-synchronous resonance-Sources of reactive power: Capacitor & Reactor, Transformer, Synchronous condenser, Excitation system-Static excitation system, Functionality ,Technical features ,IEEE standards, Generator capability, Under excitation and over excitation limiters-Power system stabilizer (PSS):Function ,Design ,IEEE standard models for PSS-Introduction to Energy Storage (ES) devices: Need for ES, Types & application of ES devices.

Total: 15 Hours

Reference(s)

1. D. M. Tagare, Reactive Power Management, Tata McGraw Hill Publishing Company Ltd, Fourth Edition 2007.
2. Ter-Gazarian, A.G, Energy Storage for Power Systems, 2nd Edition, IET Publications,2011.

15EE0XH SUBSTATION DESIGN 1 0 0 1

Course Objectives

- To understand the operation and basic concepts of substation devices.
- To identify the international standards and codes for substation

Programme Outcomes (POs)

a. **Engineering Knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. **Problem Analysis**: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

Course Outcomes (COs)

1. Explain the components, types and industrial topics of Electrical Substation.
2. Construct a single line diagram of distribution panel.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	1	2											1	2
2	1	1											1	3

Module 1- Introduction to Substation Devices **4 Hours**
Overview of Electrical substation – Types of substation- Isolater, Circuit breaker, Earthswitch, CT, VT Basic concepts, Single line diagram, Industrial methods and steps for building the substation- Bus bar arrangements.

Module 2 – Substation industrial Topics **4 Hours**
Remote tap changer control – Auto bus transfer scheme – Capacitor bank concepts- Anitpumping relay - Trip circuit supervision – Breaker Failure concepts.

Module 3 - Relay panel & International standards **4 Hours**
Single line diagram – Schematic overview –General Arrangements – bill of Materials – AC Distribution panel – DC Distribution panel – ANSI Code & IEC codes.

Hands on training on Session **3 Hours**
Hands on training from Microstation software and AutoCAD software for Doing the Single line diagram, Breaker Tripping logic, AC Distribution, DC Distribution circuits, Relay circuit, Tripping and Closing Circuit for the Circuit breaker.

Reference(s)

1. John D MC Donald, Electric Power Substation Engineering, CRC Press, Taylor & Francis Group, 3rd Edition,2012.
2. L.G. Hewitson, Mark Brown, Ramesh Balakrishnan, Practical Power System Protection, Newnes, 2004.

15GE0XA HEALTH AND FITNESS 1 0 0 1

Course Objectives

- To understand the fundamental concepts about physical fitness & its types, training and assessment of physical fitness.

Course Outcomes (COs)

1. Acquire the knowledge and training of the individual physical, mental and social concepts.
2. Understand the fundamental concepts of yogic practice and physical fitness.
3. To acquire the knowledge about nutrition and health consciousness.

Fitness: Meaning & Definition – Need & importance of Physical fitness – Types Physical fitness - Exercise, Training and Conditioning and it is important.

Yoga: Meaning and definition – Principles of practicing – Basic Asana and it important – Pranayama and Meditation - Relaxation Techniques.

Nutrition and Balance Diet: Needs and Important – Significant of Nutritional Food - Tips for balance diet. **Common Diseases for IT professionals:** Common diseases - cause – prevention – First aid for common sports injuries.

Total: 15 hours

References

1. Anderson, Bob., Pearl, Bill.,&Burke, Edmund R., (2001). *Getting in Shape Workout Programs for Men&Women*. Mumbai: Jaico Publishing House.
2. Baechle, Thomas. R, & Earle, Roger. W., (2000). *Essentials of Strength Training and Conditioning*. Champaign: Human Kinetics.
3. Iyengar, BKS., (2003). *The Art of Yoga*. New Delhi: Harper Collins Publishers.
4. Singh, Hardayal, (1995). *Science of Sports training*. New Delhi: D.V.S. Publications.
5. Begum, Raheena. M., (2002). A Textbook of Foods, Nutrition and Dietetics. New Delhi: Sterling Publishers Private Limited.

15GE0XB FOUNDATION COURSE IN COMMUNITY RADIO TECHNOLOGY

1 0 0 1

Course Objective

- The course focuses on community radio technology and various program productions techniques for radio broadcasting.

Course Outcomes (COs)

1. Understand the hardware required for field recording and setting up a studio and carry out studio and field recording
2. Examine the available options for telephony interfaces for radio
3. Demonstrate proper techniques of wiring, fixing of connectors, soldering and use of tools and equipment for studio work.

INTRODUCTION TO COMMUNITY RADIO

Evolution of Community Radio (CR) in India- principles behind setting up of CR- policy guidelines and their impact on technology and content of a CR station- fundamental principles behind deciding the technology for a CR station.

STUDIO TECHNOLOGY

Properties and components of sound-difference between analogue and digital audio-hardware required for field recording and setting up a studio-fundamental principles for setting up an audio studio

AUDIO PRODUCTION

Concept of recording and storing audio-hardware related to audio recording-open source software solutions for audio production- telephony interfaces for radio- audio Post Production

STUDIO OPERATIONS

Wiring, fixing of connectors, soldering and use of tools and equipment- preventive and corrective maintenance of studio and equipment.

RADIO TRANSMISSION TECHNOLOGY

Components of the FM transmission chain- FM transmitter-different types of FM antenna - coaxial cable- propagation and coverage of RF signals-FM transmitter setup

Total: 15 Hours

Reference(s)

1. UNESCO (2001). Community Radio Handbook.
2. Vinod Pavarala, Kanchan K Malik, “Other Voices: The Struggle for Community Radio in India”, SAGE Publications India,2007.
3. Steve Buckley, Mark Raboy, Toby Mendel, Kreszentia Duer, Monroe E. Price, Seán Ó Siochrú, “Broadcasting, Voice, and Accountability: A Public Interest Approach to Policy, Law, and Regulation”, University of Michigan Press, 2008.
4. www.floridasound.com
5. www.mediacollege.com
6. www.procosound.com

15GE0XC VEDIC MATHEMATICS 1 0 0 1

Course Objectives

- To improve their calculation speed, analytical thinking and numerical skills.

Course outcome (CO)

1. Solve problems creatively in mathematics and its applications.

Vedic Mathematics

Addition- Subtraction- System of Multiplication- Squaring numbers- Cube roots- Square roots- Solution of simultaneous equations- Solutions of Quadratic equations-

Total: 15 Hour

References

1. Dhaval Bathia, Vedic Mathematics, JAICO Publishing House, 29th Edition, Mumbai, 2014.
2. Jagadguru Swami Sri Bharathi Krsna Tirthaji Maharaja, Vedic Mathematics, Motilal Banarsidass Publishers Private Limited, New Delhi, 1997.

15GE0XD INTRODUCTION TO ALGORITHM 1 0 0 1

Course Objectives

- Analyze the asymptotic performance of algorithms, Divide and conquer and Dynamic Problems.
- Use Sorting and Searching algorithms for arranging the data.
- Apply important algorithmic techniques to solve the real world Problems.

Course Outcomes (COs)

1. Apply Divide and conquer and Dynamic Programming Algorithm techniques to Provide the solutions for simple Problems.
2. Design algorithms for Performing Sorting and Searching of data.
3. Construct the Graph, Heap and BST for the given Data information.

Algorithm Design Techniques: Divide and Conquer, Dynamic Programming, Sorting and Searching, Basic graph algorithms –Simple Data Structures: Heaps, Balanced Search Trees.

Total: 15 Hours

References

1. Mark Allen Weiss, Data Structures and Algorithm Analysis in C, Second Edition, Pearson Education, 2015.
2. Thomas H. Cormen. Charles E. Leiserson. Ronald L. Rivest. Clifford Stein, Introduction to Algorithms, Second Edition, MIT Press, 2014.
3. J.P.Tremblay and P.G.Sorenson, An Introduction to Data Structures with Application II Edition, Tata McGraw Hill Publishing Company Ltd., New Delhi, 2008.

1 0 0 1

15GE0XE ETYMOLOGY

Course Objectives:

- To enhance the level of vocabulary by understanding the origin / root of English words
- To stimulate an appreciation for the English language
- To promote effective oral and written communication through improved vocabulary

Course Outcome (COs):

1. Examine prefixes, roots, and suffixes of Latin, Greek, Germanic, and Anglo-Saxon origin.
2. Explore the historical aspects of language, including the infusion of Indo-European languages, semantic changes, and the influence of world events.

CONVENTIONS &VOCABULARY

Acronyms – Abbreviations – Initialisms – Jargon – Neologisms - Idiomatic Expressions – Euphemisms – Spoonerisms – Malapropisms – Mondegreens - Words Derived from Latin - Words Derived from Greek - Words Derived from - Germanic/Anglo-Saxon - Abstract word Acronym - Affix Analogy - Antonym – Apheresis - Blend word Assimilation - Colloquial language Clipped word

WORD ANALYSIS

Concrete word Derivative - Dialect Diminutive suffix - Dissimilation Doublet - Etymology Euphemism - Figurative word Homonym - Hybrid word Inflection - Informal language Infusion - Jargon Linguistics - Loan words Metathesis – Modify - Philology Onomatopoeia - Romance language Prefix - Semantics - Root-base word - Suffix Slang - Word component Synonym

Total : 15 hours

Reference(s)

1. Norman, Lewis. *Word Power Made Easy*,Goyal Publisher. Edition 2.2014.
2. C T Onions. *The Oxford Dictionary of English* Etymology.Volume 11, Issue 1.70, Wynford Drive, Don Mills, Ont.Oxford University Press.1965.
3. Nurnberg W, Maxwell and Rosenblum, Morris, How to build a better Vocabulary, Completely Revised and Updated, Popular Library.1961

15GE0XF HINDUSTANI MUSIC **1 0 0 1**

Course Objectives:

- To have an awareness on aesthetic and therapeutic aspects of Hindustani music
- To identify and differentiate the various styles and nuances of Hindustani music
- To apply the knowledge accumulated throughout the duration of the course by way of improvisation, composition and presentation

Course Outcomes (COs):

1. Have Basic knowledge of aesthetic and therapeutic value of Hindustani Music

AESTHETICS

Introduction to music - Aesthetics of Hindustani Music - Classification (Raga, instruments, style as per the presentation and the gharaanaas) - Folk music, Dhamaar, Dhrupad

COMPOSITION AND THERAPEUTIC VALUE

Taal and Raga - Bandeesh, Taraanaa – Madhya and drut laya, Vilambit khyaal as demonstration - Therapeutic benefits of Hindustani music - Stage performance

Total : 20 hours

Reference(s):

1. Devdhar B.R., *Raga bodh (Part 1 & 2)*, Devdhar School of Indian Music, Mumbai, 2012.
2. Vasant, *Sangeet Vishaarad* , Hathras, Uttar Pradesh, 2015.

Websites:

1. *raag-hindustani.com/*
2. *play.raaga.com/Hindustani*
3. *raag-hindustani.com/Scales3.html*
4. *www.poshmaal.com/ragas.html*
5. *www.soundofindia.com/raagas.asp*
6. *https://www.quora.com/Which-is-the-toughest-raga-in-Indian-classical-music*
7. www.likhati.com/2010/10/20/popular-ragas-for-the-beginner-ear-durga

15GE0XG CONCEPT, METHODOLOGY AND APPLICATIONS OF VERMICOMPOSTING 1 0 0 1

Course Objectives

- To understand the importance of safe methods of treating solid wastes generated through various human activities
- To appreciate the skills / devices / practices associated with the compact proceedures of biodegradation of unwanted solid residues

Course Outcomes (COs)

1. Understand the role of recycling of garbage leading to the sustenance of our health and environment.
2. Recognize the organic farming practices and production of healthy food products.
3. Prepare and maintain tips for small scale compost units and thereby becoming more environmentally conscious.

VERMICOMPOSTING TECHNOLOGY **15 Hours**

Ecological roles and economic importance of earthworms - need for earthworm culture – scope and importance of vermiculture – limiting factors - types of worm culturing and the relative benefits – Small scale and commercial methods: process & advantages – Vermicomposting equipments, devices – Design and maintenance of vermi bed - Products from vermiculture (matter & humus cycle) – vermicastings in organic farming/horticulture - Marketing the products of vermiculture – quality control, market research, marketing techniques – Applied vermiculture: use of urban solids & farm/ industrial residues for vermicomposting - Constraints of vermiculture and its future perspectives – Artificial Earthworm as a standalone biodegradation assembly.

Total: 15 Hours

Reference(s)

1. Sultan Ahmed Ismail, 2005. The Earthworm Book, Second Revised Edition. Other India Press, Goa, India.4
2. Vermiculture Technology; Earthworms, Organic Wastes and Environmental Management, 2011, Edited by Clive A Edwards, Norman Q Arancon & Rhonda Sherman, CRC Press
3. www.organicgrowingwithworms.com.au
4. New York Times – Scientists Hope to Cultivate and Immune System for Crops

15GE0XH AGRICULTURE FOR ENGINEERS 1 0 0 1

Course Objectives

- To impart the basic knowledge of agricultural and horticultural crops, cropping systems
- To study the weed and nutrient management, irrigation water requirement and its quality

Course Outcomes (COs)

1. Understand the science of Agriculture
2. Summarize and apply the methodologies needed in agriculture based on the field conditions.
3. Develop enough confidence to identify the crop patterns in real world and offer appropriate solutions.

AGRONOMICAL PRACTICES AND CROPS 5 hours

Definition and scope of agronomy , Classification of Crops, agricultural and horticultural crops Effect of Different Weather Parameters on Crop Growth and Development , Principal of Tillage, Tilth and Its Characteristics, Role of Water in Plant and Its Absorption, Conduction and Transpiration of Water and Plant Processes, Soil Water Extraction Pattern and Plant Response. Introduction to weeds, Weeds Control.

CROP ROTATION, CROPPING SYSTEMS, RELAY AND MIXED CROPPING 5 hours

Crop Rotation, Different Cropping Systems – I, Different Cropping Systems – II, Scope of Horticultural Crops, Soil Requirement for Fruits, Vegetables and Flowers Crops, Climatic Requirement for Fruits, Vegetables and Flowers Crops.

PLANT NUTRIENTS 5 hours

Essential Plant Nutrients, Nutrient Deficiency, Toxicity and Control Measures. Chemical fertilizers, fertilizer Reaction in Soil and Use Efficiency

QUALITY OF IRRIGATION WATER AND IRRIGATION METHODS 5 hours

Quality of Irrigation Water, Poor Quality of Irrigation Water and Management Practices. Surface Irrigation methods, and micro irrigation methods

Total:20 hours

References

1. SP. Palaniappan, and S. Sivaraman, Cropping systems in the tropics- Principles and Management, New Age international publishers, New Delhi, (2nd edition), 1998.
2. S.Sankaran and V.T Subbaiah Mudaliar, Principles of Agronomy, The Bangalore Printing and Pubg Co, Bangalore, 1993.
3. P.Balasubramain and SP. Palniappan, Principles and Practices of Agronomy, Agrobios publishers, Ludhiana, 2001.
4. T.Yellamanda Reddy and G.H. Sankara Reddi, Principles of Agronomy, Kalyani publishers, Ludhiana, 2005
5. B.Chandrasekaran, B. , K. Annadurai and E. Somasundaram, A Text book of Agronomy, Scientific publishers, Jodhpur, 2007
6. George Acquaah, Horticulture-principles and practices, Prentice-Half of India Pvt. Ltd., New Delhi, 2002.

15GE0XI INTRODUCTION TO DATA ANALYSIS USING SOFTWARE 1 0 0 1

Course Objectives

- To familiarize students on the features of MS Excel.
- To enable the students to use Excel in the area of critical evaluation.
- Facilitate the student to construct graphs.

Course Outcomes (COs)

1. Create versatile Excel document.
2. Apply built in functions for data analysis.
3. Prepare dynamic Charts.

EXCEL FUNDAMENTALS AND EDITING **4 Hours**

Starting and Navigating a Worksheet– Entering Information – Hyperlinks – Saving – Editing Techniques – Entering a Series of Labels, Numbers and Dates – Checking Errors.

FORMATTING **4 Hours**

Formatting Cells – Changing Column Widths and Row Heights – Creating Conditional Formatting – Using Styles – Creating and Modifying Templates – Changing Page Breaks.

POWER ORGANIZING AND CUSTOMIZING EXCEL **4 Hours**

Managing Worksheets – Referencing Cells in Other Worksheets – Using More than One Work Book – Managing Shared Work Books – Protecting Worksheets and Workbooks. Adjusting Views – Setting Printing Options – Using Multiple Panes – Customizing Excel Using the Options Dialog Box.

CRUNCHING NUMBERS **5 Hours**

Building a Formula – Using Basic Built-in Functions – Using Functions to Analyze Data – Using Names in Functions – Array Functions

WORK SHEET CHARTS **3 Hours**

Planning a Chart – Creating Chart – Formatting a Chart – Adding Labels and Arrows.

Total: 20 Hours

References

1. Michael J. Young, Michael Halvorson, “Office System 2007 Edition”, Prentice-Hall of India (P) Ltd., New Delhi, 2007
2. John Walkenbach, “Microsoft Office Excel 2007”, Wiley Publishing, Inc. 2007
3. Curtis D. Frye, Microsoft Office Excel 2007 Step by Step, Microsoft Press, 2007
4. Mark Dodgeand Craig Stinson, “Microsoft Office Excel 2007 Inside Out”, Microsoft Press, 2007

15GE0XJ ANALYSIS USING PIVOT TABLE 1 0 0 1

Course Objectives

- To familiarize students on the features of Pivot Table.
- To enable the students to use Pivot Table in the area of data analysis.
- Facilitate the student to construct the charts for visualization of data.

Course Outcomes (COs)

1. Able to construct the Pivot Table and Group, Sort, Filter the Data to do the analysis.
2. Able to do the Calculation with in Pivot Table for advance analysis.
3. Capable of Constructing Pivot Charts to make visual presentation.

PIVOT TABLE FUNDAMENTALS **4 Hours**

Introduction about Pivot Table, Why and When to use the Pivot Table, Anatomy of the Pivot Table, Limitations, Preparing the Source Data, Creating the Pivot Table.

GROUPING PIVOT TABLE DATA 4 Hours

Grouping the Items in a Report Filter, Grouping Text Items, Grouping Dates by Month, Grouping Dates Using the Starting Date, Grouping Dates by Fiscal Quarter, Grouping Dates by Week, Grouping Dates by Months and Weeks, Grouping Dates in One Pivot Table Affects Another Pivot Table, Grouping Dates Outside the Range.

SORTING AND FILTERING PIVOT TABLE DATA 4 Hours

Sorting a Pivot Field: Sorting Value Items, Sorting Text Items, Sorting Items in a Custom Order. Filtering a Pivot Field: Manual Filter, Label Filter, Value Filter, Multiple Filters.

CALCULATIONS WITHIN THE PIVOT TABLES 5 Hours

Using Formulae: Creating a Calculated Field with and without "IF Condition, Calculated Item, Using Custom Calculations: % of Column, % of Row, % of Total, % Of, Running Total, Difference From, % Difference From, Index.

PIVOT CHARTS 3 Hours

Creating a Normal Chart from Pivot Table Data, Filtering the Pivot Chart, Changing the Series Order, Changing Pivot Chart Layout Affects Pivot Table, Changing Number Format in Pivot Table Affects Pivot Chart, Converting a Pivot Chart to a Static Chart, Refreshing the Pivot Chart, Creating Multiple Series for Years

Total: 20 Hours

Reference(s)

1. Debra Dalgleish, "Excel 2007 - PivotTables Recipes A Problem-Solution Approach", Apress, 2007, (ISBN-13 (pbk): 978-1-59059-920-4)
2. Bill Felen and Michael Alexander, "Pivot Table Data Crunching for Microsoft Office 2007", Pearson Education, Inc., QUE Series.
3. Wayne L. Winston, "Microsoft Office Excel 2007: Data Analysis and Business Modeling", Microsoft Press, 2007
4. John Walkenbach, "Microsoft Office Excel 2007", Wiley Publishing, Inc. 2007.
5. Mark Dodgeand Craig Stinson, "Microsoft Office Excel 2007 Inside Out", Microsoft Press, 2007.
6. Curtis D. Frye, Microsoft Office Excel 2007 Step by Step, Microsoft Press, 2007.

Total : 15 Hours

15GE0XL INTERVIEW SKILLS 1 0 0 1

Course Objectives:

- To develop an understanding of interview dynamics and techniques, and its importance in career enhancement.
- To train students to face interviews.

Course Outcomes (COs):

1. Demonstrate appropriate interview skills and attend all types of interviews
2. Participate in group discussions with confidence

Interview preparation - Overcoming interview nerves - Types of Interview - Handling questions - Group Discussion - Dynamics of group discussion - Presentation skills - E-mail etiquette - Body Language.

Total: 15 hours

References:
1. Gray Jack, Interviewing: Interview Questions - Job Interviews, New York : Great Reads Publishing, 2015.
2. Corfield Rebecca, Successful Interview Skills, New York: Kogan Page, 2006.
3. Carnegie Dale, How to Win Friends and Influence People, New York: Simon & Schuster, 1998.
4. Butterfield Jeff, Soft Skills for Everyone, New Delhi: Cengage Learning, 2014.

15GE0XN JOURNALISM AND MASS COMMUNICATION

1 0 0 1

Course Objectives:
- T o offer a basic knowledge of mass communication and its various forms
- T o provide a basic understanding of mass communication in India

Course Outcomes (COs):
1. Understand the underlying principles of Journalism
2. Understand the importance, functions & scope of mass communication
3. Follow and adapt to the periodic changes in media

What is News - Components of a Newspaper - Structure of an Article - How to Write Headlines - Introduction to Script Writing - News Reporting - Advertising and Marketing - Online Journalism - Rules of Editing - Proof Reading - Optimization and Key Words - Media Ethics - TV Studies - Media Propaganda - Identifying Fake News - International Communication

Total: 15 hours

References:
1. Kumar, Keval. Mass Communication in India. IV Ed. Jaico Publishing House: 2012.
2. Agarwal, S.K. A Handbook of Journalism & Editorial Excellence. Jaico Publishing House: 2012.

15GE0XO VISUAL MEDIA AND FILM MAKING **1 0 0 1**

Course Objectives:
- To acquire fundamental knowledge on development of film making as an art
- To provide students a basic understanding of the techniques and nuances of visual medium
- To inculcate an ability to plan and produce a short film

Course Outcomes (COs):
1. Understand the significance and techniques of visual medium
2. Analyse and produce visual clippings

History of Cinema (Origin and Narrative) – Cinema as a visual medium -Significance of Editing – Styles of Editing – Editing as a methodology (Hollywood’s Invisible Editing) – Technical Aspects of Editing (Final Cut Pro (FCP), AVID and Premire Pro) - Basics of video production (pre-production to post-production) – Different types of shots and angles – Film style and Narrative – (Italian Neo-realism, Avant Garde, Russain Formalism, Alternative Cinema etc.,) – Regional Cinema to National Cinema – Basics of Script Writing (Double and Single Column) – Basics of Video Production (script to screen) – Final submission of a script for five minutes short film.

Total: 15 hours

References:
1. Monaco, James, How to Read a Film: Movies, Media, and Beyond. Auckland: OUP, 2009.
2. Belavadi, Vasuki, Video Production. India: OUP, 2013.

15GE0XP YOGA FOR HUMAN EXCELLENCE **1 0 0 1**

Course Objectives:

- To know about the history and schools of yoga
- To know the difference between supreme consciousness and individual consciousness
- To apply the knowledge by the way of practice and introspection

Course Outcome (COs):

1. Understand the historical aspects and schools of yoga
2. Ensure their physical & mental wellness through yoga practice
3. Develop the power to concentrate and have stress free mind

What is Yoga – History of Yoga - Yoga in today's scenario- Schools of Yoga - Eight Limbs of Yoga - Sathvic, Rajasic, Tamasic Foods and Thoughts - Science of Yoga -Loosening Exercises - Yogasanas & Benefits - Super Brain Yoga - Surya Namaskar - Standing Asanas - Sitting Asanas - Prone Asanas - Supine Asanas - Mudras-Relaxation - Pranayama - Meditation

Total:15 Hour

References:

1. Vethathiri Publications, Yoga Practices-2, Erode, 2012.
2. Iyengar B.K.S. Yoga: Wisdom & Practice, B.K.S. Iyengar, 2009.
3. Ramesh Partani, The Complete Secret, Ru Education, 2013.

Websites:

1. http://www.sarvyoga.com/
2. http://www.wikihow.com/Do-Superbrain-Yoga

15GE0XQ CARNATIC MUSIC

1 0 0 1

Course Objectives

- To know the basics of Carnatic Music
- To foster a blend of practical and theoretical understanding of Carnatic Vocal music
- To give a brief understanding of History of Indian Music, Evolution of the Raga system, Tala system, Structure of compositions

Course Outcomes (COs):

1. Develop an understanding of the basics of Carnatic music
2. Understand the aspects of Carnatic music which will help to create a strong foundation in Carnatic Music

History of Carnatic music - History of Carnatic Composers - Music Technical Terms Part I: Music, Nadam, Sangeetham, Marga Sangeetham, Suddha Sangeetham, Desiya Sangeetham, Kalpita, Kalpana, Ahata Nadam, Anahata Nadam, Shruthi, Swaram, Swarasthanas, Seven Swaras, Tamil Swaras, Prakruthi, Vikruthi, Kamala, Tivra, Twelve Swaras, Arohanam, Avarohanam, Swarna Kalas, Thala Symbols, Sthayi - Music Technical Terms Part II: Ragas, Janaka Ragas, Janya Ragas, Melakartha Ragas, Upanga Ragas, Bhashanga Ragas, Akshara Kalas, Sangathi, Anya Swaram, Chakras and Meanings, Jaaru, Poorvangam, Thadu and Madu, Saptaham, Ashtakam, Uthrangam, Gamaga, Abhyasa Ghanam, Sapta Kriyas, Nisapta Kriyas, Three Sathanas, Sabahaa gananas, Alapana, Thala, Laghu, Dhrutham - Jantavarisai - Classification (Raga, Thala, Instruments) -12 Melakartha Schemes – Practical Exercises in Music

Total: 15 hours

References:

1. Bhagyalekshmy, S. Ragas in Carnatic Music. CBH Publications, 2003.
2. Deva, Bigamudre Chaitanya. An Introduction to Indian Music. Publications Division, Ministry of Information and Broadcasting, Government of India, 2015.
3. Sambamoorthy, P. South Indian Music. Indian Music Pub. House, 1954.

15GE0XR GENERAL PSYCHOLOGY 1 0 0 1

Course Objectives:

- Defining Psychology and the subject matter of psychology.
- Defining Psychology and the subject matter of psychology.
- To provide an awareness of various methods and branches of psychology
- To explain social and work psychology of people and the need for mental health.

Course Outcomes (COs):

1. Understand the basics of human behavior in the workplace and society at large
2. Understand the different fields of psychology and its uses
3. Deal people effectively in their personal and social life

Psychology - Introduction - Mind body relationship - Methods and Scope of Psychology Motivation-Types of Needs- Motivational Cycle- Intelligence: Concept of Intelligence and IQ- measurement - Social psychology: individual behavior and group behavior - Group dynamics- group formation-social influence-social cognition, stereotypes- prejudice- discrimination - Definitions, formation of attitude, factors of attitude formation-change of attitude

Total: 15 hours

References:

1. Atkinson & Atkinson, Introduction to Psychology, 6th Ed McGraw-Hill Publications.1975.

2. Mishra, B. K, Psychology: The study of human behavior, 2nd Ed New Delhi: Prentice Hall of India Learning Pvt. Ltd. 2016.

3. Baron, R. A., Branscombe.N.R, Social Psychology, 14th Ed. New Delhi; PearsonEducation. 2016.

4. Morgan, C.T., King, R.A., Weisz, J.R., & Schopler, J. Introduction to Psychology, 7th Ed.Nehi: Tata McGraw Hill. 1993.

15GE0XS NEURO BEHAVIOURAL SCIENCE 1 0 0 1

Course Objectives:

- To provide an introduction to the Cognitive Neuro Science of languages
- To provide an understanding of the Cognitive processes

Course Outcomes (COs):

1. Identify the psychological problems that will impact mental health
2. Value ethical conduct in professional and personal life
3. Recognise the need for rationale and evidence in decision-making

Introduction to physiology - Anatomy - Neuro Biology - Psycho Neuro Science - Behaviour and Hormones - Behaviour Modifications - Relaxation Therapy - Psycho Education for minds.

Total: 15 hours

References:

1. Beck. Robert "Handbook of Physiology". Vol I. Oxford University Press March 15, 1996.
2. Horon C Philip "Sexology and Mind". Academic Press. 1993.
3. Blatteis M.Clark and Melvin J. Fregly Handbook of Physiology Sect 4, Oxford University Press. March 15, 1996.

15GE0XT NEW AGE INNOVATION AND ENTREPRENEURSHIP

1 0 0 1

Course Objectives

- To make the participants understand as to how to get along with the task of setting independent business units and on the various facets of running a business.
- To get the budding young entrepreneurs to appreciate the structured knowledge of the dynamics of operationalizing a business opportunity

Course Outcomes (COs)

1. Understanding entrepreneurship as an important career option
2. Concept and methodology of idea translation to viable start-ups
3. Events to occur in the building of a technology based venture for students or working professionals or women
4. Overview of Indian trends in the start-up scene

NEW AGE INNOVATION AND ENTREPRENEURSHIP 15 Hours

Introduction to Entrepreneurship - Opportunity Identification – ideation -MVPPositioning as an Entrepreneur – Starting own Business - Developing Effective Business Model - Industry and Competitor Analysis - Building Business Plan-Mentoring Session with Investors- Legal and Ethical Foundation for Startup – Types of startups and licensing systems - MSME - Evaluating the Financial Strength of a New Venture/Project - Getting Funding - Types of Sources – VCs, Angel funding, PE etc. -Marketing Strategies for New Ventures - IT Systems - IPR - Strategies for New Venture Growth - Talent Acquisition and Management for New Ventures – Valuation Challenge in Entrepreneurship - Intrapreneurship – Sustainability - Exit strategies and Start-up trends in India.

Total 15 Hours

Reference(s)

1. Kathleen R. Allen, Launching New Ventures, South-WesternCengage Learning,6th Edition, 2012.
2. Alex Osterwalder and Yves Pigneur, Business Model Generation, published by the authors, 2010
3. Branson. R. "Business stripped bare", New York, Penguin books, 2011
4. Moris MH, Kuratko DF and Covin JG, Corporate entrepreneurship and innovation, 3rd edition, Mason, Oh; CENGAGE/SOUTH WESTERN publisher,2011.

15GE0XW DISRUPTIVE INNOVATION BASED START UP ACTIVITIES

1 0 0 1

Course Objectives

- To make the participants understand as to how to get along with the task disruption led innovations.
- To get the budding young entrepreneurs to appreciate the structured knowledge of the dynamics of operationalizing creativity based disruption strategy

Course outcomes

1. Understanding contemporary entrepreneurship as an important career option
2. Concept and methodology of creative disruption to viable start-ups
3. Events to occur in the building of a technology based venture for students or working professionals or women with disruptive technology option
4. Overview of Indian trends with reference to disruptive innovation based start-ups

DISRUPTIVE INNOVATION BASED START UP ACTIVITIES 15 Hours

Creativity linked innovation – Differences between Disruptive & incremental Innovations - Historical, theoretical, and practical evolution of disruptive innovation (DI). - Idea generation & communication of creativity leading to DI. Innovation management concepts in DI based entrepreneur generation - How do firms bring in new business models and get new products and services to the market? – Investor preferences in core versus new or disruptive business models - disruptors and the disrupted frameworks for assessing company's capabilities and rethinking product, market and strategy - Right customers for DI: strategy in a world that is changing so rapidly – Application of disruptive theories to complex problems and opportunities.

Total 15 Hours

References

1. https://onlinelibrary.wiley.com/doi/pdf/10.1111/j.1540-5885.2005.00177.x
2. http://www.brinq.com/workshop/archives/2005/01/08/what-is-disruptive-innovation
3. https://hbr.org/2006/12/disruptive-innovation-for-social-change

15GE0XX VISION INDIA 1 0 0 1

(START UP INDIA, MAKE IN INDIA, IMPRINT INDIA, SMART CITIES etc.)

Course Objectives

- To make the participants understand as to how government schemes are creating a favorable frame work in India for innovation based entrepreneurship.
- To get the budding young entrepreneurs to appreciate the preparedness of stakeholders in the innovation handling machinery in India.

Course Outcomes (COs)

1. Understanding Indian competitiveness
2. Concept and methodology of national vision programmes
3. Latest avenues & opportunities for students or working professionals or women
4. Overview of Indian trends in the start-up scene

INDIAN VISION PROGRAMMES 15 Hours

Theme, Concept and Practice of Make in India (Experience in 3 Years) - India growth story after Make in India - Objectives and targets of Make in India - Nation building initiatives through Make in India – 25 Sectors under the *Swadeshi* Movement called Make in India - Future of ‘Manufacturing in India’ initiative - Programme and objectives of Startup India – DIPP - Incentives and benefits under Startup India - Startup India Hub - Various Government schemes helping Indian Startups - Features and benefits envisaged in stand up India - Mission, Features and Advantages of Skill India Programme – PMKVY -Promising scene of *Ayush* - Digital India /E-Governance / DEiTY (Digitalized India Platform) – Impacts of firms like Connect India – Clean India, Community led Environmental Action Network - Smart Cities Mission: Features and promises – Imprint India

Total 15 Hours

References

1. http://www.makeinindia.com/article/-/v/make-in-india-reason-vision-for-the-initiative/
2. https://www.startupindia.gov.in/
3. https://www.standupmitra.in/Home/SUISchemes
4. http://www.digitalindia.gov.in/content/about-programme

15EE0V1 INTRODUCTION TO VIRTUAL INSTRUMENTATION

Course Objectives

- To provide an overview of Virtual instruments
- To bring out the overview of the software
- To know about the programming structure of the software
- To familiarize the student with the Applications

Course Outcomes (COs)

1. Summarize the basics of Virtual Instrumentation (VI).
2. Write simple programs using LabVIEW.
3. Analyze operating systems and hardware aspects of the VI
4. Develop VI for simple applications.

UNIT I INTRODUCTION **8 hours**

Virtual Instrumentation: Historical perspective - advantages - block diagram and architecture of a virtual instrument - Conventional Instruments versus Virtual Instruments - data-flow techniques, graphical programming in data flow, comparison with conventional programming – Data types – numeric –boolean –Real time comparison of applications – String input to system

UNIT II VI PROGRAMMING TECHNIQUES **8 hours**

VIs and sub-VIs, formula node , evaluating expression , types of loops – while loop – for loop , arrays and types of functionality , structure types – case structure , flat sequence

Total: 16 hours

15EE0V2 INDUSTRIAL AUTOMATION

Course Objectives

- To understand the measurement techniques in industrial automation
- To analyse the various configuration of Industrial automation

Course Outcomes (COs)

1. Explain the measurement techniques and instruments in industrial automation
2. Analyse the configuration of CENTUM VP architecture

UNIT I

Introduction to Instrumentation Basics, Instrumentation Standards, Introduction to Industrial Measurement techniques : Pressure Measurement, Temperature Measurement, Flow Measurement, Level Measurement, Basic Control Loops and Tuning, Introduction to Field Instruments, Principle and Operation of Transmitters, Principle and Operation of Flow meters, Principle and Operation of Control Valves, Single Loop Controllers and Operation, Principle and Operation of Data acquisition System

UNIT II

CENTUM VP overview, CENTUM VP system architecture, FCS hardware configuration, HIS configuration, Network details, Address settings, Introduction to CENTUM VP engineering, Project creation, Project attribute utility, IOM creation/ IOM builder settings, Practice session, Creation of open loop, Creation of closed loop, Introduction to FCS simulation, Concept of download : Offline download, Online download, IOM load, System defined windows: Faceplate, Tuning, System defined windows, Practice session

UNIT III

Creation of cascade loop, Signal selectors, Configuration of FOUT block, Configuration of SPLIT block , Creation of control group window, Creation of trend window, HIS setup window , Scheduler, Practice session, Concept of discrete I/Os, switches, Concept of interlocks, Configuration of sequence table, configuration of logic chart , Configuration of MC-2 block, Configuration of MC-2 in logic chart, TPCFL block, CALCU block, Overview window, Graphics window, Practice session, Introduction PLC concepts Types of PLCs, Difference between DCS and PLC, PLC System Configuration, PLC Hardware Configuration, Prosafe-RS safety PLC-features, hardware details, Introduction to Work bench, Project Creation, Screens of Workbench - Link Architecture

UNIT IV

Hardware Architecture - I/O Wiring – Dictionary, I/O Variable Creation and Wiring, Introduction to FBD, FBD logic using digital signal, Configuration of SCALER Block, Configuration of FILTER Block, Configuration of MUXREAL4 Block, Configuration of SEL_R Block, Configuration of ANLG_S Block, Offline Download/Online download, I/O Lock Window/Forcing Function, Introduction to Integration with CENTUM VP for implementing SCADA, Engineering on SENG Side, Engineering on CENTUM VP Side, Function Blocks for Integration, Introduction to Ladder diagrams, Introduction to Structured text, SOE Viewer

15EE0V3 AUTOCAD ELECTRICAL

BASIC AUTOCAD ELECTRICAL

Basic AutoCAD Electrical - Project Basics-Schematic Wiring-Schematic Editing-Schematic Components-Schematic Reports-Panel Layouts-Setting and Configurations-Custom Components-Custom Data- Automation Tools- Auto Desk Vault Integration- PLC Modules- Advanced Tools.