B.E. (Mechatronics)

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)	
	Conduct of Experiment	
	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)*	**50**
	Presentation (20)	
	Viva voce (10)	
	Total Marks	**100**

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

V	**PROJECT**	**Marks**
	Continuous Assessment	**50**
	Distribution of marks for Continuous Assessment:	
	Review I	
	Literature survey (10)	
	Problem Identification (5)	
	Methodology (10)	
	Review II	
	Continuation in Methodology (10)	
	Results / Progress (15)	
	End Semester Examination	
	Report[#] (20)	**50**
	Presentation (20)	
	Viva voce (10)	
	Total Marks	**100**

VI	**LANGUAGE ELECTIVE**	**Marks**
	(CONTINUOUS ASSESSMENT ONLY)	
	Test 1	
	Listening (10)	
	Speaking (5)	**25**
	Reading (5)	
	Writing (5)	
	Test 2	
	Listening (10)	
	Speaking (5)	**25**
	Reading (5)	
	Writing (5)	
	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**	**Marks**
	(CONTINUOUS ASSESSMENT ONLY)	
	Review I	**25**
	Review II	**25**
	Project Evaluation	**50**
	Report (25)[#]	
	Presentation&Viva Voce (25)	
	Total Marks	**100**

IX	**LIFE SKILLS**	**Marks**
	(CONTINUOUS ASSESSMENT ONLY)	
	Test I	**25**
	Test II	**25**
	Final Examination	**50**
	Total Marks	**100**
	Grades (Excellent / Good / Satisfactory/Not Satisfactory)	

X	**VALUE ADDED / CERTIFICATE COURSES**	**Marks**
	(CONTINUOUS ASSESSMENT ONLY)	
	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 / National / International level Sports events with prior permission from the Head of the*

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

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**

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)	
	Conduct of Experiment	
	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)	**50**
	Presentation (20)	
	Viva voce (10)	
	Total Marks	**100**

V	**PROJECT**	**Marks**
	Continuous Assessment	**50**
	Distribution of marks for Continuous Assessment:	
	Review I	
	Literature survey (10)	
	Problem Identification (5)	

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

	Methodology (10)	
	Review II	
	Continuation in Methodology (10)	
	Results / Progress (15)	
	End Semester Examination	
	Report[#] (20)	**50**
	Presentation (20)	
	Viva voce (10)	
	Total Marks	**100**

VI	**LANGUAGE ELECTIVE (CONTINUOUS ASSESSMENT ONLY)**	**Marks**
	Test 1	
	Listening (10)	
	Speaking (5)	**25**
	Reading (5)	
	Writing (5)	
	Test 2	
	Listening (10)	
	Speaking (5)	**25**
	Reading (5)	
	Writing (5)	
	Oral Exam	**50**
	Total Marks	**100**

VII	**ONE-CREDIT COURSE**	**Marks**
	Test	**30**
	Quiz	**20**
	Final Examination	**50**
	Total Marks	**100**

VIII	**MINI-PROJECT (CONTINUOUS ASSESSMENT ONLY)**	**Marks**
	Review I	**25**
	Review II	**25**
	Project Evaluation	**50**
	Report (25)[#]	

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

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

	Presentation&Viva Voce (25)	
	Total Marks	**100**

IX	**LIFE SKILLS**	**Marks**
	(CONTINUOUS ASSESSMENT ONLY)	
	Test I	**25**
	Test II	**25**
	Final Examination	**50**
	Total Marks	**100**
	Grades (Excellent / Good / Satisfactory/Not Satisfactory)	

X	**VALUE ADDED / CERTIFICATE COURSES**	**Marks**
	(CONTINUOUS ASSESSMENT ONLY)	
	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 / 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**

PROGRAMMEEDUCATIONALOBJECTIVES(PEOs)

I. Graduates possess adequate knowledge on mechanical, electronics and electrical engineering to solve problems pertaining to mechatronics

II. Graduates are capable of integrating and using systems or devices incorporating information technologies and modern engineering tools for product design, development and manufacturing

III. Graduates aspire for higher studies and can reveal professional interaction and work effectively on multi-disciplinary teamsalong with professional and ethical responsibility

PROGRAM OUTCOMES

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 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. **EnvironmentandSustainability**:Understandtheimpactoftheprofessionalengineeringsolutions 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.

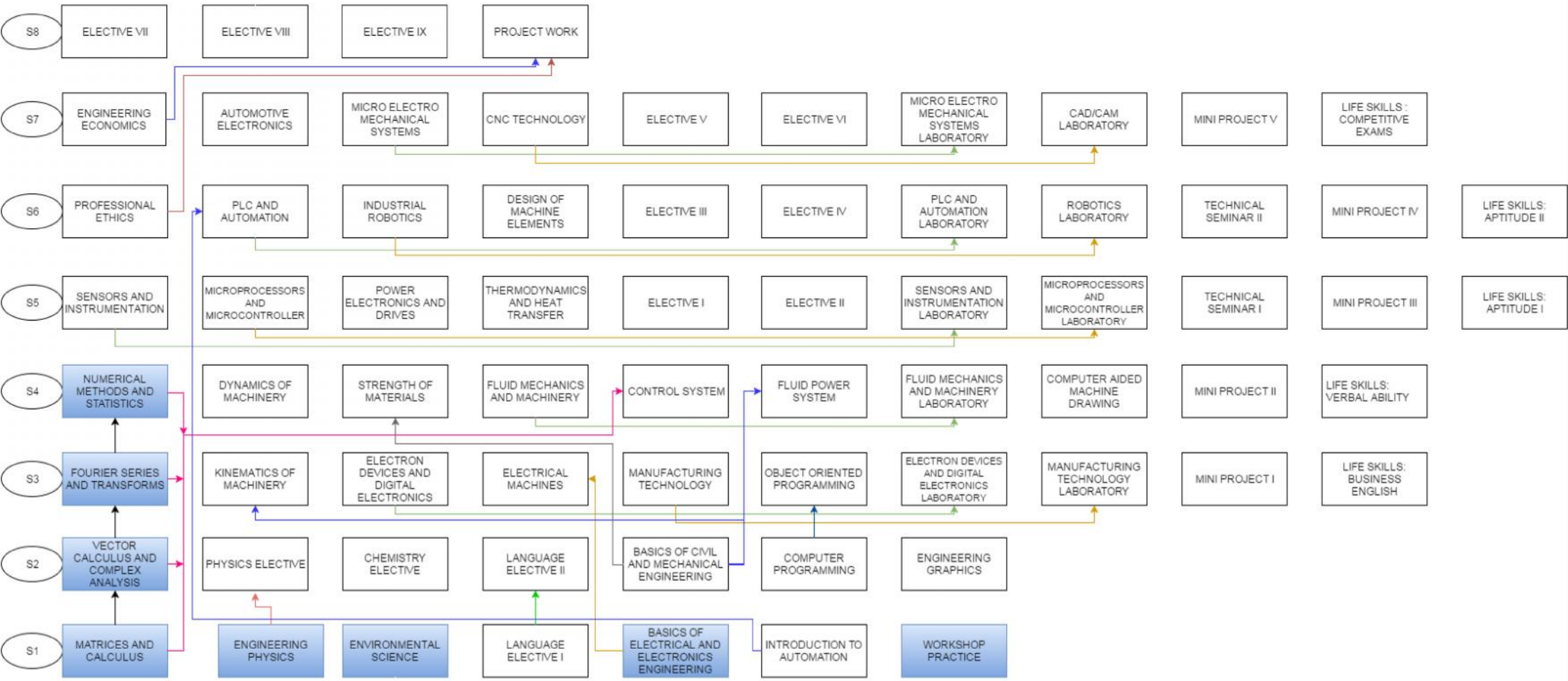
k. **Project Management and Finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to ones own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

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.

MAPPING OF PEOs AND POs

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

DEPARTMENT OF MECHATRONICS
CONNECTIVITY CHART



B.E. MECHATRONICS
Minimum Credits to be Earned : 177

First Semester

Code No.	Course	Objectives & Outcomes		L	T	P	C	Maximum Marks			Category
		PEOs	POs					CA	ES	Total	
15MA101	MATRICES AND CALCULUS*	I	a,b	3	2	0	4	50	50	100	BS
15PH102	ENGINEERING PHYSICS*	I	a	2	0	2	3	50	50	100	BS
15CH103	ENVIRONMENTAL SCIENCE*	II	g	2	0	2	3	50	50	100	HSS
	LANGUAGE ELECTIVE I#	-	-	-	-	-	3	100	-	100	HSS
15GE105	BASICS OF ELECTRICAL AND ELECTRONICS ENGINEERINGΔ	I	a	2	0	2	3	50	50	100	ES
15MC106	INTRODUCTION TO AUTOMATION	I	a,b,c	2	0	2	3	50	50	100	ES
15GE107	WORKSHOP PRACTICEΩ	I	b	0	0	2	1	50	50	100	ES
			Total	11	2	10	20	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*	I	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
15GE205	BASICS OF CIVIL AND MECHANICAL ENGINEERING⊕	I	a	3	0	0	3	50	50	100	ES
15GE206	COMPUTER PROGRAMMINGΨ	III	a,b,e	3	0	2	4	50	50	100	ES
15GE207	ENGINEERING GRAPHICSλ	I,II	a,b,d,e	0	0	4	2	50	50	100	ES
			Total	9	2	6	24	400	300	700	-

* Common to all branches of B.E./B.Tech
# Common to all branches of B.E./B.Tech (Continuous Assessment)
Δ Common to AE,AG,AU,CE,ME,MTRS, BT,TT,FD (I Semester) and to CSE,FT,IT (II Semester)
Ω Common to AE, AG,AU,ME,MTRS, BT,FT,TT ,FD (I Semester) and to CE,CSE,ECE,EEE,EIE,IT (II Semester)
⊕ Common to CSE,ECE,EEE,EIE,FT,IT (I Semester) and to MTRS, BT,TT, FD (II Semester)
Ψ Common to CE (I Semester) and to AE,AG,AU, ME,MTRS, BT,FT,TT,FD (II Semester)
λ Common to CE,CSE,ECE,EEE,EIE,IT (I Semester) and to AE, AG,AU,ME,MTRS, BT,FT,TT, FD (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$^{\alpha}$	I	a	3	2	0	4	50	50	100	BS
15MC302	KINEMATICS OF MACHINERY	I,II	a,b,c	3	2	0	4	50	50	100	PC
15MC303	ELECTRON DEVICES AND DIGITAL ELECTRONICS	II	a,b,c	3	0	0	3	50	50	100	ES
15MC304	ELECTRICAL MACHINES	I,II	a,b,c,d	3	0	2	4	50	50	100	PC
15MC305	MANUFACTURING TECHNOLOGY	II	a,c	3	0	0	3	50	50	100	PC
15MC306	OBJECT ORIENTED PROGRAMMING	III	a,b,e,h,i	2	0	2	3	50	50	100	ES
15MC307	ELECTRON DEVICES AND DIGITAL ELECTRONICS LABORATORY	II,III	d,e,h	0	0	2	1	50	50	100	ES
15MC308	MANUFACTURING TECHNOLOGY LABORATORY	I,III	a,f,h,k	0	0	2	1	50	50	100	PC
15MC309	MINI PROJECT I	I,II,III	a-l	0	0	2	1	100	-	100	EES
15GE310	LIFE SKILLS: BUSINESS ENGLISH$^{\Phi}$	III	j	0	0	2	-	100	-	100	EES
			Total	17	4	12	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$^{\beta}$	I	a	2	2	0	3	50	50	100	BS
15MC402	DYNAMICS OF MACHINERY	I,II	a,b,c	3	2	0	4	50	50	100	PC
15MC403	STRENGTH OF MATERIALS	I,II	a,b,c	3	2	0	4	50	50	100	PC
15MC404	FLUID MECHANICS AND MACHINERY	I,II	a,b,c,d,e	3	0	0	3	50	50	100	ES
15MC405	CONTROL SYSTEM	I,II	a,b,c	3	2	0	4	50	50	100	PC
15MC406	POWER ELECTRONICS AND DRIVES	I,II,III	a,b,c,e,f	3	0	2	4	50	50	100	PC
15MC407	FLUID MECHANICS AND MACHINERY LABORATORY	I,II,III	a,b,d,h	0	0	2	1	50	50	100	ES
15MC408	COMPUTER AIDED MACHINE DRAWING	III	f,h,i	0	0	2	1	50	50	100	PC
15MC409	MINI PROJECT II	I,II,III	a-l	0	0	2	1	100	-	100	EES
15GE410	LIFE SKILLS: VERBAL ABILITY$^{\Phi}$	III	j	0	0	2	-	100	-	100	EES
			Total	17	8	10	25	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**	
15MC501	SENSORS AND INSTRUMENTATION	II	a,c,e	3	0	0	3	50	50	100	PC
15MC502	MICROPROCESSORS AND MICROCONTROLLER	I,II	a,b,c	3	0	0	3	50	50	100	PC
15MC503	FLUID POWER SYSTEM	II	a,c,e,i	2	0	2	3	50	50	100	PC
15MC504	THERMODYNAMICS AND HEAT TRANSFER	I,II	a,b,c,e	3	2	0	4	50	50	100	PC
	ELECTIVE I	-	-	-	-	-	3	50	50	100	PE
	ELECTIVE II	-	-	-	-	-	3	50	50	100	PE
15MC507	SENSORS AND INSTRUMENTATION LABORATORY	III	a,b,c,h,i	0	0	2	1	50	50	100	PC
15MC508	MICROPROCESSORS AND MICROCONTROLLER LABORATORY	I,II,III	b,d,f,h,i	0	0	2	1	50	50	100	PC
15MC509	TECHNICAL SEMINAR I	I,II,III	i,j	0	0	2	1	50	50	100	EEC
15MC510	MINI PROJECT III	I,II,III	a-l	0	0	2	1	100	-	100	EEC
15GE511	LIFE SKILLS: APTITUDE I[Φ]	I	a,b	0	0	2	-	100	-	100	EEC
			Total	11	2	12	23	650	450	1100	-

Sixth Semester											
Code No.	**Course**	**Objectives & Outcomes**		**L**	**T**	**P**	**C**	**Maximum Marks**			**Category**
		PEOs	**POs**					**CA**	**ES**	**Total**	
15GE601	PROFESSIONAL ETHICS[+]	II,III	f,g,h	2	0	0	2	50	50	100	HSS
15MC602	PLC AND AUTOMATION	I,II,III	a,b,c,e,f,h,i	3	0	0	3	50	50	100	PC
15MC603	INDUSTRIAL ROBOTICS	II	a,b,e	3	0	0	3	50	50	100	PC
15MC604	DESIGN OF MACHINE ELEMENTS	I,II	a,b,c,e	3	2	0	4	50	50	100	PC
	ELECTIVE III	-	-	-	-	-	3	50	50	100	PE
	ELECTIVE IV	-	-	-	-	-	3	50	50	100	PE
15MC607	PLC AND AUTOMATION LABORATORY	I,II,III	b,c,e,h	0	0	2	1	50	50	100	PC
15MC608	ROBOTICS LABORATORY	II	b,d,e,h,i	0	0	2	1	50	50	100	PC
15MC609	TECHNICAL SEMINAR II	I,II,III	i,j	0	0	2	1	50	50	100	EEC
15MC610	MINI PROJECT IV	I,II,III	a-l	0	0	2	1	100	-	100	EEC
15GE611	LIFE SKILLS: APTITUDE II[Φ]	I	a,b	0	0	2	-	100	-	100	EEC
			Total	11	2	10	22	650	450	1100	-

[Φ] Common to all branches of B.E./B.Tech (Non-Credit Course)

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

Seventh Semester											
Code No.	**Course**	**Objectives & Outcomes**		**L**	**T**	**P**	**C**	**Maximum Marks**			**Category**
		PEOs	**POs**					**CA**	**ES**	**Total**	
15GE701	ENGINEERING ECONOMICS[$]	I,II,III	a,f,g,k,l	3	0	0	3	50	50	100	HSS
15MC702	AUTOMOTIVE ELECTRONICS	I,II	b,e	3	0	0	3	50	50	100	PC
15MC703	MICRO ELECTRO MECHANICAL SYSTEMS	I,II,III	b,d,e,f	3	0	0	3	50	50	100	PC
15MC704	CNC TECHNOLOGY	II	e,f	3	0	0	3	50	50	100	PC
	ELECTIVE V	-	-	-	-	-	3	50	50	100	PE
	ELECTIVE VI	-	-	-	-	-	3	50	50	100	PE
15MC707	MICRO ELECTRO MECHANICAL SYSTEMS LABORATORY	I,II,III	b,d,e,f	0	0	2	1	50	50	100	PC
15MC708	CAD/CAM LABORATORY	I,II,III	b,c,f,h,i	0	0	2	1	50	50	100	PC
15MC709	MINI PROJECT V	I,II,III	a-l	0	0	2	1	100	-	100	EEC
15GE710	LIFE SKILLS : COMPETITIVE EXAMS[Φ]	I,III	a,b,l	0	0	2	-	100	-	100	EEC
			Total	12	0	8	21	600	400	1000	-

Eight Semester											
Code No.	**Course**	**Objectives & Outcomes**		**L**	**T**	**P**	**C**	**Maximum Marks**			**Category**
		PEOs	**POs**					**CA**	**ES**	**Total**	
	ELECTIVE VII	-	-	-	-	-	3	50	50	100	PE
	ELECTIVE VIII	-	-	-	-	-	3	50	50	100	PE
	ELECTIVE IX	-	-	-	-	-	3	50	50	100	PE
15MC804	PROJECT WORK	I,II,III	a-l	-	-	-	9	50	50	100	EEC
			Total	-	-	-	18	200	200	400	-

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

[Φ] 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	III	j	3	0	0	3
15LE102	COMMUNICATIVE ENGLISH I	III	j	3	0	0	3
15LE201	BASIC ENGLISH II	III	j	3	0	0	3
15LE202	COMMUNICATIVE ENGLISH II	III	j	3	0	0	3
15LC203	CHINESE	III	j	3	0	0	3
15LF203	FRENCH	III	j	3	0	0	3
15LG203	GERMAN	III	j	3	0	0	3
15LH203	HINDI	III	j	3	0	0	3
15LJ203	JAPANESE	III	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	3	0	2	4
15CH202	APPLIED CHEMISTRY	I	a,b,d	3	0	2	4
15CH203	APPLIED ELECTROCHEMISTRY	I	a,b	3	0	2	4
15CH204	INDUSTRIAL CHEMISTRY	I	a,b	3	0	2	4
15CH205	WATER TECHNOLOGY AND GREEN CHEMISTRY	I	a,b	3	0	2	4
DISCIPLINE ELECTIVES							
15MC001	DESIGN FOR MANUFACTURE AND ASSEMBLY	II	c,e	3	0	0	3
15MC002	MAINTANANCE ENGINEERING	II,III	c,j	3	0	0	3
15MC003	ENGINEERING MATERIALS AND METALLURGY	II,III	a,c,d,e,g,h,k	3	0	0	3
15MC004	PRODUCT DESIGN AND COSTING	I,II,III	b,c,d,e,f,g,h,i,k	3	0	0	3
15MC005	RAPID PROTOTYPING	I,III	a,f	3	0	0	3
15MC006	DIGITAL SIGNAL PROCESSING	II	a,b,c	3	0	0	3
15MC007	SOFT COMPUTING	II,III	e,f	3	0	0	3
15MC008	LINEAR INTEGRATED CIRCUITS	II,III	a,b,c	3	0	0	3

15MC009	INDUSTRIAL ELECTRONICS	II,III	a,b,c	3	0	0	3
15MC010	FUZZY LOGIC AND NEURAL NETWORKS	I,II	a,c,e	3	0	0	3
15MC011	BIOMEDICAL INSTRUMENTATION	III	a,e,g,l	3	0	0	3
15MC012	PROCESS CONTROL	II	c,e	2	0	2	3
15MC013	INDUSTRIAL ENGINEERING	I,II	a,b,c	3	0	0	3
15MC014	EMBEDDED SYSTEM DESIGN	I,II	a,b,c,d	3	0	0	3
15MC015	CAM AND FACTORY AUTOMATION	II	a,c,e	3	0	0	3
15MC016	INDUSTRIAL METROLOGY	I,II	a,c,e	3	0	0	3
15MC017	OPTIMAL CONTROL SYSTEM	I,II	a,b,c,d,e	3	0	0	3
15MC018	INDUSTRIAL DRIVES AND CONTROL	I,II	a,b,c,d,e	2	0	2	3
15MC019	ROBOTICS – PREHENSION & PROGRAMMING	I,II	a,b,c,d,e	3	0	0	3
15MC020	TOTAL QUALITY MANAGEMENT	I,II	a,b,d,e,h	3	0	0	3
ENTREPRENEURSHIP ELECTIVES							
15GE001	ENTREPRENEURSHIP DEVELOPMENT I	I,II,III	b,c,d,e,f,k	3	0	0	3
15GE002	ENTREPRENEURSHIP DEVELOPMENT II	I,II,III	b,c,h,i,j,k	3	0	0	3
PHYSICAL SCIENCE ELECTIVES							
15GE0P1	NANOMATERIALS SCIENCE	I	a,b	3	0	0	3
15GE0P2	SEMICONDUCTOR PHYSICS & DEVICES	I	a,b	3	0	0	3
15GE0P3	APPLIED LASER SCIENCE	I	a,b	3	0	0	3
15GE0C1	CORROSION SCIENCE	I	a,b,g	3	0	0	3
15GE0C2	ENERGY STORING DEVICES AND FUEL CELLS	I	a,b,d	3	0	0	3
15GE0C3	POLYMER CHEMISTRY AND PROCESSING	I	a,b,c	3	0	0	3
OPEN ELECTIVES							
15MC0YA	FUNDAMENTALS OF AUTOMATION	I,II,III	b,c,e,f	3	0	0	3
15MC0YB	ROBOTICS	I,II,III	a,b,c,e,f	3	0	0	3
15MC0YC	MICRO ELECTRO MECHANICAL SYSTEMS	I,II,III	a,c,f	3	0	0	3
15MC0YD	SENSORS AND SIGNAL CONDITIONING	I,II,III	a,c,j	3	0	0	3
15MC0YE	MECHATRONICS	I,II,III	a,b,c,f,i,j,k	3	0	0	3
15MC0YF	MACHINE VISION	I,II,III	c,d,e	3	0	0	3
ONE CREDIT COURSES							
15MC0XA	INDUSTRIAL HYDRAULICS	II	c,e	-	-	-	1
15MC0XB	AC/DC DRIVES	II	c,e	-	-	-	1
15MC0XC	BASICS OF MS EXCEL	II	e,j	-	-	-	1
15MC0XD	ANALYSIS USING PIVOT TABLE	II	e,j	-	-	-	1
15MC0XE	ONLINE WEB MONITORING	II	e,j	-	-	-	1
15MC0XF	TOOLING FOR CNC MACHINING	I	c,e	-	-	-	1

15MC0XG	PRODUCT LIFE CYCLE MANAGEMENT	II	b,f,g	-	-	-	1
15MC0XH	DESIGN AND ASSEMBLY OF ELECTRONIC COMPONENTS IN PCB	I,II	b,c	-	-	-	1
15MC0XI	ELECTRONICS ENGINE MANAGEMENT SYSTEM	I,II	b,c,g	-	-	-	1
15MC0XJ	SMART FACTORY	I,II	b,c,g	-	-	-	1
15MC0XK	ADVANCED METROLOGY AND QUALITY CONTROL	I,II	c,e,f,g	-	-	-	1
15MC0XL	PRODUCTION AUTOMATION	I,II	b,c,g	-	-	-	1
15MC0XM	CNC SERVICING	I,II	c,e,f,g	-	-	-	1
15MC0XN	INTEGRATED PRODUCT DESIGN IN VALVES	I,II	b,c,d	-	-	-	1
ADDITIONAL ONE CREDIT COURSES (I to III Semesters)							
15GE0XA	HEALTH & 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			
BRIDGE COURSES							
15MCB01	INTRODUCTION TO AUTOMATION						
15MCB02	BASICS OF ELECTRICAL AND MECHANICAL ENGINEERING						

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	14.5%	15%	20%
2	ES	7	9	7	4					27	15.2%	15%	20%
3	HSS	6	3				2	3		14	7.9%	5%	10%
4	PC			12	17	15	12	11		67	37.8%	30%	40%
5	PE					6	6	6	9	27	15.2%	10%	15%
6	EEC			1	1	2	2	1	9	16	9%	10%	15%
Total		20	24	24	25	23	22	21	18	177	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)
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. Apply the suitable techniques and solve the higher order ordinary differential equations.
4. Characterize the functions and get the solutions of the unconstrained maxima and minima
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
1												
2												
3												
4												
5												

UNIT I **12 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 **13 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 **12 Hours**

MULTIVARIABLE CALCULUS

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

UNIT V **11 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: 86 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.

15PH102 ENGINEERING PHYSICS 2 0 2 3

Course Objectives

- Impart knowledge in properties of matter, crystallography and ultrasonics
- Understand the applications of lasers and fiber optics
- 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.
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 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	2	2							1					
2	2	2							1					
3	2	2							1					
4	2	2							1					
5	2	2							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 **1 Hours**

INTRODUCTION

Exposure to Engineering Physics Laboratory and precautionary measures

2 **2 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 **2 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 **2 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 **2 Hours**

EXPERIMENT 4

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

6 **2 Hours**

EXPERIMENT 5

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

7 **2 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 **2 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: 45 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.

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 the public 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. 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												
3			3			3	1							
4			2			1	3							
5			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

3 **4 Hours**

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

15GE105 BASICS OF ELECTRICAL AND ELECTRONICS ENGINEERING

2 0 2 3

Course Objectives

- To understand the basic concepts of electric circuits and magnetic circuits.
- To illustrate the construction and operation of various electrical machines and semiconductor devices.
- To Learn the fundamentals of communication 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.
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.
m. Analyze, design and develop electro mechanical system using contemporary tools
n. Acclimate multidisciplinary approach to solve complex engineering problems associated with mechanical, control systems, robotics, drives and automation.

Course Outcomes (COs)

1. Apply the fundamental laws to electric circuits and compute the different alternating quantities.
2. Apply the laws of magnetism for the operation of DC motor.
3. Examine the construction and working principle of different AC machines
4. Analyze the different speed control methods of DC motors and special machines.
5. Analyze the performance characteristics and applications of semiconductor devices.

Articulation Matrix

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

UNIT I **7 Hours**

ELECTRIC CIRCUITS

Definition of Voltage, Current, Electromotive force, Resistance, Power & Energy, Ohms law and Kirchoffs Law & its applications - Series and Parallel circuits - Voltage division and Current division techniques - Generation of alternating emf - RMS value, average value, peak factor and form factor- Definition of real, reactive and apparent power.

UNIT II **5 Hours**

DC MACHINES

Introduction of magnetic circuits - Law of Electromagnetic induction, Flemings Right & Left hand rule- Types of induced emf - Definition of Self and Mutual Inductance - DC Motor- Contruction - Working Principle- Applications.

UNIT III **6 Hours**

AC MACHINES

Single Phase Transformer - Alternator - Three phase induction motor - Single phase induction motor - Contruction - Working Principle - Applications.

UNIT IV **5 Hours**

ELECTRICAL DRIVES

Speed control of dc shunt motor and series motor - Armature voltage control - Flux control - Construction and operation of DC servo motor - Construction and operation of DC servo motor stepper motor.

UNIT V **7 Hours**

ELECTRON DEVICES AND COMMUNICATION

Characteristics of PN Junction diode and Zener diode - Half wave and Full wave Rectifiers - Bipolar Junction Transistor - Operation of NPN and PNP transistors - Logic gates - Introduction to communication systems.

FOR FURTHER READING

Voltage Regulator - Stepper motor - Energy meter - SMPS, Satellite and Optical communication.

1 **4 Hours**

EXPERIMENT 1

Analyze the VI characteristics of a fixed resistor and a lamp by varying its temperature.

2 **4 Hours**

EXPERIMENT 2

Apply the voltage division and current division techniques for series and parallel connections of lamp loads.

3 **4 Hours**

EXPERIMENT 3

Understand the concept of electromagnetic induction using copper coil.

4 **4 Hours**

EXPERIMENT 4

Understand the construction and working principle of DC machines.

5 **6 Hours**

EXPERIMENT 5

Determine the VI Characteristics of PN Junction diode and plot the input and output wave shapes of a half wave rectifier.

6 **4 Hours**

EXPERIMENT 6

Realize the working of transistor as an electronic switch through experiments.

7 **4 Hours**

EXPERIMENT 7

Lighting applications using logic gates principle.

Total: 60 Hours

Reference(s)

1. T. K. Nagsarkar and M. S. Sukhija, Basic of Electrical Engineering, Oxford University Press, 2011.
2. Smarjith Ghosh, Fundamentals of Electrical and Electronics Engineering, Prentice Hall (India) Pvt. Ltd., 2010
3. A. Sudhakar, Shyammohan S Palli, Circuits and Networks Analysis and Synthesis, Tata McGraw Hill, 2010
4. R. S. Sedha, A Textbook of Applied Electronics, S.Chand & Company Ltd, 2013
5. Muthusubramanian & Salivahanan, Basic Electrical and Electronics Engineering and Communication Engineering, Seventh Edition, Tata MCGraw Hill Education Private Limited, 2011

15MC106 INTRODUCTION TO AUTOMATION 2 0 2 3

Course Objectives

- To Impart fundamental knowledge in the areas of robotic system
- To apply the fundamental knowledge of hydraulic and pneumatic system
- To provide an overall view on Programmable Logic Controllers (PLC) and its application

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.
n. Acclimate multidisciplinary approach to solve complex engineering problems associated with mechanical, control systems, robotics, drives and automation.

Course Outcomes (COs)

1. Interpret the fundamentals of a control systems and industrial robots
2. Identify different types of sensors and transducers used in automation
3. Classify various types of valves and actuators used in hydraulic and pneumatic systems.
4. Summarize different types of mechanical and electrical actuation systems.
5. Illustrate the architecture of PLC and its programs

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

UNIT I **6 Hours**

INTRODUCTION TO MECHATRONICS AND ROBOTICS

Introduction - Systems - Open loop system - closed loop system, Basic elements, sequential controller and Microprocessor based controllers. Industrial Robot: Definition, laws of robots - Robot Anatomy - Robot configurations - motions - work volume - drive system - Types of Robot Controls - Precision of movement - Application

UNIT II **6 Hours**

SENSORS AND TRANSDUCERS

Introduction to sensors and transducers, Types - Displacement, position and proximity - velocity and motion - force - fluid pressure - liquid flow and level - Temperature - Light - Selection of sensors

UNIT III **6 Hours**

HYDRAULICS AND PNEUMATICS SYSTEM

Pneumatic and hydraulic systems: Actuation system - Direction Control Valves - Pressure Control Valves-Cylinders - Cylinder Sequencing - Servo and Proportional Control Valves - Process Control Valves - Rotary Actuator

UNIT IV **6 Hours**

MECHANICAL AND ELECTRICAL ACTUATION SYSTEMS

Mechanical actuation System: Mechanical system - types of motion - Kinematic chain - cams - Gear Trains - Ratchet and pawl - Belt and chain drives - Bearings - Mechanical aspects of Motor selection. Electrical actuation system: Electrical Systems - Mechanical switches - Solid state switches - Solenoids - Stepper motor

UNIT V **6 Hours**

PROGRAMMABLE LOGIC CONTROLLER

Introduction - Basic structure - Input/output processing - programming - Mnemonics - Timers, relays and counters - Shift registers - Data handling - Analogue input/output - Selection of PLC - Simple problems

FOR FURTHER READING

Application of PLC - Elevator control, traffic light control, sensors in automobiles, ATM & mobiles phones, introduction to Smart Sensors (basics only)

1 **3 Hours**

EXPERIMENT 1

Identification of various components in the pneumatic system and hydraulic system to understand their working principle. Symbolic representation of each and every component.

2 **3 Hours**

EXPERIMENT 2

Automating the operation of a machine vice according to specified need using pilot valves.

3 **3 Hours**

EXPERIMENT 3

Automating the operation of a machine by means of electrical signals and distinguishing the actuation of cylinders using solenoid valves and pilot actuated valves.

4 **3 Hours**

EXPERIMENT 4

Identifying proper circuit to control the speed of a double acting cylinder and performing the same.

5 **3 Hours**

EXPERIMENT 5

Designing a simple pneumatic direct control circuit using FluidSIM software to open and close the Gate of a factory such that by operating a push button valve, gate should open or close.

6 **3 Hours**

EXPERIMENT 6

Using FluidSIM software design a pneumatic circuit with a double acting cylinder and 5/2 air spring valve to open the main gate of a factory which can be controlled by a security personnel from the security room.

7 **4 Hours**

EXPERIMENT 7

Designing a pneumatic circuit by FluidSIM software using a double acting cylinder and 5/2 air spring valve to lift the carton boxes at the loading point. The raising and lowering speeds are to be adjustable separately.

8 **4 Hours**

EXPERIMENT 8

There are three double acting cylinders. The cylinders are extended first one after another. After the extension of the entire three cylinders they want to retract one after another from the first cylinder and the operations to the continued. Also there is a need to stop the piston of the cylinder within the required length. Design a suitable circuit.

9 **4 Hours**

EXPERIMENT 9

Application based Experiment Clamping of work piece using two single acting cylinder

Total: 60 Hours

Reference(s)

1. W. Bolton, Mechatronics: electronic control systems in mechanical and electrical engineering, Pearson Education (Singapore) Pvt. Ltd., New Delhi, 2006
2. Devdas Shetty and Richard A. Kolk, Mechatronics System Design, Cengage Delmar Learning India Pvt Learning, 2012.
3. Mikell P.Groover, Automation, Production Systems and Computer Integrated Manufacturing, Prentice Hall of India Private Limited, New Delhi, 2008.
4. V. S. Bagad, Mechatronics, Technical Publication, Pune, 2009.
5. Mikell P.Groover, Mitchall Lueiss, Roger N. Nagel and Nicholas G.Odery, Industrial Robotics Technology, Programming and Application, McGraw Hill Book Company, Singapore, 1996.

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.
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.
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 ones own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

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

1 **1 Hours**

EXPERIMENT 1

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

2 **2 Hours**

EXPERIMENT 2

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

3 **1 Hours**

EXPERIMENT 3

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

4 **1 Hours**

EXPERIMENT 4

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

5 **2 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 **2 Hours**

EXPERIMENT 6

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

7 **2 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 **2 Hours**

EXPERIMENT 8

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

9 **1 Hours**

EXPERIMENT 9

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

10 **1 Hours**

EXPERIMENT 10

Mini Project(Fabrication of Small Components).

Total: 15 Hours

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)

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. Explain 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
1												
2												
3												
4												
5												

UNIT I **13 Hours**

VECTOR CALCULUS

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

UNIT II **12 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 **11 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 **11 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 **13 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: 90 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

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. Identify various mechanical properties of materials and illustrate the various manufacturing processes
4. Classify and explain the working principles and operations of Internal Combustion Engines and Refrigeration cycles.
5. 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	1													
2	1						-							
3	3						-							
4	2													
5	1						-							

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

15GE206 COMPUTER PROGRAMMING 3 0 2 4

Course Objectives

- To learn the basics of computer organisation.
- To study the basics of C primitives, operators and expressions.
- To understand the different primitive and user defined data types.

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.
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.
n. Acclimate multidisciplinary approach to solve complex engineering problems associated with mechanical, control systems, robotics, drives and automation.

Course Outcomes (COs)

1. Develop solutions using problem solving techniques and number system conversions
2. Develop programs using operators, type conversion and input-output functions
3. Apply decision making and looping statements in writing C programs
4. Apply the concepts of arrays and strings in developing C programs
5. Design applications using structures and functions in C

Articulation Matrix

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

UNIT I **8 Hours**

INTRODUCTION TO COMPUTERS

Introduction to computers - Characteristics of Computers - Evolution of Computers - Computer Generations - Basic Computer Organization - Number System - Problem Solving Techniques - Features of a Good Programming Language.

UNIT II **9 Hours**

INTRODUCTION TO C PROGRAMMING

Overview of C-Structure of C program-Keywords-Constants- Variables-Data types-Type conversion Operators and Expressions: Arithmetic-Relational-Logical-Assignment- Increment and Decrement-Conditional-Bitwise -Precedence of operators-Managing I/O operations-Formatted I/O-Unformatted I/O.

UNIT III **10 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 statement Jump Statements: goto-break-continue-return statement

UNIT IV **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 V **9 Hours**

STRUCTURES AND FUNCTIONS

Structures and Unions: Introduction-defining a structure- declaring structure variables-accessing structure members- structure initialization-Unions-Enumerated data type
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-Preprocessor directives and macros.

FOR FURTHER READING

Creating and manipulating document using word - Mail merge - Creating spread sheet with charts and formula using excel - developing power point presentation with Animations - C graphics using built in functions

1 **1 Hours**

EXPERIMENT 1

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

2 **1 Hours**

EXPERIMENT 2

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

3 **1 Hours**

EXPERIMENT 3

Write a C program to find the greatest of three numbers using if-else statement.

4 **2 Hours**

EXPERIMENT 4

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

5 **2 Hours**

EXPERIMENT 5

Write a C program to generate pyramid of numbers using for loop.

6 **3 Hours**

EXPERIMENT 6

Write a C program to perform Matrix Multiplication

7 **2 Hours**

EXPERIMENT 7

Write a C program to check whether the given string is Palindrome or not.

8 **2 Hours**

EXPERIMENT 8

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

9 **2 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:

Total: 61 Hours

Reference(s)

1. Pradeep K. Sinha, Priti Sinha, Computer Fundamentals, BPB publications, 2008
2. Ashok. N. Kamthane, Computer Programming, Second Edition, Pearson Education, 2012
3. E.Balagurusamy, Programming in ANSI C, Tata McGraw-Hill, 2012
4. Herbert Schildt, C -The complete Reference, Tata McGraw-Hill, 2013
5. Byron Gottfried, Programming with C, Schaum's Outlines, Tata Mcgraw-Hill, 2013

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 the public 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.
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, and give and receive clear instructions.
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. Analyze, design and develop electro mechanical system using contemporary tools

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

1 **6 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.

2 **6 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.

3 **6 Hours**

SECTION OF SOLIDS AND DEVELOPMENT OF SURFACE

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

4 **6 Hours**

ISOMETRIC AND PERSPECTIVE PROJECTIONS

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

5 **6 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: 30 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.

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. Identify 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
1	1											
2	1	2										
3	1											
4	1	3										
5	1											

UNIT I **12 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 **12 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 **11 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 **11 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.

UNIT V **12 Hours**

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: 88 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.

15MC302 KINEMATICS OF MACHINERY 3 2 0 4

Course Objectives

- To learn various mechanisms and find their velocity and acceleration
- To generate the cam profile for radial cams
- To determine gear ratio for simple, compound, reverted and epicycle gear train
- To understand the effects of dry friction in transmission and in machine components

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. Compute the mobility of a given planar mechanism
2. Apply vector mechanics principles to draw the velocity and acceleration diagram of planar mechanisms
3. Construct the cam profile for a given type of follower
4. Analyze the effects of friction in various machine components
5. Compute speed ratio of major gear trains

Articulation Matrix

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

UNIT I **9 Hours**

BASICS OF MECHANISMS

Basic concepts of link, pair, chain, mechanism, machine and structure, degree of freedom, mobility of mechanism - Kutzbach criterion, Grashoffs law Inversions of mechanisms Four bar and slider crank Mechanical advantage Transmission angle Description of some common mechanisms Straight line generators, dwell mechanisms, ratchets and escapements, universal joint Basic structures of robot manipulators (serial and parallel)

UNIT II **9 Hours**

KINEMATICS

Displacement, velocity and acceleration - Graphical method of velocity (relative velocity method) and acceleration diagrams for simple mechanisms - Kliens construction for single slider crank mechanism Coriolis component of acceleration

UNIT III **9 Hours**

KINEMATICS OF CAM

Classifications of cam and follower Radial cam nomenclature Analysis of follower motion uniform velocity motion, Simple harmonic motion, uniform acceleration and retardation motion and cycloidal motion Construction of cam profile for a radial cam Pressure angle and undercutting

UNIT IV **9 Hours**

DRY FRICTION

Types of Friction Types of Dry friction: Static, Dynamic and Rolling friction - Laws Friction in inclined plane and screw threads Friction in Journal bearings Friction in clutches Single plate and multi plate clutches, Cone clutches Friction in flat and V-belt drives - Friction aspects in brakes

UNIT V **9 Hours**

GEARS AND GEAR TRAINS

Law of toothed gearing Involutes and cycloidal tooth profiles Spur gear terminology and definitions Gear tooth action Interference and undercutting Problems Helical, bevel, worm, rack and pinion gears [basics only] - Introduction to gear correction gear trains Speed ratio, train value Parallel axis gear trains Epicyclic gear trains - Determination of gear speeds using tabular method

FOR FURTHER READING

Internal and external shoe brakes - Davis and Ackermanns steering mechanisms - Instantaneous method of velocity and acceleration diagram - Tangent and circular arc cams - Automobile gear box: constant mesh

Total: 75 Hours

Reference(s)

1. S. S. Rattan, Theory of Machines, Tata McGraw Hill Publishing Company Limited, New Delhi, 2014.
2. Ashok G. Ambekar, Mechanism and Machine Theory, Prentice Hall of India Learning. Ltd., New Delhi, 2009
3. Joseph E. Shigley, John J. Uicker and Gordon R. Pennock, Theory of Machines and Mechanism, Tata McGraw-Hall Publishing Company Limited, New Delhi, 2009
4. R. S. Khurmi and J. K. Gupta, Theory of Machines, Eurasia Publishing House, New Delhi, 2008.
5. Kenneth J.Waldron and Garny L. Kinzel, Kinematics, Dynamics and Design of Machinery, Wiley India Pvt. Ltd., New Delhi, 2007

15MC303 ELECTRON DEVICES AND DIGITAL ELECTRONICS

3 0 0 3

Course Objectives

- To understand the fundamentals of digital logic
- To understand the various number systems and codes
- To design various combinational and sequential circuits
- To study the basics about synchronous and asynchronous 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 the public health and safety, and the cultural, societal, and environmental considerations.

Course Outcomes (COs)

1. Analyze the operation of JFET, MOSFET using semiconductor properties
2. Design the structure of six number systems and its application in digital logic design
3. Analyze, design, produce and troubleshoot a combinational circuit using digital ICs
4. Analyze, design, produce and troubleshoot a sequential circuit using digital ICs
5. Generate various synchronous and asynchronous sequential circuits for several applications

Articulation Matrix

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

UNIT I **9 Hours**

FIELD EFFECT TRANSISTORS

JFET's Drain and Transfer characteristics,-Current equations-Pinch off voltage and its significance-MOSFET- Characteristics- Threshold voltage -Channel length modulation, D-MOSFET, E-MOSFET-, Current equation - Equivalent circuit model and its parameters.

UNIT II **9 Hours**

MINIMIZATION TECHNIQUES AND LOGIC GATES

Number systems, Basic digital circuits: Logic cricuits - universal building block construction using logic gates - Boolean Algebra- Simplification of Boolean functions - special forms of Boolean functions minterm (SOP) maxterm (POS) - K Map representation of logic functions - simplification of logic functions using K Map - Dont care conditions

UNIT III **9 Hours**

COMBINATIONAL CIRCUITS

Half and Full Adders-Half and Full Subtractors - Code converters - Encoder-Decoder - Multiplexer-Demultiplexer - Binary/ BCD adders, subtractors - Carry look ahead adder- parity checker-parity generators- Magnitude comparator

UNIT IV **11 Hours**

SEQUENTIAL CIRCUITS

General model of sequential circuits - flip-flops - latches - level triggering, edge triggering - master slave configuration - Mealy/Moore models - state diagram - state table - State minimization State assignment Excitation table and maps - shift registers

Sequential Memories: Recirculation shift registers Programmable Logic Devices (PLD) - Programmable Logic Array (PLA) - Programmable Array Logic (PAL) Field Programmable Gate Arrays (FPGA) - Implementation of combinational logic circuits using ROM, PLA, PAL

UNIT V **7 Hours**

SYNCHRONOUS AND ASYNCHRONOUS SEQUENTIAL CIRCUITS

Design of synchronous sequential circuits - parity checker - sequence detector - Asynchronous sequential logic: Race conditions and Cycles - Hazards in combinational circuits.

FOR FURTHER READING

Memory types and terminology - static and dynamic RAM - ECL RAM - Non Volatile RAM --First in first out memories - Magnetic core memories - magnetic disk memories- Magnetic tape and Bubble memories

Total: 45 Hours

Reference(s)

1. M. Morris Mano, Michel D. Ciletti, Digital Design, Pearson Education, New Delhi, 2012.
2. Ronald J. Tocci Neal S. Widmer and Gregory L. Moss, Digital Systems: Principles and Applications, Prentice Hall of India, New Delhi, 2010.
3. A. Anand Kumar, Fundamentals of Digital Circuits, PHI Learning Pvt. Ltd. 2003.
4. Thomas L. Floyd, Digital Fundamentals, Pearson Education Inc, New Delhi, 2003.
5. Donald P.Leach and Albert Paul Malvino, Digital Principles and Applications, Tata McGraw-Hill
6. Charles H.Roth. Fundamentals of Logic Design, Thomson Learning, 2003.

15MC304 ELECTRICAL MACHINES 3 0 2 4

Course Objectives

- To understand the working principle and performance characteristics of DC Generator and DC Motor
- To understand the working principle of induction motor and synchronous machines
- To provide knowledge in the area of special electrical 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.
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.

Course Outcomes (COs)

1. Compare characteristics of different types of DC motor and generator.
2. Implement the equivalent circuit of transformer with help of construction details of transformer
3. Compute the essential parameters for slip-speed characteristics of induction motor
4. Carry out various operating characteristics of synchronous motor to find the regulation.
5. Identify the special electrical machines for specified application.

Articulation Matrix

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

UNIT I **9 Hours**

UNIT I DC MACHINES

Constructional details - Principle - Self and separately excited generators - Characteristics of series and shunt generators. DC Motors: Types - Characteristics of series and shunt motors, starting methods.

UNIT II **9 Hours**

UNIT II TRANSFORMERS

Constructional details - Types of windings - Principle of operation - EMF equation - Transformation ratio - Transformer on no-load and load - Equivalent circuit - Auto transformer.

UNIT III **9 Hours**

UNIT III INDUCTION MACHINES

Three phase induction motors: Constructional details - Types of rotors - Principle of operation - Slip - Slip-torque characteristics - Condition for maximum torque - Losses and efficiency - Starters - Single Phase induction motors: Double field revolving Theory -Types-Applications

UNIT IV **9 Hours**

UNIT IV SYNCHRONOUS MACHINES

Constructional details - Types of rotors, operating characteristics - Emf equation - Synchronous reactance - Armature reaction - Voltage regulation - EMF, MMF, methods - Synchronous motor: Principle of operation - Torque equation - Starting methods - V and inverted V curves

UNIT V **9 Hours**

UNIT V SPECIAL MACHINES

Special machines - Shaded pole induction motor, reluctance motor, repulsion motor, hysteresis motor, stepper motor, servo motor, BLDC. Dynamic, regenerative and plugging.

FOR FURTHER READING

Testing of DC machines - Brake test. Open circuit and short circuit test on transformer, No load and blocked rotor tests, Speed control of DC motor- Armature control and field control, Speed control of induction motor.

1 **4 Hours**

EXPERIMENT 1

Load test on DC shunt motor

2 **4 Hours**

EXPERIMENT 2

Load test on DC series motor

3 **4 Hours**

EXPERIMENT 3

Load characteristics of separately excited DC generator

4 **4 Hours**

EXPERIMENT 4

Load test on single phase transformer

5 **4 Hours**

EXPERIMENT 5

O C and S C test on single phase transformer

6 **4 Hours**

EXPERIMENT 6

Load test on three phase slip ring Induction motor

7 **3 Hours**

EXPERIMENT 7

Speed control of 3 phase Induction motor

8 **3 Hours**

EXPERIMENT 8

Load test on 1 phase Induction motor

Total: 75 Hours

Reference(s)

1. D.P.Kothari and J.J.Nagrath, Electric Machines, Tata McGraw-Hill Publishing Company Ltd, New Delhi, 2010
2. A.E.Fitzgerald, Charles Kingsley and Stephen D. Umans, Electric Machinery, Tata McGraw-Hill Publishing Company Ltd, New Delhi, 2003.
3. Stephen J. Chapman, Electric Machinery Fundamentals, Tata McGraw Hill Publishing Company Limited, New Delhi, 2009.
4. P. S. Bhimbhra, Electrical Machinery, Khanna Publishers, New Delhi, 2007.
5. B.L.Theraja and A.K.Theraja, A Text Book of Electrical Technology - Volume II, S.Chand and Company Ltd, New Delhi, 2007.

15MC305 MANUFACTURING TECHNOLOGY 3 0 0 3

Course Objectives

- To understand working principle of conventional and non conventional casting, welding and metal working processes
- To study the working of machining processes including non-conventional types
- To learn about the production methods of thermo and thermosetting plastics

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.

Course Outcomes (COs)

1. Explain the basics and working principle of sand casting and special casting processes
2. Explain the principles of different joining processes like welding, brazing, soldering and adhesive bonding
3. Identify the suitable metal forming processes for various application
4. Demonstrate the process of conventional machining and explain the principles of a few non-conventional machining processes
5. Recognize suitable method to produce thermo and thermosetting plastics

Articulation Matrix

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

UNIT I **9 Hours**

CASTING PROCESSES

Casting types, procedure to make sand mould, types of core making, moulding tools, machine moulding - Introduction to special casting techniques: CO2 moulding, shell molding, investment casting, permanent mould casting, pressure die casting, centrifugal casting, continuous casting and blow molding process - casting defects.

UNIT II **9 Hours**

JOINING PROCESSES

Introduction to welding process - Principle of arc and gas welding - Tools and equipment - Filler and flux materials - Flame types - Weld defects - Inspection standards - Safety in welding - Other welding processes: resistance welding, ultrasonic welding, TIG welding, MIG welding - Brazing and soldering - Adhesive bonding

UNIT III **9 Hours**

MECHANICAL WORKING OF METALS

Introduction to hot and cold working - Forging: open and close die, upsetting - Rolling: high roll mills and shape rolling - Extrusion: forward and backward, tube extrusion - Drawing of wires, rods and tubes - Sheet metal work: shearing bending and drawing operations - Stretch forming - Special forming methods: hydro forming, rubber pad forming - Powder metallurgy (basics only)

UNIT IV **9 Hours**

MACHINING PROCESSES

Constructional features of machine tools: universal milling machine, shaping machine, cylindrical grinding machine, capstan and turret lathe - Basics of CNC machines - General principles and applications of water jet machining, electro discharge machining, electro chemical machining and laser beam machining

UNIT V **9 Hours**

FORMING AND SHAPING OF PLASTICS

Types of plastics - Characteristics of the forming and shaping processes -Moulding of Thermoplastics - Working principles and typical applications of - Injection moulding -Plunger and screw machines - Blow moulding -Rotational moulding -Film blowing -Extrusion - Typical industrial applications - Thermoforming -Processing of Thermosets -Working principles and typical applications - Compression moulding -Transfer moulding -Bonding of Thermoplastics -Fusion and solvent methods -Induction and Ultrasonic methods

FOR FURTHER READING

Foundry: Disamatic moulding process - Automobile body assembly - Basics of rapid prototyping - Introduction to modular production system.

Total: 45 Hours

Reference(s)

1. J. P. Kaushish, Manufacturing Processes, Prentice Hall of India Learning Private Limited, New Delhi, 2014.
2. P. N. Rao, Manufacturing Technology - Vol I and II, Tata McGraw-Hill Publishing Company Limited, New Delhi, 2013.
3. D. K. Singh, Fundamentals of Manufacturing Engineering, ANE Books, New Delhi, 2008
4. Roy A. Lindberg, Processes and Materials of Manufacture, Prentice Hall of India Learning. Ltd., New Delhi, 2009
5. T. R. Mishra, Non-Conventional Machining, Narosha Publishing House, New Delhi, 2012
6. Mikell P. Groover, Automation, Production System and Computer Integrated Manufacturing,Pearson Education, New Delhi, 2015.

15MC306 OBJECT ORIENTED PROGRAMMING 2 0 2 3

Course Objectives

- To understand the concepts of Object Oriented Programming.
- To study the concepts of objects and classes.
- To solve a real world problem applying the concepts operator overloading, file streams.

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.
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.

Course Outcomes (COs)

1. Summarize the characteristics and data types of C++ language.
2. Exemplify the concepts of objects and classes in C++ language.
3. Develop efficient programs using operator overloading
4. Demonstrate the concepts of polymorphism to large scale software
5. Generate C++ program for real world problems using the concepts of files streams

Articulation Matrix

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

UNIT I **6 Hours**

INTRODUCTION

Need for object oriented programming Procedural Languages vs. Object oriented approach - Characteristics Object oriented programming - C++ Programming Basics: Basic Program Construction - Output Using Cout - Input with Cin - Data types - Variables and Constants Operators - Control Statements-Manipulators - Type conversion

UNIT II **6 Hours**

OBJECTS AND CLASSES

Objects and Classes Simple Class - C++ Objects as Physical Objects C++ Object as Data types- Constructors and Destructors- Object as Function Arguments - Returning Objects from Functions - Structures and Classes - Arrays and Strings.

UNIT III **6 Hours**

OPERATOR OVERLOADING AND INHERITANCE

Operator overloading and Inheritance Need of operator overloading- Overloading Unary Operators- Overloading binary Operators - Overloading Special Operators - Data Conversion Inheritance: Derived Class and Base Class - Derived Class Constructors-Overriding Member Functions-Class Hierarchies-Public and Private Inheritance-Levels of Inheritance-Multiple Inheritance.

UNIT IV **6 Hours**

POLYMORPHISM AND FILE STREAMS

Polymorphism and File Streams Virtual Function Friend Function Static Function-Assignment and Copy Initialization- Memory Management: new and delete Pointers to Objects, this Pointer- Streams String I/O Character I/O Object I/O I/O with Multiple Objects File Pointers Disk I/O with Member Functions- Error Handling in File I/O.

UNIT V **6 Hours**

STREAMS

Stream classes- Formatted I/O- I/O Manipulators- User defined manipulators- File handling-File pointer and manipulation- Sequential and random access- Error handling.

FOR FURTHER READING

Function templates, overloaded function templates, user defined template arguments, class templates - Exception Handling: Exception handling mechanism, multiple catch, nested try, rethrowing the exception Namespaces std namespace- Standard Template Library.

1 **3 Hours**

EXPERIMENT 1

Program using constructors

2 **3 Hours**

EXPERIMENT 2

Program to implement function overloading

3 **3 Hours**

EXPERIMENT 3

Implement the concept of default argument function.

4 **3 Hours**

EXPERIMENT 4

Implement the concept of array of objects

5 **3 Hours**

EXPERIMENT 5

Implement a class with dynamic objects and use constructors and Destructors

6 **3 Hours**

EXPERIMENT 6

Implement the concept of inheritance.

7 **3 Hours**

EXPERIMENT 7

Implement the concept of operator overloading.

8 **3 Hours**

EXPERIMENT 8

Implement the concept of class using static data member and static member functions.

9 **3 Hours**

EXPERIMENT 9

Implement friend and friend classes to add the private data member of two different classes.

10 **3 Hours**

EXPERIMENT 10

Implement and Program using files

Total: 60 Hours

Reference(s)

1. Robert Lafore, Object Oriented Programming in-C++,4th Edition, Galgotia Publication,Pearson India, New Delhi.
2. Deitel & Deitel, C++ How to program, Prentice Hall, 2005.
3. D.S.Malik, C++ Programming, Thomson, 2007.
4. K.R. Venugopal, Raj Kumar and T.Ravishankar, Mastering C++, Tata McGraw Hill Publishing Co. Ltd., New Delhi, 2006..

15MC307 ELECTRON DEVICES AND DIGITAL ELECTRONICS LABORATORY

0 0 2 1

Course Objectives

- To design and implement the digital circuits
- To gain expertise in digital systems implementation

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.

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. Summarise basic knowledge in solid state electronics including diode, FET, BJT.
2. Generate the digital circuits for a various application
3. Construct digital systems and simulation of digital circuits

Articulation Matrix

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

1 **4 Hours**

EXPERIMENT 1

FET Characteristics

2 **4 Hours**

EXPERIMENT 2

Study of Logic gates

3 **4 Hours**

EXPERIMENT 3

Design and implementation of code converters using logic gates

BCD to excess-3 code and vice versa

Binary to gray and vice-versa

4 **3 Hours**

EXPERIMENT 4

Design and implementation of 4 bit binary adder/ subtractor and BCD adder.

5 **3 Hours**

EXPERIMENT 5

Design and implementation of Magnitude comparator.

6 **3 Hours**

EXPERIMENT 6

Design and implement a multiplexer and de-multiplexer

7 **3 Hours**

EXPERIMENT 7

Design and implement an encoder and decoder

8 **3 Hours**

EXPERIMENT 8

Construction and verification of 4 bit ripple counter and Mod 10 Ripple counter.

9 **3 Hours**

EXPERIMENT 9

Implementation of SISO, SIPO, PISO and PIPO shift registers using Flip- flops

Total: 30 Hours

Reference(s)

1. I. N. Nagrath, Electronics: Analog and Digital, Prentice Hall of India Pvt. Ltd, New Delhi, 2009.
2. Anant Agarwal, Joffrey H. Lang, Foundations of Analog and Digital Electronic Circuit, Elsevier, 2006.

15MC308 MANUFACTURING TECHNOLOGY LABORATORY

0 0 2 1

Course Objectives

- Operate conventional machine tools such as lathe, milling machine, shaping machine, drilling machine, gear hobbing machine, surface grinding machine and tool and cutter grinder
- Correlate the theory course on machining processes
- Measure various linear dimensions

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.
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.
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 ones own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

Course Outcomes (COs)

1. Summarise and classify various machine tools and measure various linear dimensions
2. Demonstrate various conventional machine tools for drilling and welding operations.
3. Produce various machine parts according to design

Articulation Matrix

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

1 **3 Hours**

EXPERIMENT 1

Machining a model whose diameter is continuously varying throughout its length (cotter pin).

2 **3 Hours**

EXPERIMENT 2

Making a model of screw used in vernier caliper.

3 **3 Hours**

EXPERIMENT 3

Practicing to make models like table, chair, rack, teapoy, stool, etc using arc welding equipment.

4 **3 Hours**

EXPERIMENT 4

Fabrication of a pin and hole with push fit assembly using centre lathe.

5 **3 Hours**

EXPERIMENT 5

Preparing the shaft/key/coupling assembly by selecting suitable machining operations and to list the sequence of operations.

6 **3 Hours**

EXPERIMENT 6

Machining of flange with four holes placed at 90 and with internal thread at the centre that can be used to connect pipes.

7 **3 Hours**

EXPERIMENT 7

Machining a spur gear with 14 number of teeth of module 2 mm by selecting suitable machine tool.

8 **3 Hours**

EXPERIMENT 8

Grinding of single point cutting tool in the 10 mm MS square rod with standard nomenclature using tool and cutter grinding machine.

9 **3 Hours**

EXPERIMENT 9

Preparing the surface of the shaft within the tolerance limit of Ã‚Â±0.002 mm to assemble with a bearing of inside diameter 22 mm.

10 **3 Hours**

EXPERIMENT 10

Producing a square bar from the given Ãƒ?25 mm shaft with minimum material wastage by selecting suitable machining operations.

Total: 30 Hours

Reference(s)

1. Central Machine Tool Institute (CMTI), Machine Tool Design Handbook, Tata McGraw-Hill Publishing Company Ltd, Bangalore, 2008.
2. Geoffery Boothroyd and Winston A. Knight, Fundamentals of Machining and Machine Tools, CRC Press, Taylor and Francis Group, Indian Edition, 2008.
3. Heinrich Gerling and Karl H. Heller, All About Machine Tools, New Age International (P) Limited Publishers, Noida, 2008
4. Steve F. Krar, Arthur R. Gill and Peter Smid, Technology of Machine Tools, Tata McGraw-Hill Publishing Company Ltd, New Delhi, 2008

15MC309 MINI PROJECT I 0 0 2 1

Course Objectives

- To develop self learning capabilities and utilize technical resources to make presentations
- To promote technical presentation and communication skills
- To impart knowledge on importance of intonation,word and sentence stress for improving communicative
- To promote the ability for interacting and sharing attitude
- To encourage to produce report and do oral presentation.

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

Total: 0 Hours

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
1	1											
2	2											
3	3											
4	3											
5	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: Poisson'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.

15MC402 DYNAMICS OF MACHINERY 3 2 0 4

Course Objectives

- To perform force analysis and balancing of reciprocating engines
- To understand the function of flywheel and to determine basic parameters of flywheel
- To understand the effects of vibration in beams
- To know the control mechanisms employed in governors and gyroscopes

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. Analyze the static and dynamic forces in different parts of reciprocating engine
2. Estimate the parameters involved in flywheel by constructing turning moment diagram
3. Recognize the need of balancing the unbalanced forces developed in the reciprocating engine
4. Illustrate the functioning of different systems during the happening of free and forced vibration
5. Explain the effects of governor and gyroscope for several applications

Articulation Matrix

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

UNIT I **9 Hours**

FORCE ANALYSIS

Static force analysis: Applied and constraint forces Free body diagrams Static equilibrium conditions Two, three and four members Static force analysis of simple mechanisms The principle of superposition Dynamic force analysis: Inertia force and Inertia torque D Alemberts principle Dynamic Analysis in reciprocating engines : Gas forces Bearing loads Crank shaft torque inertia force of piston and connecting rod

UNIT II **9 Hours**

TURNING MOMENT DIAGRAM AND FLYWHEEL

Turning Movement Diagram for a Single Cylinder Double acting Steam Engine, Four stroke engine and Multi Cylinder Engine - Fluctuation of Energy. Flywheel and Flywheel in Punching Press - Balancing of masses (Basics only)

UNIT III **9 Hours**

BALANCING

Single Rotating mass by a single mass rotating in the same plane and two masses rotating in different planes - Several masses rotating in the same plane and different planes. Partial balancing of unbalanced primary force in a reciprocating engine - Partial balancing of locomotives - Variation of tractive force - Swaying couples - Hammer blow - coupled locomotives. Primary and secondary forces of multi cylinder in-line engine, Radial engines

UNIT IV **9 Hours**

VIBRATION

Free vibration: Natural frequency of free transverse vibration due to a point load, uniformly distributed load acting over a Simply Supported beam and Shaft fixed at both ends carrying a uniformly distributed load and a shaft subjected to a number of point loads - Critical speed at a shaft - Viscous Damping - Damping and Magnification Factor - random vibrations - Resonance migration from one point to another - Isolation and Transmissibility - Free Torsional Vibrations of a Single, Two and Three Rotor System Condition monitoring

UNIT V **9 Hours**

MECHANISM FOR CONTROL

Governors Types Centrifugal governors Gravity controlled and spring controlled centrifugal governors Characteristics Effect of friction Controlling force Other Governor mechanisms. Gyroscopes Gyroscopic forces and torques Gyroscopic stabilization Gyroscopic effects in Automobiles, ships and airplanes

FOR FURTHER READING

Equivalent masses- Flywheel in printing and cutting machines - Effect of partial balancing of reciprocating parts of two cylinder locomotives - Torsionally equivalent shaft - Sensitiveness and Hunting of governor

Total: 75 Hours

Reference(s)

1. S. S. Rattan, Theory of Machines, Tata McGraw-Hill Publishing Company Ltd, New Delhi, 2011
2. R. S. Khurmi, J. K. Gupta, Theory of Machines, Eurasia Publishing House Pvt. Ltd., New Delhi, 2008
3. R. L. Norton, Kinematics and Dynamics of Machinery, Tata McGraw-Hill Publishing Company Ltd, New Delhi, 2009
4. Sadhu Singh, Theory of Machines, Prentice Hall of India Learning, New Delhi, 2012
5. Kenneth J .Waldron and Garny L. Kinzel, Kinematics, Dynamics and Design of Machinery, John Wiley and Sons (Asia) Pvt. Ltd., New Delhi, 2007
6. C .S .Sharma and Kamlesh Purohit, Theory of Mechanics and Machines, Prentice Hall of India Learning. Ltd., New Delhi, 2006

15MC403 STRENGTH OF MATERIALS 3 2 0 4

Course Objectives

- To impart knowledge on stress, strain and elastic modulii for components with mathematical principles to solve engineering problems
- To familiarize the method to find shear stress, bending stress, deflection and slopes in statically determinate beams under different load conditions
- To solve problems related to shafts and columns

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. Characterize the materials and compute the axial stresses and strains developed due to mechanical and thermal forces
2. Analyze the biaxial stresses at a point on deformable body using analytical and graphical methods
3. Construct the bending and shear stress distributions and compute the slope and deflection of standard beams
4. Use Rankines and Eulers formulae to compute the crippling load for the columns of different end conditions
5. Design a shaft subjected to pure torsional effect and compare solid and hollow shafts

Articulation Matrix

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

UNIT I **10 Hours**

STRESS, STRAIN AND DEFORMATION OF SOLIDS

Properties of mild steel, cast iron, aluminium alloys, copper alloys and magnesium alloys - Mechanical properties of materials - Simple stress and strain - Stresses and strains due to axial force - Hookes law - Factor of safety - Poissons ratio - Elastic constants and their relationship- Thermal stresses: Simple and Composite bars

UNIT II **9 Hours**

ANALYSIS OF STRESSES IN TWO DIMENSIONS

State of stresses at a point - Normal and tangential stresses on inclined planes - Principal planes and stresses - Plane of maximum shear stress - Mohrs circle for biaxial stresses

UNIT III **9 Hours**

BEAMS

Types of beams: Supports and Loads - Theory of simple bending - Stresses in beams: bending and shear stress - Stress variation along the length and section of the beam, Slope and Deflection of beams: Double integration for Cantilever and simply supported beams

UNIT IV **8 Hours**

COLUMNS

Columns - Buckling of long columns due to axial load - Equivalent length of a column - Eulers and Rankines formulae for columns of different end conditions

UNIT V **9 Hours**

TORSION IN SHAFTS AND SPRINGS

Analysis of torsion of circular bars - Shear stress distribution - Bars of Solid and hollow circular section - Compound shafts

FOR FURTHER READING

Stress-Strain Curve for Ductile and Brittle Materials - Section modulus - Deflection in overhanging beams

Total: 75 Hours

Reference(s)

1. R. K. Bansal, A text book of Strength of Materials, Laxmi Publications (P) Limited, New Delhi, 2012.
2. Egor P. Popov, Engineering Mechanics of Solids, Prentice Hall of India Learning. Ltd., New Delhi, 2010.
3. R.K.Rajput, Engineering Materials, S. Chand and Company Ltd, New Delhi, 2007.
4. P. Purushothama Raj and V. Ramasamy, Strength of Materials, Pearson Education, India, 2013.
5. S. Rattan, Strength of Materials, Tata McGraw-Hill Publishing Company Limited, New Delhi, 2011.
6. Irring H. Shames and James M. Pitarresi, Introduction to Solid Mechanics, Prentice Hall of India Learning. Ltd., New Delhi, 2009.

15MC404 FLUID MECHANICS AND MACHINERY 3 0 0 3

Course Objectives

- To understand the fluid properties and its application
- To acquire knowledge on kinematics and dynamics of internal flows of fluids
- To carry out the dimensional and model analysis of systems using Newtonian fluid
- To understand the concepts of hydraulic 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.
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.

Course Outcomes (COs)

1. Analyze the dynamic behavior of fluid motion using various theorems.
2. Examine the nature of internal fluid flow and determine the losses occurring in the fluid path
3. Predict the performance of hydraulic machine using dimensional and model analyses
4. Analyze the performance of major turbines by applying principles of fluid mechanics.
5. Analyze the performance of centrifugal pump and outline the working principle of positive displacement pumps

Articulation Matrix

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

UNIT I **9 Hours**

INTRODUCTION TO FLUID AND FLUID MOTION

Fluid - Fluid Mechanics - Properties of fluids and its application - Types of fluid and fluid flow Pressure measurement using U-tube and Differential Manometer -Dynamics of Fluid flow: Two dimensional Continuity equation, Bernoulli equation, energy equation, momentum equation and moment of momentum equation.

UNIT II **9 Hours**

INTERNAL FLUID FLOW AND FRICTIONAL LOSSES

Flow in circular pipe,Reynolds Experiment - Darcy Weisbach equation - Chezy's formula -Minor losses in pipes - Flow through syphon - Flow through pipes in series and in parallel

UNIT III **9 Hours**

BOUNDARY LAYER FLOW AND DIMENSIONAL ANALYSIS

Definitions of Boundary layer - Expression for drag and lift on air foils - Separation of Boundary layer - Dimensional analysis - Rayleigh's Method, Buckingham's Pi Theorem - Similitude - Types of Similarities - Dimensionless parameters - Model laws

UNIT IV **9 Hours**

HYDRAULIC MACHINES - TURBINES

Turbines- definition - Classification, Types of Heads and Efficiencies - Pelton Wheel - Reaction Turbine - Francis Turbine, Kaplan Turbine - working principles - velocity triangles - work done - specific speed - Unit quantities - Characteristic curve for hydraulic turbines - Governing of turbines.

UNIT V **9 Hours**

HYDRAULIC PUMPS

Centrifugal pump: Construction and working principles - Velocity Triangle - Definitions of Head and Efficiencies - Minimum speed - Priming and cavitation - Characteristic curves. Reciprocating Pump: Construction and working principle - Slip - Classification of Reciprocating Pump - Indicator diagram (Description only) Rotary pump: working principles of gear pump

FOR FURTHER READING

Capillary and Surface Tension - Case studies - Analyze the fluid properties, fluid flow by simple experiments

Total: 45 Hours

Reference(s)

1. R. K. Bansal, A text book of Fluid Mechanics and Hydraulic Machines, Laxmi Publications, New Delhi, 2010.
2. Bruce R. Munson , Donald F. Young, Theodore H. Okiishi and Wade W. Huebsch, Fundamentals of Fluid Mechanics, John Wiley and Sons (Asia) Pvt. Ltd., New Delhi, 2012.
3. Pijush K. Kundu and Ira M. Cohen, Fluid Machines, Academic Press, Burlington, USA, 2010.
4. Yunus A. Cengel and John M. Cimbala, Fluid Mechanics Fundamentals and Application, Tata McGraw-Hill Publishing Company Ltd, New Delhi 2009.
5. John F. Douglas, J. M. Gasoriek, John Swaffield and Lynne Jack, Fluid Mechanics, Pearson Education, New Delhi, 2008.
6. S. K. Som , Gautam Biswas and S. Chakraborty, Introduction to Fluid Mechanics and Fluid Machines, Tata McGraw-Hill Publishing Company Ltd, New Delhi 2011.

15MC405 CONTROL SYSTEM 3 2 0 4

Course Objectives

- To describe feedback control and basic components of control systems
- To understand the various time domain and frequency domain tools for analysis and design of linear control systems
- To study the methods to analyze the stability of systems from transfer function forms
- To describe the methods of designing compensators

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. Execute the transfer functions of control system with the application of Laplace transforms.
2. Design a physical system with high response by analyzing the system characteristics in time domain.
3. Design controllers to meet the desired specifications by analyzing the system in frequency domain.
4. Design a compensator for a physical system to improve the performance of the control system.
5. Critique the dynamic behavior of physical system and can design full state feedback controllers and observers.

Articulation Matrix

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

UNIT I **9 Hours**

SYSTEMS REPRESENTATION

Basic elements in control systems open loop & closed loop Transfer functions of mechanical, electrical, thermal and analogous systems. Block diagram reduction and signal flow graphs

UNIT II **11 Hours**

TIME RESPONSE ANALYSIS

Time response Time domain specifications -Types of test inputs I and II order system response Steady state error, error constants, generalized error coefficient Introduction to P, PI, PID controllers Stability concept and definition, Characteristic equation Location of poles Routh Hurwitz criterion Root locus techniques: construction

UNIT III **9 Hours**

FREQUENCY TIME ANALYSIS

Bode plots Polar plot Nyquist stability criterion Correlation between frequency domain and time domain specifications stability analysis using frequency response methods.

UNIT IV **8 Hours**

COMPENSATOR AND CONTROLLER DESIGN

Realization of basic compensators, cascade compensation in time domain and frequency domain, feed back compensation Design of lag, lead, lag lead series compensator (using Bode plot)

UNIT V **8 Hours**

STATE SPACE ANALYSIS

State equation Solutions Realization Controllability Observability State space to transfer function conversion Pole placement.

FOR FURTHER READING

Need for time domain, analysis and its applications - Need for frequency domain analysis and its applications - Impacts of stability and its important methods - Application of compensation

Total: 75 Hours

Reference(s)

1. Norman S. Nise, Control System Engineering, John Wiley & Sons, 6th Edition, 2010
2. J. Nagrath and M. Gopal, Control System Engineering, New Age International Publisher, New Delhi, 2011
3. Graham C. Goodwin, Stefan F.Graebe, Mario E. Sagado,Control System Design, Phi,2003
4. M. Gopal, Digital Control And State Variable Methods, Tata McGraw Hill, 2003.
5. Rao V Dukkipatti, Control Systems, Narosa Publications, 2005
6. K. Ogata, Modern Control Engineering, Pearson Edition 4th Ed. 2005

15MC406 POWER ELECTRONICS AND DRIVES 3 0 2 4

Course Objectives

- To obtain the switching characteristics of different types of power semi-conductor devices
- To determine the operation, characteristics and performance parameters of converters
- To understand the concept of DC and AC 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 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.
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. Characterize the operating condition of different types of power semiconductor devices and its operational parameters.
2. Compare and characterize the performance of converter and choppers under different load conditions.
3. Construct the inverter circuits and implement the various controlling techniques used for power conversion process.
4. Select the suitable drives and use the proper converter for controlling the DC drives.
5. Analyze the operations of various solid state AC drives and power factor correction

Articulation Matrix

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

UNIT I **9 Hours**

POWER SEMI-CONDUCTOR DEVICES

Construction, Operation, Characteristics of Power Diode - SCR - TRIAC - Power transistor, MOSFET and IGBT - di/dt and dv/dt protection

UNIT II **9 Hours**

CONVERTERS AND CHOPPERS

Phase Control - Single Phase and Three phase uncontrolled and controlled rectifiers with R and RL load, Choppers, Time ratio control, Types, Buck-boost chopper-four quadrant operation, cycloconverters

UNIT III **9 Hours**

INVERTER

Single phase and three phase (both 120 Ã‚Â° and 180 Ã‚Â° modes.) voltage source inverters - PWM techniques: Sinusoidal PWM modified sinusoidal PWM and multiple PWM - Current source inverters - Harmonics elimination technique

UNIT IV **9 Hours**

SOLID STATE DC DRIVES

Types of electrical drives - selection of drives - heating and cooling curves - Four quadrant operation of hoist -Ward Leonard control system - Control of DC drives using rectifiers and choppers

UNIT V **9 Hours**

SOLID STATE AC DRIVES

Control of three phase induction motors using stator voltage and frequency control - variable frequency drive - static rotor resistance control - Slip power recovery schemes - Static Kramer control method - Static Scherbius control method - Power factor correction

FOR FURTHER READING

Sepic, pi, T converters, UPS-PV power conversion, Application of Closed Loop control method, Permanent magnet brushless DC motor drive.

1 **6 Hours**

EXPERIMENT 1

Characteristics of SCR

2 **6 Hours**

EXPERIMENT 2

Characteristics of IGBT

3 **6 Hours**

EXPERIMENT 3

Single phase uncontrolled and controlled rectifiers with R, RL load

4 **6 Hours**

EXPERIMENT 4

Three phase uncontrolled and controlled rectifiers with R, RL load

5 **6 Hours**

EXPERIMENT 5

Single phase PWM inverters

Total: 75 Hours

Reference(s)

1. Muhammad H. Rashid, Power Electronics - Circuits, Devices and Applications, Prentice Hall of India Learning. Ltd., New Delhi, 2004
2. G. K. Dubey, Fundamentals of Electrical Drives, Wiley Eastern Ltd., New Delhi, 2007

3. S. K. Pillai, A First Course on Electrical Drives, New Age International Pvt. Ltd., New Delhi, 2012.
4. M. D. Singh and K. B. Khanchandani, Power Electronics, Tata McGraw-Hill Publishing Company Ltd, New Delhi, 2008.
5. Vedam Subrahmaniam, Electric Drives (concepts and applications), Tata McGraw-Hill Publishing Company Ltd, New Delhi, 2007
6. P. S. Bhimbra, Power Electronics, Khanna Publishers, New Delhi, 2012

15MC407 FLUID MECHANICS AND MACHINERY LABORATORY

0 0 2 1

Course Objectives

- To Gain knowledge on standard measurement techniques of fluid mechanics and their applications
- To understand various flows, application of basic equations of Fluid mechanics and turbo machinery.
- To provide Knowledge on Measurement of friction loss, drag force, pressure drop calculations, and performance of fluid flow machinery

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

Course Outcomes (COs)

1. Apply Bernoullie's equation for flow through venturimeter
2. Compare theoretical and actual discharge in venturimeter, orificemeter,rotameter and v -notch apparatus
3. Analyze the friction in pipe with various diameter and materials
4. Compute the efficiency of hydraulic pumps widely used

Articulation Matrix

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

1 **3 Hours**

EXPERIMENT 1

Determination of coefficient of discharge by selecting a simple flow measuring device applicable to any closed pipe flow

2 **3 Hours**

EXPERIMENT 2

Determination of coefficient of discharge by selecting an efficient flow measuring device to measure the flow of water in a closed pipe

3 **4 Hours**

EXPERIMENT 3

Measurement of discharge of a pipe flow using a vertically oriented flow measuring device and identifying the significant parameters

4 **4 Hours**

EXPERIMENT 4

Measure the discharge of open channel flow using V notch or trapezoidal notch

5 **4 Hours**

EXPERIMENT 5

Measure and Comparison of major losses in two pipes in which the water flowing inside them

6 **4 Hours**

EXPERIMENT 6

Selection of suitable pump for domestic application and determining its optimum performance parameters.

7 **4 Hours**

EXPERIMENT 7

Selection of a non rotary positive displacement pump and determining its optimum performance parameters

8 **4 Hours**

EXPERIMENT 8

Design an experiment to verify the various fluid laws

Total: 30 Hours

Reference(s)

1. Yunus A. Cengel and John M. Cimbala, Fluid Mechanics Fundamentals and Application, Tata McGraw-Hill Publishing Company Ltd, New Delhi 2009
2. P. N. Modi and S. M. Seth, Hydraulic and Fluid Mechanics including Hydraulic Machines, Standard Book House, New Delhi, 2011
3. Laboratory Manual prepared by faculty incharge

15MC408 COMPUTER AIDED MACHINE DRAWING

0 0 2 1

Course Objectives

- To know the specifications and symbols of standard machine components used in machine drawing
- To understand the concept of various tolerances and fits used for component design
- To understand and practice the drawings of machine components and simple assemblies using standard CAD packages
- At the end of the course the students will able to understand and create drawings manually or using any one CAD packages for standard machine components and assemblies with tolerance

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.

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.

Course Outcomes (COs)

1. Recall the specifications and symbols of standard machine components used in machine drawing
2. Interpret various tolerances and fits used for component design and to practice the drawings of machine components and simple assemblies using standard CAD packages
3. Represent machine components and assemblies using anyone CAD packages for standard

Articulation Matrix

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

1 **3 Hours**

EXPERIMENT 1

Converting given isometric view into orthographic views

2 **3 Hours**

EXPERIMENT 2

Reading and understanding an industrial drawing: Joint pipe

3 **3 Hours**

EXPERIMENT 3

Direction control valves: 3/2 and 4/2 way valves

4 **3 Hours**

EXPERIMENT 4

Modeling of Proximity sensors using a modeling software

5 **3 Hours**

EXPERIMENT 5
Modeling of Induction motor using a modeling software

6 **3 Hours**

EXPERIMENT 6
Modeling of Hydraulic lift using a modeling software

7 **3 Hours**

EXPERIMENT 7
Modeling of Universal coupling using a modeling software

8 **3 Hours**

EXPERIMENT 8
Modeling of Pedestal bearing using a modeling software

9 **3 Hours**

EXPERIMENT 9
Modeling of Screw jack using a modeling software

10 **3 Hours**

EXPERIMENT 10
Modeling of Robot manipulator using a modeling software

Total: 30 Hours

Reference(s)

1. K. R. Gopalakrishna, Machine Drawing, Subhas Stores, Bangalore, 1992
2. N.D. Bhatt and V.M. Panchal, Machine Drawing, Charotar Publishing House, New Delhi, 2011

15MC409 MINI PROJECT II 0 0 2 1

Course Objectives

- To develop knowledge to formulate a real world problem and project goals
- Identify technical ideas, strategies and methodologies
- To identify new tools, algorithms and techniques
- Test and validate through conformance of the developed prototype and analysis the cost effectiveness.
- To understand the guidelines to prepare report for oral demonstrations.

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

Total: 0 Hours

15MC501 SENSORS AND INSTRUMENTATION 3 0 0 3

Course Objectives

- To impart knowledge about the operation of electrical,mechanical instruments and measuring techniques
- To understand the concept of signal conditioning and design same for real time problem.
- Ro acquire knowledge on virtual instrumentation and to develop LabView program for suitable application

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. List various units and standards, their conversions, characteristics and error analysis of measurement systems
2. Classify major devices available in mechanical measurements
3. Illustrate major transducers used for measuring parameters such as displacement, temperature, humidity etc
4. Generate a signal conditioning circuit and data acquisition system
5. Generate a LabView program for various applications and to know the use of LabView and DAQ card

Articulation Matrix

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

UNIT I **9 Hours**

SCIENCE OF MEASUREMENT

Units and Standards - Calibration techniques - Errors in Measurements - Generalized Measurement System - Static and dynamic characteristics of transducers - Generalized Performance of Zero Order and First Order Systems - Response of transducers to different time varying inputs. Classification of transducers

UNIT II **9 Hours**

MECHANICAL MEASUREMENTS

Temperature measurement: Filled thermometer, Bimetallic thermometer. Pressure measurement: manometers, elastic transducers, Bourdon gauge, bellows, diaphragm.

Vacuum measurement: McLeod gauge, thermal conductivity gauge, Ionization gauge. Flow measurement: orifice, venture, nozzle, pilot tube, turbine flow meter, hot wire anemometer.

UNIT III **9 Hours**

ELECTRICAL MEASUREMENTS

Potentiometer - RTD - Thermistor - Thermocouple - Strain gauges - LVDT - RVDT - Capacitive transducers - Piezo electric transducer - Pyrometers - load cell - Hall effect transducers - Photoelectric transducers - Fiber optic transducers - Electromagnetic Transducers - Anemometers - Variable reluctance type transducers and hygrometer.

UNIT IV **9 Hours**

SIGNAL CONDITIONING AND DATA ACQUISITION

Wheatstone and Schering bridges - Amplification - Filtering - V/I, I/V and I/P converters - Sample and Hold circuits - D/A converter (R -2R ladder and weighted resistor types) - A/D converter (Dual slope, successive approximation and flash types) - Data logging - Display devices: CRO, LED and LCD

UNIT V **9 Hours**

VIRTUAL INSTRUMENTATION

Introduction to LabVIEW - Graphical user interfaces - Data types - Data flow programming - Graphical programming - Palettes and tools Front panel objects - Functions and libraries - FOR Loops - WHILE Loops - CASE Structure - Arrays and Clusters - Attribute modes Local and Global variables - Data acquisition using DAQ card

FOR FURTHER READING

Radiation Sensors - Smart Sensors - Film sensor, MEMS & Nano Sensors - applications - Automobile, Aerospace, Home appliances, Manufacturing, Medical diagnostics, Environmental monitoring.

Total: 45 Hours

Reference(s)

1. A.K.Sawhney and P.Sawhney, A Course on Mechanical Measurement Instrumentation and Control, Dhanpat Rai and Co, New Delhi, 2011.
2. E. O. Doeblin, Measurement Systems: Applications and Design, Tata McGraw-Hill Publishing Company Limited, 2003.
3. D. Patranabis, Principles of Industrial Instrumentation, Tata McGraw Hill Publishing Company Limited, New Delhi, 2011.
4. Garry M. Johnson, Labview Graphical Programming, Tata McGraw-Hill Publishing Company Limited, New Delhi, 2006.
5. Jeffrey Travis and Jim Kring, LabVIEW for Everyone: Graphical Programming made Easy and Fun, Tata McGraw Hill Publishing Company Limited, New Delhi, 2006.

15MC502 MICROPROCESSORS AND MICROCONTROLLER

3 0 0 3

Course Objectives

- To give an emphasis on the hardware features of Microprocessor and Microcontroller with their functions
- To provide essential knowledge on various operating modes of I/O ports Timers/Counters, control registers and various types of interrupts
- To design and verify the various interfacing techniques 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 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 internal hardware architecture and instruction of 8085 microprocessor
2. Analyse the hardware architecture and instruction of 8086 microprocessor.
3. Ability to develop an interfacing circuit using various interfacing device with Microprocessor 8085
4. Analyse the hardware architecture and instruction of microcontroller 8051, ATMEGA and arduino
5. Apply the microprocessor and microcontroller used for various industrial application

Articulation Matrix

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

UNIT I **9 Hours**

INTEL 8085 MICROPROCESSOR

Organization of 8085: Architecture, Internal Register Organization and Pin Configuration - Instruction Set of 8085 - addressing modes - instruction and machine cycles with states and timing diagram.

UNIT II **9 Hours**

INTEL 8086 MICROPROCESSOR

Introduction to Microprocessors, 8086 Architecture - Register organization of 8086, Modes of Operation - Physical Memory organization - I/O addressing capability - Special Processor activities, 8086 Instruction set and assembler directives: Addressing modes of 8086 - Instruction set of 8086

UNIT III **9 Hours**

8085 INTERFACING DEVICES

Programmable peripheral Interface (8255) - Programmable interval timer (8253) - Programmable communication interface (USART) - Programmable interrupt controller - Programmable DMA Controller (8257).

UNIT IV **9 Hours**

8051 ARCHITECTURE

Microcontroller Hardware - I/O Pins, Ports - External memory - Counters and Timers - Serial data I/O - Interrupts - 8051 Assembly Language Programming: Instruction set of 8051, Addressing modes, Data transfer instructions, Arithmetic and Logical Instructions, Jump and Call Instructions. Introduction to ATMEGA and Arduino

UNIT V **9 Hours**

APPLICATIONS

Temperature monitoring system - Closed loop process control - Stepper motor control - Interfacing of Keyboards - Interfacing of Display Devices - Analog to Digital and Digital to Analog Converter Ã¢?? DC Motor control using Arduino

FOR FURTHER READING

Designing real time clock, detecting power failure, detecting presence of objects using 8253. Microcontroller System Design - Testing the Design, Look up Tables.

Total: 45 Hours

Reference(s)

1. Ramesh Gaonkar, Microprocessor Architecture, Programming and Applications with the 8085 6/e, Penram International Publishing (India) Pvt. Ltd., 2013.
2. Douglas V Hall., Microprocessor and Interfacing: Programming and Hardware, McGraw Hill Inc., New Delhi, Second Edition 2002.
3. Muhammad Ali Mazidi and Janice Gillipie mazidi, The 8051 Microcontroller and Embedded System, Pearson Education Asia, 2011.
4. Kenneth J Ayala, The 8051 Microcontroller Architecture Programming and Application, Thomson Delmar New Delhi, 2014.
5. Krishna Kant, Microprocessor and Microcontroller Architecture, Programming and System Design using 8085, 8086, 8051 and 8096, PHI, 2007.

15MC503 FLUID POWER SYSTEM 2 0 2 3

Course Objectives

- To gain knowledge on properties of fluid and various types of losses in fluid
- To design and execute hydraulic and pneumatic circuits for various applications using software and hardware 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 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.
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. Explain the fundamentals of hydraulic systems and determine losses incurred in hydraulic circuit.
2. Compare various pumps and actuators of hydraulic system on its working principles.
3. Exemplify the working of different valves of a hydraulic system
4. Execute the working of various components in pneumatic system
5. Construct hydraulic and pneumatic circuits for simple application using three different methods

Articulation Matrix

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

UNIT I **6 Hours**

FLUID POWER SYSTEMS

Introduction to fluid power History Pascalas law Components - Advantages Drawbacks Applications. Hydraulic fluids: Functions, Properties. Darcys equation Frictional losses Losses in valves and fittings Determination of head losses &pump power in a hydraulic circuit

UNIT II **6 Hours**

HYDRAULIC SYSTEM AND COMPONENTS

Positive and non positive displacement pumps Pumping theory Pump classification Construction and working principle of Gear, Vane and Piston pumps. Pump performance Pump performance curves. Hydraulic cylinder (double acting) Construction & Working principle Double rod cylinder Telescopic cylinder. Hydraulic motors: Gear, Vane and Piston motors

UNIT III **6 Hours**

HYDRAULIC VALVES

Directional control valves: Check valve Pilot operated check valve 3/2 valves 4/2 valves methods of valve actuation Shuttle valve. Pressure control valves: Pressure relief valves - Pressure reducing valve, Unloading valves, Counter balance valves - Flow control valves - Servo valves: Mechanical type

UNIT IV **6 Hours**

PNEUMATIC SYSTEM COMPONENTS AND SERVO SYSTEMS

Introduction Properties of air gas laws Compressors: Piston compressor, Screw compressor and Vane compressor. Fluid conditioners: Air filters, Air pressure regulators, Air lubricators, Pneumatic silencers and Air dryers. Pneumatic actuators: Pneumatic cylinders, Rotary air motors Performance curves.

UNIT V **6 Hours**

DESIGN OF HYDRAULIC AND PNEUMATIC CIRCUITS

Sequential circuit design for simple applications: Step counter method, Cascade methods &Karnaugh Veitch map method PLC circuit design using ladder logic .

FOR FURTHER READING

Applications of Pascal's law and Accumulators: types and applications. Intensifiers - Hydraulic system: maintenance, failure and troubleshooting

1 **4 Hours**

EXPERIMENT 1

Identification of fluid power system components

2 **4 Hours**

EXPERIMENT 2

Drawing standard symbols of FPS

3 **4 Hours**

EXPERIMENT 3

Actuating Single Acting Cylinder

4 **0 Hours**

EXPERIMENT 4

Actuating Double Acting Cylinder

5 **0 Hours**

EXPERIMENT 5

Circuits with logic controls AND valve and OR valve

6 **4 Hours**

EXPERIMENT 6

Circuit design using ladder logic

7 **4 Hours**

EXPERIMENT 7

Circuit design using step counter method

8 **0 Hours**

EXPERIMENT 8

Circuit design using cascade method

9 **0 Hours**

EXPERIMENT 9

Circuit design using KV map method

10 **0 Hours**

EXPERIMENT 10

Circuit design using three methods and making comparison

Total: 50 Hours

Reference(s)

1. Anthony Esposito, Fluid Power with Applications, Pearson Education New Delhi, 2015
2. S. R. Majumdar, Oil Hydraulics, Tata McGraw Hill Publishing Company Pvt Ltd. New Delhi, 2014.
3. James L. Johnson, Introduction to Fluid Power, Delmar Thomson Learning, 2013.
4. S. R. Majumdar, Pneumatic systems - Principles and maintenance, Tata McGraw Hill Publishing Company Pvt Ltd. New Delhi, 2014.
5. Andrew Parr, Hydraulics and Pneumatics, Jaico Publishing House, 2015.
6. Illangov Soundarrajan, Introduction to Hydraulics and Pneumatics, Prentice hall of India, New Delhi, 2015.

15MC504 THERMODYNAMICS AND HEAT TRANSFER

3 2 0 4

Course Objectives

- To acquire knowledge on laws of thermodynamics concepts, principles and mechanism for physical systems
- To learn the concept of air standard cycles
- To impart knowledge on conduction,convection and radiation

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.
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. Recall fundamental concepts and basic laws of thermodynamics.
2. Illustrate P-V diagram and obtain the performance of air standard cycle
3. Determine one dimensional heat transfer coefficient for a given system
4. Compute the heat transfer coefficient for convection system
5. Compare the radiation effect among different surfaces

Articulation Matrix

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

UNIT I **9 Hours**

LAWS OF THERMODYNAMICS

Systems-closed and open systems -properties, processes and cycles- equilibrium- work and heat transfers-first law for a closed system and flow processes - enthalpy - second law -entropy- entropy change

UNIT II **9 Hours**

AIR STANDARD CYCLES

Air standard cycles: Carnot cycle - Otto cycle - Diesel cycle - Brayton cycle - Rankine cycle- cycle efficiency Ã¢?? IC Engine: two stroke and four stroke engines

UNIT III **9 Hours**

HEAT TRANSFER: CONDUCTION

Basic Concepts- Mechanism of Heat Transfer - Conduction, Convection and Radiation - Fourier Law of Conduction - General Differential equation of Heat Conduction -Cartesian and Cylindrical Coordinates - One Dimensional Steady State Heat Conduction

UNIT IV **9 Hours**

CONVECTION

Convection: Basic Concepts -Heat Transfer Coefficients - Boundary Layer Concept - Types of Convection - Forced Convection - External Flow and Internal Flow - Flow over Plates, Cylinders and Spheres

UNIT V **9 Hours**

RADIATION

Basic Concepts, Laws of Radiation - Stefan Boltzmann Law, Kirchhoff's Law -Black Body Radiation and radiation between different surfaces

FOR FURTHER READING

Reversibility- S.I and C.I engines- Conduction through Plane Wall, Cylinders and Spherical system- Grey body radiation -Shape Factor Algebra - Electrical Analogy- Convective Mass Transfer Correlations.

Total: 75 Hours

Text Book(s)

1. P. K. Nag, Engineering Thermodynamics, Tata McGraw-Hill Publishing Company Limited, New Delhi, 2008
2. Yunus A. Cengel and Michael A. Boles, Thermodynamics - An Engineering Approach in SI Units, Tata McGraw Hill Publishing Company, New Delhi, 2010
3. C. P. Kothandaraman and S. Subramanya, Fundamentals of Heat and Mass Transfer, New Age International Publishers, New Delhi, 2008
4. T. D. Eastop and McConkey, Applied Thermodynamics for Engineering Technologists, Pearson, New Delhi, 2004
5. C. P. Kothandaraman, S. Domkundwar and A. V. Domkundwar, A course in Thermal Engineering, Dhanpatrai and Co. Pvt. Ltd., New Delhi, 2012
6. 6. Frank P. Incropera and David P. DeWitt, Fundamentals of Heat and Mass Transfer, John Wiley and Sons Pvt. Ltd., Singapore, 2006

15MC507 SENSORS AND INSTRUMENTATION LABORATORY

0 0 2 1

Course Objectives

- To acquire knowledge on types of sensors
- To interface the sensor in LabView software through DAQ
- To design a circuit and measure the performance of various 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.
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.
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.

Course Outcomes (COs)

1. Classify the various types of sensors based on application
2. Identify a suitable sensor for a specific application
3. Develop a front panel interlinked with block diagram using software
4. Construct hardware and software using interfacing devices
5. Execute the measurement for various parameters and signal conversions

Articulation Matrix

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

1 **3 Hours**

EXPERIMENT 1

Temperature Measurement using RTD

2 **3 Hours**

EXPERIMENT 2

Temperature Measurement using J,K and E Type Thermocouples

3 **3 Hours**

EXPERIMENT 3
Temperature Measurement using Thermistor

4 **3 Hours**

EXPERIMENT 4
Load Cell Measurement

5 **3 Hours**

EXPERIMENT 5
Strain Measurement using Strain Gauge

6 **3 Hours**

EXPERIMENT 6
Displacement Measurement using LVDT

7 **3 Hours**

EXPERIMENT 7
Vibration Measurement using Accelerometer

8 **3 Hours**

EXPERIMENT 8
Analog to Digital Conversion

9 **3 Hours**

EXPERIMENT 9
Digital to Analog Conversion

10 **3 Hours**

EXPERIMENT 10
Speed and Position Control of Servo Motor

Total: 30 Hours

Reference(s)

1. LabVIEW: Basics I & II Manual, National Instruments, Bangalore, 2011.
2. A. K. Sawhney and P. Sawhney, A Course on Mechanical Measurement Instrumentation and Control, Dhanpat Rai and Co, New Delhi, 2011

15MC508 MICROPROCESSORS AND MICROCONTROLLER LABORATORY

0 0 2 1

Course Objectives

- To focus the implementation of arithmetic operations using microprocessors and microcontroller.
- To simulate assembly language programs
- To implement various on-chip and off-chip interfacing and algorithms.

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.

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.

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.

Course Outcomes (COs)

1. Implement the arithmetic and logical operations using microcontrollers and microprocessors
2. Carry out the digital and analog hardware interface for microcontroller-based systems
3. Generate an assembly language program to control stepper and DC motor

Articulation Matrix

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

1 **3 Hours**

EXPERIMENT 1

Perform the basic arithmetic operations using Assembly Language Programming (ALP) in Microprocessor 8085/8086.

2 **3 Hours**

EXPERIMENT 2

Perform the search operation for finding the number (largest, smallest) in the array using Assembly Language Programming (ALP) in Microprocessor 8085/8086.

3 **3 Hours**

EXPERIMENT 3

Execute code conversions like HEX to ASCII and Vice versa using Assembly Language Programming (ALP) in Microprocessor 8085/8086.

4 **3 Hours**

EXPERIMENT 4

Perform the basic arithmetic operations using Assembly Language Programming (ALP) in Microcontroller 8051.

5 **3 Hours**

EXPERIMENT 5

Implement the search operation for finding the number (largest, smallest) in the array using Assembly Language Programming (ALP) in Microcontroller 8051.

6 **3 Hours**

EXPERIMENT 6

Execute code conversions like HEX to ASCII and Vice versa using Assembly Language Programming (ALP) in Microcontroller 8051.

7 **3 Hours**

EXPERIMENT 7

Perform the different mode of operation using Assembly Language Programming (ALP) by interfacing the Programmable Peripheral Interface with the Microprocessor 8085 and Microcontroller 8051.

8 **3 Hours**

EXPERIMENT 8

Perform the controlling operation to the stepper motor using Assembly Language Programming (ALP) by interfacing the stepper motor with the Microprocessor 8085 and Microcontroller 8051.

9 **3 Hours**

EXPERIMENT 9

Perform the controlling operation of DC motor using Assembly Language Programming (ALP) by interfacing the DC motor controller with the Microprocessor 8085 and Microcontroller 8051.

10 **3 Hours**

EXPERIMENT 10

Conversion of Analog to digital and vice versa using Assembly Language Programming (ALP) Microprocessor 8085/8086 and Microcontroller 8051.

Total: 30 Hours

Reference(s)

1. Ramesh Gaonkar, Microprocessor Architecture, Programming and Applications with the 8085 6/e, Penram International Publishing (India) Pvt. Ltd., 2013.
2. Douglas V Hall., Microprocessor and Interfacing: Programming and Hardware, McGraw Hill Inc., New Delhi, Second Edition 2002.
3. Muhammad Ali Mazidi and Janice Gillipie mazidi, The 8051 Microcontroller and Embedded System, Pearson Education Asia, 2011.
4. Kenneth J Ayala, The 8051 Microcontroller Architecture Programming and Application, Thomson Delmar New Delhi, 2014.
5. Krishna Kant, Microprocessor and Microcontroller Architecture, Programming and System Design using 8085, 8086, 8051 and 8096, PHI, 2007.

15MC509 TECHNICAL SEMINAR I 0 0 2 1

Course Objectives

- To develop self learning capabilities and utilize technical resources to make presentations.
- To promote technical presentation and communication skills
- To impart knowledge on importance of intonation,word and sentence stress for improving communicative competence,identifying and overcoming problem sounds
- To promote the ability for interacting and sharing attitude.
- To encourage to produce report and do oral presentation.

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.
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.
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. Refer and utilize various technical resources available from multiple field
2. Improve the technical presentation and communication skills
3. Analyze the importance of intonation, word and sentence stress for improving communicative competence, identifying and overcoming problem sounds.
4. Interact and share their technical knowledge to enhance the leadership skills
5. Prepare report and present oral demonstrations

Articulation Matrix

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

Total: 0 Hours

15MC510 MINI PROJECT III 0 0 2 1

Course Objectives

- To formulate a real world problem and identify the requirement and develop the design solutions.
- To give guidance in technical ideas, strategies and methodologies for the project
- To teach use of new tools, algorithms, techniques to obtain the solution for the project.
- To give guidance to develop a prototype and analysis the cost effectiveness.
- To provide guidelines to prepare technical report of the project

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

Total: 0 Hours

15MC602 PLC AND AUTOMATION 3 0 0 3

Course Objectives

- To provide knowledge on PLC hardware and instructions used in PLC
- To impart knowledge on application of PLC and SCADA in industries.
- To familiarize with the communication protocols in DCS

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.
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.
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.

Course Outcomes (COs)

1. Construct the simple programmable logic controller and differentiate the relay logic with ladder logic.
2. Characterize the different instructions available in PLC and implement the instructions for various applications.
3. Design the ladder logic and execute the operation for the particular industrial application.
4. Identify the networking and communication devices available in PLC with SCADA monitoring.
5. Describe the Distributed Control System and differentiate the PLC over advanced systems.

Articulation Matrix

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

UNIT I **10 Hours**

PROGRAMMABLE LOGIC CONTROLLERS

Introduction - Parts of PLC - Principles of operation - PLC sizes - PLC hardware components - I/O section - Analog I/O modules - digital I/O modules CPU processor memory module - PLC

programming Simple instructions - Output control devices - Latching relays PLC ladder diagram, Converting simple relay ladder diagram in to PLC relay ladder diagram

UNIT II **9 Hours**

INSTRUCTIONS

Timer instructions ON Delay, OFF Delay and Retentive Timers-UP Counter, DOWN Counter and UP down Counters, program control instructions - Data manipulating instructions-math instructions

UNIT III **9 Hours**

APPLICATION OF PLC

Traffic light control, 24 hour clock design, Automatic stacking process, temperature control, Automatic control of warehouse door, Automatic lubrication of supplier Conveyor belt, motor control.

UNIT IV **9 Hours**

NETWORKING OF PLC AND SCADA

Networking of PLCs-Data communication-Fieldbus, PROFI bus, and Mod bus-OSI Model types-OPC function. Supervisory Control and Data Acquisition-Architecture-Remote terminal unit-Master terminal unit-Data Storage

UNIT V **8 Hours**

DISTRIBUTED CONTROL SYSTEM

Evolution - Architectures - Comparison - Local control unit - Process interfacing issues - Communication facilities. Operator interfaces - Low level and high level operator interfaces - Operator displays - Engineering interfaces - Low level and high level engineering interfaces

FOR FURTHER READING

Applications of DCS in - Pulp and paper environment -Power plant - Petroleum - Refining environment

Introduction to Soft PLC.

Total: 45 Hours

Reference(s)

1. Petruzella Frank D, Programmable Logic Controllers, Tata McGraw-Hill Publishing Co. Ltd., New Delhi, 2010.
2. Lucas, M.P., Distributed Control System, Van Nonstrand reinhold Co. NY, 1986.
3. Webb, John W. Programmable Logic Controllers: Principles and Application, Fifth edition, Prentice Hall of India, New Delhi, 2004.
4. Stuart A. Boyer, SCADA: Supervisory Control and Data Acquisition, (4e), ISA Publication, 2009.
5. Bolton , "Programmable Logic Controllers 5th Edition Newnes,2009

15MC603 INDUSTRIAL ROBOTICS 3 0 0 3

Course Objectives

- To impart knowledge on components of robot and types of endeffectors
- To understand kinematics of robot and programming methods
- To learn trajectory and motion analysis of robotic movements with suitable sensors

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. Identify the components and recognize the parameters of an Industrial Robot.
2. Estimate the gripping force and Illustrate the various types of grippers and robot cell layouts.
3. Analyze position kinematics and DH convention of serial manipulator industrial robot
4. Analyze the velocity kinematics and plan the trajectory for industrial robot.
5. Exemplify the ultrasonic sensor, LIDAR and vision systems used in Robots.

Articulation Matrix

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

UNIT I **9 Hours**

INTRODUCTION

Robotics: A brief history, definition, laws of Robotics, Basic components of robot, concept of workcell, degrees of freedom (DOF), Resolution, accuracy, repeatability, Payload, Precision classification of Industrial robot manipulator, common kinematic arrangement.

UNIT II **9 Hours**

END EFFECTORS

Unilateral Vs Multilateral end effectors - mechanical grippers gripping force estimation with payload under acceleration - vacuum ans magnetic grippers Remote centre compliance. Robot cell layouts.

UNIT III **9 Hours**

KINEMATICS OF ROBOT MANIPULATOR

Representing position and rotation - rotation in plane - rotation in three dimension - Rotational transformation - Rotation with respect to the current frame and fixed frame - Rule for composition of rotational transformation - Parameterization of rotation - Euler angle, Roll, Pitch, Yaw angles

Axis/angle representation - rigid motion - Homogeneous transformation - Denavit Hartenberg convention

UNIT IV **9 Hours**

ROBOT DYNAMICS AND TRAJECTORY PLANNING

Velocity kinematics - Jacobian - Derivative of rotation matrix - addition of angular velocity - Derivation of Jacobian combining the linear and angular velocity Jacobian - Euler Lagrange equation, kinetic and potential energy,Trajectory planning for point to motion - Cubic polynomial

UNIT V **9 Hours**

ROBOT SENSOR

Ultrasonic sensors -Range finding- time of flight LIDAR- triangulation techniques -Vision for 3D measurement - structured lighting stereo vision and camera calibration

FOR FURTHER READING

Industrial robots for welding, painting and assembly, remote Controlled robots, Robots for nuclear thermal and chemical plants, Industrial automation, Typical example of automated industries, application of visual inspection

Total: 45 Hours

Reference(s)

1. Mikell P. Groover, Mitchell Weiss, Roger N. Nagel, Nicholas G. Odrey, "Industrial Robotics:Technology, Programming and Applications", McGraw Hill Book Company, 2012
2. Ashitava Ghosal, Robotics: Fundamental Concepts and Analysis, Oxford University Press, 2008
3. J.J. Craig, Introduction to Robotics: Mechanics and Control, Prentice Hall Inc. / Pearson Education, 2008
4. R.N. Jazer, Theory of Applied Robotics. Springer, 2010
5. Tsai, L. W., Robot Analysis: The Mechanics of Serial and Parallel Manipulators, John Wiley & Sons, Inc, New York, 1999
6. Mark W Spong,Seth Hutchinson, M.Vidyasagar Ã¢?? Robot Modeling and ControlÃ¢?? Wiley India Edition , New Delhi., Nov, 2006

15MC604 DESIGN OF MACHINE ELEMENTS 3 2 0 4

Course Objectives

- To learn the design procedure of machine elements subjected to simple and variable loads
- To study the design procedure of shaft and coupling
- To provide knowledge on design of joints,levers ,spring, flywheel and bearings.

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.
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. Select the materials and compute the stresses for static loads and apply the theories of failure to design the machine components
2. Design shaft, keys and couplings based on power transmission capability
3. Analyze the forces acting on bolts in eccentric loading, welded joints and design the elements.
4. Compute stresses in springs for different end conditions and design a flywheel for an IC engine applications.
5. Compute static and dynamic load carrying capacity for a bearings and select the suitable bearings

Articulation Matrix

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

UNIT I **9 Hours**

STEADY STRESSES AND VARIABLE STRESSES IN MACHINE MEMBERS

Introduction to the design process - factor influencing machine design, selection of materials based on mechanical properties - Direct, Bending and Torsional stress equations - Impact loading - Calculation of principle stresses for various load combinations- Design of curved beams - Crane hook and C frame - Factor of safety - The theories of failure

UNIT II **9 Hours**

DESIGN OF SHAFTS AND COUPLINGS

Design of solid and hollow shafts based on strength, rigidity and critical speed - Design of keys and key ways - Design of rigid and flexible couplings - Muff, Clamp, Rigid Flange, Bushed-pin flexible couplings

UNIT III **9 Hours**

DESIGN OF JOINTS AND LEVERS

Threaded fasteners - Design of bolted joints - Eccentrically loaded bolted joint in shear - Eccentric load perpendicular to axis of bolt - Eccentric load on Circular base - Design of welded joints for structures - Butt, Fillet welded Joints - Strength of Parallel, Traverse fillet Welded Joints - Theory of bonded joints - Design of levers

UNIT IV **9 Hours**

DESIGN OF SPRINGS AND FLYWHEEL

Design of helical, multi- leaf and torsional springs under constant loads and varying loads - End conditions and length of springs - Stresses in Helical springs of circular wire - Wahl stress factor - Design of flywheels involving stresses in rim and arm

UNIT V **9 Hours**

DESIGN OF BEARINGS

Design of bearings - Sliding contact and rolling contact types - Cubic mean load - Design of journal bearings - McKeeâ€™s equation - Lubrication in journal bearings - Calculation of bearing dimensions

FOR FURTHER READING

Stress intensity factor - Introduction to gear and shock absorbing couplings - Metal stir welding Process - Flywheel energy storage - Advance Bearings

Total: 75 Hours

Reference(s)

1. V. B. Bhandari, Design of Machine Elements, Tata McGraw-Hill Publishing Company Pvt. Ltd., New Delhi, 2010
2. J. E. Shigley and C. R. Mischke, Mechanical Engineering Design, Tata McGraw-Hill Publishing Company Pvt. Ltd., New Delhi, 2003
3. R. C. Juvinall and K. M. Marshek, Fundamentals of Machine Component Design, John Wiley and Sons, New Delhi, 2002
4. R. L. Norton, Design of Machinery, Tata McGraw-Hill Publishing Company Pvt. Ltd., New Delhi, 2004
5. W. Orthwein, Machine Component Design, Jaico Publishing Company, New Delhi, 2003
6. Faculty of Mechanical Engineering, PSG College of Technology, Design Data Book, M/s.Kalaikathir Achchagam, Coimbatore, 2009

15MC607 PLC AND AUTOMATION LABORATORY 0 0 2 1

Course Objectives

- To obtain a practical knowledge and programming on PLC and advance controllers
- To develop a program in PLC for process control application

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 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.

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

Course Outcomes (COs)

1. Explain the use of RS Logix software in PLC
2. Generate the PLC program for the implementation of logic gates
3. Generate the PLC program for controlling the parameters such as Pressure, Level and Flow
4. Generate the PLC program for various applications such as bottle filling, cylinder actuation and elevator control
5. Justify the necessity of using Supervisory Control and Data Acquisition (SCADA) for complex projects

Articulation Matrix

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

1 **2 Hours**

EXPERIMENT 1

Using RS logic software implementation of logic gates.

2 **3 Hours**

EXPERIMENT 2

Automate the level and flow control using PLC

3 **3 Hours**

EXPERIMENT 3

Select the I/O module for temperature control using PLC

4 **3 Hours**

EXPERIMENT 4

Find I/O module and input and output devices for pressure and flow control using PLC

5 **3 Hours**

EXPERIMENT 5

Select the suitable I/O module for control of elevator using PLC

6 **3 Hours**

EXPERIMENT 6

Bottle filling process using PLC

7 **3 Hours**

EXPERIMENT 7

Identify I/O module for automate the cylinder sequencing using simple pneumatic direct control valve.

8 **3 Hours**

EXPERIMENT 8

Traffic light controller.

9 **3 Hours**

EXPERIMENT 9

Choose the special I/O for speed control of DC motor using PLC.

10 **4 Hours**

EXPERIMENT 10

Programming in HMI and SCADA.

Total: 30 Hours

Reference(s)

1. Petruzella Frank D., Programmable Logic Controllers, Tata McGraw-Hill Publishing Co. Ltd., New Delhi, 2010.
2. Webb, John W. Programmable Logic Controllers: Principles and Application, Fifth edition, Prentice Hall of India, New Delhi, 2004.
3. Bolton , "Programmable Logic ControllersÃ¢?? 5th Edition Newnes, ,2009

15MC608 ROBOTICS LABORATORY 0 0 2 1

Course Objectives

- To impart knowledge on programming of SCARA robot and robo analyzer
- To derive the forward and inverse kinematics of SCARA robot
- To know about the motion planning of 4-axes robot
- To learn programming of a kinematic robot for various application

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.

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.

Course Outcomes (COs)

1. Classify major types of robot configuration and illustrate their work volume
2. Find forward kinematics of major robot configuration
3. Find inverse kinematics of SCARA robot
4. Demonstrate trajectory planning for pick and place operation
5. Generate program to compute forward kinematics of SCARA robot

Articulation Matrix

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

1 **3 Hours**

EXPERIMENT 1

Study of various types of robots.

2 **3 Hours**

EXPERIMENT 2

Geometric Modeling: As an example of a geometric modeling system a SCARA robot is modeled in a common modeling language using an industrial robot simulation system

3 **4 Hours**

EXPERIMENT 3

Offline Programming: The previously modeled SCARA robot is then programmed offline, also using the industrial robot simulation system.

4 **4 Hours**

EXPERIMENT 4

Forward and Inverse Kinematics: The forward and inverse kinematics of the SCARA robot are derived and calculated in a simulation software.

5 **4 Hours**

EXPERIMENT 5

Motion Planning: A small motion planning module for the SCARA robot has to be implemented that can be checked in the framework of the simulation system

6 **4 Hours**

EXPERIMENT 6

Visualization of Denavit-Hartenberg parameter for the Robot with PRP configuration using Robo Analyser.

7 **4 Hours**

EXPERIMENT 7

Programming a parallel kinematic robot for a pick and place application

8 **4 Hours**

EXPERIMENT 8

Programming the robot for a drilling application

Total: 30 Hours

Reference(s)

1. Ashitava Ghosal, Robotics: Fundamental Concepts and Analysis, Oxford University Press, 2008.
2. Mikell P. Groover, Mitchell Weiss, Roger N. Nagel and Nicholas G. Odrey, Industrial Robotics Technology, Programming and Applications, Tata McGraw-Hill Publishing Company Limited, New Delhi, 2000
3. K. S. Fu, R. C. Gonzalez and C. S. G. Lee, Robotics Control, Sensing, Vision, and Intelligence, Tata McGraw-Hill Publishing Company Limited, New Delhi, 1987.

15MC609 TECHNICAL SEMINAR II 0 0 2 1

Course Objectives

- To develop the self learning skills to utilize various resources available from multiple fields
- To promote technical presentation and communication skill
- To impart knowledge on intonation, word and sentence stress for improving communicative competence, identifying and overcoming problem sounds.

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.
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.
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. Refer and utilize various technical resources available from multiple fields
2. Improve the technical presentation and communication skills
3. Analyze the importance of intonation, word and sentence stress for improving communicative competence, identifying and overcoming problem sounds.
4. Interact and share their technical knowledge to enhance the leadership skills
5. Produce report and present oral demonstrations

Articulation Matrix

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

Total: 0 Hours

15MC610 MINI PROJECT IV 0 0 2 1

Course Objectives

- To develop knowledge to formulate a real world problem and project goals
- Identify technical ideas, strategies and methodologies
- To identify new tools, algorithms and techniques
- Test and validate through conformance of the developed prototype and analysis the cost effectiveness.
- To understand the guidelines to prepare report for oral demonstrations.

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

Total: 0 Hours

15MC702 AUTOMOTIVE ELECTRONICS 3 0 0 3

Course Objectives

- To study the basics of electronics, emission controls and its importance in environment.
- To study the various sensors and actuators used in automobiles for improving fuel economy and emission control
- To study about various blocks of control units used for control of fuel, ignition and exhaust 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.

Course Outcomes (COs)

1. classify the different types of emission laws and technology used in India and Europe in order to reduce air pollution.
2. Recall the fundamental components of an internal combustion engine and to summarize the need for advanced ignition and injection systems.
3. Identify the use of sensors and equipment for measuring mechanical quantities, temperature and appropriate actuatorscomfort and safety systems in automobiles
4. summarize the function and working of engine control system towards the efficiency of engine management system.
5. Interpret the requirement for different technologies used to improve the comfort and safety aspects of modern vehicles.

Articulation Matrix

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

UNIT I **8 Hours**

INTRODUCTION

Evolution of electronics in automobiles - emission laws - introduction to Euro I, Euro II, Euro III, Euro IV, Euro V standards - Equivalent Bharat Standards. Charging systems: Working and design of charging circuit diagram - Alternators - Requirements of starting system - Starter motors and starter circuits.

UNIT II **10 Hours**

IGNITION AND INJECTION SYSTEM

Ignition systems: Ignition fundamentals - Electronic ignition systems - Programmed Ignition - Distribution less ignition - Direct ignition - Spark Plugs. Electronic fuel Control: Basics of

combustion - Engine fueling and exhaust emissions - Electronic control of carburetion - Petrol fuel injection - Diesel fuel injection.

UNIT III **7 Hours**

SENSORS AND ACTUATORS

Working principle and characteristics of Airflow rate, Engine crankshaft angular position, Hall effect, Throttle angle, temperature, exhaust gas oxygen sensors - study of fuel injector, exhaust gas re-circulation actuators, stepper motor actuator, vacuum operated actuator.

UNIT IV **10 Hours**

ENGINE CONTROL SYSTEM

Control modes for fuel control - Engine control subsystems - Ignition control methodologies - Different ECU's used in the engine management - block diagram of the engine management system. In vehicle networks: CAN standard, format of CAN standard - Diagnostics systems in modern automobiles.

UNIT V **10 Hours**

CHASSIS AND SAFETY SYSTEM

Traction control system - Cruise control system - Electronic control of automatic transmission - Anti-lock braking system - Electronic suspension system - Working of airbag and role of MEMS in airbag systems - Centralized door locking system - Climate control of cars.

FOR FURTHER READING

Power Train Control, Safety System Control (Brake System (ASR, ESP) and Airbag-Seat Belt Tensioners), Steering System Control, Security System (Centralized Remote Door Locking, Immobilizer).

Total: 45 Hours

Reference(s)

1. Tom Denton, Automobile Electrical and Electronics Systems, Butterworth Heinemann Publishers, India, 2012.
2. William Ribbens, Understanding Automotive Electronics, Newnes Publishers, India, 2013.
3. BOSCH Automotive Handbook, Bentley Publishers, USA, 2005.
4. Barry Hollembeak, Automotive Electricity, Electronics and Computer Controls, Delmar Publishers, USA, 2001.
5. Ronald. K. Jurgon, Automotive Electronics Handbook, Tata McGraw-Hill Publishing Company Pvt. Ltd., New Delhi, 1999.
6. Ronald. K. Jurgon, Automotive Electronics Handbook, Tata McGraw-Hill Publishing Company Pvt. Ltd., New Delhi, 1999.

15MC703 MICRO ELECTRO MECHANICAL SYSTEMS

3 0 0 3

Course Objectives

- To acquire knowledge about materials for MEMS
- To study about various micromanufacturing techniques.
- To implement knowledge about microsensors and microactuators

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.

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 scaling laws to determine if MEMS devices would perform than existing non-microscale devices and to understand properties and behavior of different materials that are in micro devices.
2. Recognize a suitable fabrication methods used to build/construct MEMS devices.
3. Identify a suitable micromachining technique for a specific MEMS fabrication process
4. Illustrate the operational theory of common MEMS sensors and MEMS actuators and to identify situations where MEMS sensors and actuators would be ideal for application to various products
5. Explain the need for micro system packaging.

Articulation Matrix

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

UNIT I **9 Hours**

UNIT I SCALING LAWS AND MATERIALS FOR MEMS

Introduction to Microsystems and micro electronics - Trimmers scaling vector and scaling laws - scaling in geometry scaling in rigid body dynamics scaling in electrostatic forces scaling in electricity - scaling in fluid mechanics scaling in heat transfer. Materials for MEMS: Silicon as a MEMS material Crystal structure of silicon Miller indices - silicon compounds SiO2, SiC, Si3N4 and polycrystalline silicon silicon piezo-resistors - Gallium arsenide - polymers for MEMS - Need for micromechanics considerations in MEMS design, Clean room technology - Substrates and wafer

UNIT II **9 Hours**

UNIT II FABRICATION OF MEMS

Processes for Surface micromachining Deposition processes - ion implantation Diffusion oxidation chemical vapor deposition physical vapor deposition deposition by epitaxy photolithography, photoresists and light sources

UNIT III **9 Hours**

UNIT III OVERVIEW OF MICRO MANUFACTURING

Processes for bulk micromachining Isotropic and Anisotropic etching - Wet etchants - Etch stop - Dry etching - DRIE - Wet Vs dry etching - Surface micromachining Mechanical problems associated with surface micromachining - Limitations of Bulk and surface micromachining LIGA, SLIGA

UNIT IV **9 Hours**

UNIT IV MICRO SENSORS AND ACTUATORS

Piezoelectric crystals Shape memory alloys bimetallics - electrostatic forces. Micro motors micro grippers - Microfluidic devices - Micro pumps mechanical and non - mechanical micro pumps - micro valves valve less micro pumps Lab on Chip. Types of micro sensors Micro accelerometer Micro pressure sensors.

UNIT V **9 Hours**

UNIT V MICROSYSTEM PACKAGING AND DESIGN

Micro system packaging materials die level device level system level packaging techniques die preparation surface bonding wire bonding sealing Design considerations process design mechanical design.

FOR FURTHER READING

MEMS devices for automotive applications, bio medical, aerospace and telecommunication industries - Optical MEMS devices, Use of MEMS devices in cell phones and robots

Total: 45 Hours

Reference(s)

1. Tai Ran Hsu, MEMS and Micro Systems Design and Manufacture, Tata McGraw-Hill Publishing Company Ltd, New Delhi, 2008.
2. Mohamed Gad-el-Hak, The MEMS Handbook, CRC Press Publishers, India, 2002.
3. Nadim Maluf, An Introduction to Micro Electro Mechanical System Design, Artech House Publishers, London, 2004.
4. Chang Liu, Foundations of MEMS, Pearson Education, New Delhi, 2011.
5. James J. Allen, Micro Electro Mechanical System Design, CRC Press Publishers, India, 2005.
6. Julian w. Gardner, Vijay K. Varadan and Osama O. Awadelkarim, Micro sensors MEMS and smart Devices, John Wiley and Sons Ltd., England, 2002.

15MC704 CNC TECHNOLOGY 3 0 0 3

Course Objectives

- Understand evolution and principle of CNC machine tools
- Describe constructional features of CNC machine tools
- Illustrate drives and positional transducers used in CNC machine tools
- Generate simple programs for CNC turning and machining centres
- Generate CNC programs for popular CNC controllers
- Classify tooling and work holding devices for CNC machine tools

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.

Course Outcomes (COs)

1. Interpret the evolution and working principle of CNC machine tools with its relevant applications.
2. Relate the basic structure, construction, working and control of CNC machines over conventional units.
3. Identify the fundamentals of drive systems and control modules of CNC technology.
4. Implement real time program for producing desired products using CNC machines.
5. Explain the different tooling and work holding device of CNC.

Articulation Matrix

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

UNIT I 9 Hours

INTRODUCTION TO CNC MACHINE TOOLS

Evolution of CNC Technology, principles, features, advantages, applications,CNC and DNC concept, classification of CNC Machines turning centre, machining centre, grinding machine, EDM, types of control systems, CNC controllers, characteristics, interpolators Computer Aided Inspection

UNIT II 9 Hours

STRUCTURE OF CNC MACHINE TOOL

CNC Machine building, structural details, configuration and design, guide ways Friction, Anti friction and other types of guide ways, elements used to convert the rotary motion to a linear motion Screw and nut, recirculating ball screw, planetary roller screw, recirculating roller screw, rack and pinion, spindle assembly, torque transmission elements gears, timing belts, flexible couplings, Bearings.

UNIT III **9 Hours**

DRIVES AND CONTROLS

Spindle drives DC shunt motor, 3 phase AC induction motor, feed drives stepper motor, servo principle, DC and AC servomotors, Open loop and closed loop control, Axis measuring system synchro, synchro-resolver, gratings, moir fringe gratings,encoders, inductosysn, laser interferometer

UNIT IV **9 Hours**

CNC PROGRAMMING

Coordinate system, structure of a part program, G & M Codes, tool length compensation, cutter radius and tool nose radius compensation, do loops, subroutines, canned cycles, mirror image, parametric programming, machining cycles, programming for machining, generation of CNC codes from CAM packages

UNIT V **9 Hours**

TOOLING AND WORK HOLDING DEVICES

Introduction to cutting tool materials Carbides, Ceramics, CBN, PCD inserts classification- PMK, NSH, qualified, semi qualified and preset tooling, tooling system for Machining centre and Turning centre, work holding devices for rotating and fixed work parts, economics of CNC, maintenance of CNC machines

FOR FURTHER READING

CNC Program generation from CAD models, geometric modeling for NC machining & machining of free-form surfaces, CNC controller & motion control in CNC system. Application of CNC and recent advances in CNC machines, maintenance of CNC machine tools, CNC trainer

Total: 45 Hours

Reference(s)

1. HMT, "Mechatronics, Tata McGraw-Hill Publishing Company Limited, New Delhi, 2005
2. Warren S.Seamers, Computer Numeric Control, Fourth Edition Thomson Delmar, 2002.
3. P. N. Rao and N. K. Tiwari, Numerical Control and Computer Aided Manufacturing, Tata McGraw-Hill Publishing company, New Delhi
4. Tilak Raj, CNC technology & programming, Dhanpat Rai publishing company(p) ltd., N Delhi
5. P. Radhakrishnan, Computer Numerical Control Machine & Computer Aided Manufacturing, New Academic Science Limited
6. M. Adithan & B. S. Pabla, CNC Machines, New Age International Publishers , N Delhi

15MC707 MICRO ELECTRO MECHANICAL SYSTEMS LABORATORY

0 0 2 1

Course Objectives

- Create the micro level model, simulate and analyse the same
- To perform the static and thermo mechanical analysis using software
- To build a micro product using etching and additive manufacturing process

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.

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. to build a required structure of a model
2. Analyze the various performance of created MEMS models
3. Generate an appropriate procedure, to fabricate the MEMS devices

Articulation Matrix

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

1 **3 Hours**

EXPERIMENT 1

Build a square structure with a circular hole in 3D builder using mask and direct method

2 **3 Hours**

EXPERIMENT 2

Build a comb drive using 3D builder and fabricate it using Intellifab

3 **3 Hours**

EXPERIMENT 3

Perform the transient analysis for a bimorph cantilever in a periodically changing magnetic field using SYNPLE

4 **3 Hours**

EXPERIMENT 4

Perform electrostatic force analysis for a contact switch using Blueprint

5 **3 Hours**

EXPERIMENT 5

Perform the Anisotropic etching process using ANISE tool

6 **3 Hours**

EXPERIMENT 6

Perform the static analysis of piezoelectric beam using TEM module

7 **3 Hours**

EXPERIMENT 7

Perform the sub-harmonic response analysis for the beam fixed at both ends

8 **3 Hours**

EXPERIMENT 8

Build the RF switch using 3D builder and perform the static analysis

9 **3 Hours**

EXPERIMENT 9

Create a model using beams and plates and perform the AC analysis which is suitable for gyro applications using SYNPLE

10 **3 Hours**

EXPERIMENT 10

Perform the Thermo Mechanical Analysis of piezoelectric pump

Total: 30 Hours

Reference(s)

1. Chang Liu, Foundations of MEMS, Pearson Education, New Delhi, 2011.
2. James J. Allen, Micro Electro Mechanical System Design, CRC Press Publishers, India, 2005

15MC708 CAD/CAM LABORATORY 0 0 2 1

Course Objectives

- To understand and execute design problems in a systematic manner
- To gain practical knowledge in handling 2D drafting and 3D modeling software 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.

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.

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.

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.

Course Outcomes (COs)

1. Program CNC machines to generate any contour/ Profile
2. Generate part programs for CNC lathe
3. Develop the CNC program for machining centre
4. Illustrate standard machine components using any modelling software

Articulation Matrix

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

1 **3 Hours**

EXPERIMENT 1

Exercise on linear and circular interpolation CNC Lathe

2 **3 Hours**

EXPERIMENT 2

Generation of CNC code for facing and step turning operation using simulation software

3 **3 Hours**

EXPERIMENT 3

CNC code generation for taper turning operation using Caps turn

4 **3 Hours**

EXPERIMENT 4

Exercise on thread cutting

5 **3 Hours**

EXPERIMENT 5
Exercise on grooving cycle

6 **3 Hours**

EXPERIMENT 6
Exercise on drilling and boring cycle

7 **3 Hours**

EXPERIMENT 7
Exercise on linear and circular interpolation CNC Milling

8 **3 Hours**

EXPERIMENT 8
Exercise on contour milling

9 **3 Hours**

EXPERIMENT 9
Exercise on drilling using suitable simulation software

10 **3 Hours**

EXPERIMENT 10
Modelling of tail stock in a LATHE using Creo Parametric

Total: 30 Hours

Reference(s)

1. William W. Lugges, CNC A First Look Primer, Delmar Publishers, New York, 1997
2. Alan Overby, CNC Machining Handbooks: Building, Programming and Implementation, McGraw-Hill Publishing Company Ltd, New York, 2011

15MC709 MINI PROJECT V 0 0 2 1

Course Objectives

- To develop skills to formulate a technical project
- To give guidance on the various tasks of the project and standard procedures.
- To teach use of new tools, algorithms and techniques required to carry out the projects.
- To give guidance on the various procedures for validation of the product and analyse the cost effectiveness.
- To provide guidelines to prepare technical report of the project.

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 the oral demonstrations.

Articulation Matrix

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

Total: 0 Hours

15MC804 PROJECT WORK 0 0 0 9

Course Objectives

- To develop knowledge to formulate a real world problem and project's goals.
- To identify the various tasks of the project to determine standard procedures
- To identify and learn new tools, algorithms and techniques
- To understand the various procedures for validation of the product and analysis the cost effectiveness
- To understand the guideline to Prepare report for oral demonstrations.

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 the oral demonstrations.

Articulation Matrix

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

Total: 0 Hours

15MC001 DESIGN FOR MANUFACTURE AND ASSEMBLY

3 0 0 3

Course Objectives

- To introduce the basic concepts and design guidelines that suite for different manufacturing processes
- To make students familiar with solving different problems in design modifications of the product made through various manufacturing techniques

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 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. Select the suitable tolerance refer to Indian standards and ASME Y 14.5
2. Design parts based on machining considerations in manufacturing
3. Design the various parts for casting, welding and sheet metal
4. Use DFMA tools for minimizing the effort and cost in manufacturing and assembly
5. Explain environmental considerations in parts design and assembly

Articulation Matrix

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

UNIT I **9 Hours**

INTRODUCTION TO TOLERANCES

Tolerances: Limits and Fits, tolerance Chains and identification of functionally important dimensions. Dimensional chain analysis-equivalent tolerances method, geometric tolerancing for manufacture as per Indian Standards and ASME Y 14.5 standard, surface finish

UNIT II **9 Hours**

FORM DESIGN OF CASTINGS, WELDMENTS, FORGING AND SHEET METAL COMPONENTS

Materials choice - Influences of materials - Space factor - Size - Weight - Surface properties and production method on form design. Redesign of castings based on parting line considerations, Minimizing core requirements, redesigning cast members using Weldments

UNIT III **9 Hours**

COMPONENT DESIGN - MACHINING CONSIDERATIONS

Design features to facilitate machining - Drills - Milling cutters - Keyways - Doweling procedures, Counter sunk screws - Reduction of machined area - Simplification by separation - Simplification by amalgamation - Design for machinability - Design for economy

UNIT IV **9 Hours**

DFMA TOOLS

Rules and methodologies used to design components for manual, automatic and flexible assembly, traditional design and manufacture Vs concurrent engineering, DFA index, poke-yoke, lean principles, six sigma concepts, design for manual assembly; design for automatic assembly

UNIT V **9 Hours**

DESIGN FOR THE ENVIRONMENT

Introduction Environmental objectives Global issues Regional and local issues Basic DFE methods Design guide lines Example application Lifecycle assessment Techniques to reduce environmental impact Design to minimize material usage Design for disassembly Design for Recyclability

FOR FURTHER READING

Form design aspects in Forging and sheet metal components - machining considerations, redesign for manufacture, examples - Design for energy efficiency Design to regulations and standards

Total: 45 Hours

Reference(s)

1. A.K. Chitale and R. C. Gupta, Product Design and Manufacturing, PHI 2007
2. G. Boothroyd, P. Dewhurst and W. Knight, Product Design for Manufacture and Assembly, Marcell Dekker, 2002
3. R. Bryan, Fischer, Mechanical Tolerance stackup and analysis, Marcell Dekker, 2004
4. M. F. Spotts, Dimensioning and Tolerance for Quantity Production, Prentice Hall Inc., 2002
5. J.G. Bralla, Hand Book of Product Design for Manufacturing, McGraw Hill Publications, 2000

15MC002 MAINTENANCE ENGINEERING 3 0 0 3

Course Objectives

- To understand various types of maintenance, their procedure and defects analysis commonly adopted in manufacturing industries
- To know about usage of computers for maintenance management and various condition monitoring techniques

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 the public health and safety, and the cultural, societal, and environmental considerations.

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. Analyze the defects and failures encountered in manufacturing system
2. Classify the maintenance system and select suitable one based on requirement
3. Explain the documentation and record updation involved in maintenance systems
4. Explain the scope of computers in maintenance system
5. create a monitoring strategy according to system characteristics

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		
4			1							3		
5			2							3		

UNIT I **9 Hours**

DEFECTS AND FAILURE ANALYSIS

Defect generation-types of failures-Defects reporting and recording-Defect analysis-Failure analysis-Equipment down time analysis-Breakdown analysis-FTA, FMEA.

UNIT II **9 Hours**

MAINTENANCE SYSTEMS

Planned and un-planned maintenance - Breakdown maintenance - Corrective maintenance - Opportunistic maintenance - Routine maintenance - Preventive maintenance, Predictive maintenance - Condition based maintenance system selection of maintenance system.

UNIT III **9 Hours**

SYSTEMATIC MAINTENANCE

Codification and Cataloguing-Instruction manual and operating manual-Maintenance manual and Departmental manual-Maintenance time standard-Maintenance work order and work permit - Feedback and control-Maintenance records and documentation.

UNIT IV **9 Hours**

COMPUTER MANAGED MAINTENANCE SYSTEM

Selection and scope of computerization-Equipment classification-Codification of breakdown, material and facilities- - Material management module-Captive Engineering module.

UNIT V **9 Hours**

CONDITION MONITORING

Condition monitoring techniques-Visual monitoring-Temperature monitoring-vibration monitoring-Lubricant monitoring-Cracks monitoring-Thickness monitoring-Noise and sound monitoring-condition monitoring of hydraulic system. Machine diagnostics-Objectives-Monitoring strategies-Examples of monitoring and Diagnosis

FOR FURTHER READING

Failure mode effects and criticality analysis- Design out maintenance- Job monitoring- Job sequencing- Control structures for machine diagnosis

Total: 45 Hours

Reference(s)

1. Sushil Kumar Srivastava, Industrial Maintenance Management, S. Chand and Company Ltd, New Delhi, 2006.
2. Manfred Weck and H. Bibring, Handbook of Machine Tools, John Wiley and Sons, New York, 1984.
3. Don Nyman and Joel Levitt, Maintenance Planning, Scheduling and Coordination, Industrial Press Inc., New York, 2010.
4. Michael E. Brumbach and Jeffrey A. Clade, Industrial Maintenance, Cengage Learning India Pvt. Ltd., New Delhi, 2006.
5. R. Keith Mobley, Maintenance Fundamentals, Butterworth Heinmann Publications, USA, 2004.

15MC003 ENGINEERING MATERIALS AND METALLURGY

3 0 0 3

Course Objectives

- To provide knowledge on classification, micro structure, heat treatment and testing methods for metals
- To understand the types and properties of non metallic 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.
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.
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 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. Explain application of phase rule to binary alloy systems and infer their microstructures through metallography
2. Design a temperature profile of heat treatment process that improves mechanical properties such as hardness and toughness of alloys
3. Classify ferrous and non ferrous materials by composition and investigate their microstructures, properties and applications
4. Assess the properties of different types of polymers and ceramics suitable for engineering applications
5. Outline mechanical behavior of materials through standard testing methods

Articulation Matrix

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

UNIT I **9 Hours**

PHASE DIAGRAMS AND CONSTITUTION OF ALLOYS

Alloys, Solid solutions Phase diagram, phase rule, lever rule, Binary phase diagram (Isomorphous, eutectic, peritectic, eutectoid reactions) - Iron-Carbon phase diagram? Metallography, microstructure

UNIT II **9 Hours**

HEAT TREATMENT OF STEELS

Purpose of heat treatment Annealing (stress relief, recrystallization, spheroidizing) and Normalizing Hardening and Tempering, Isothermal transformation diagrams (T-T-T diagrams), Cooling curves superimposed on TTT diagrams (martensite and bainite phase formation) Hardenability, Jominy end quench test, Case hardening processes, carburizing, nitriding, carbontiriding, cyaniding, flame hardening, induction hardening

UNIT III **9 Hours**

ENGINEERING METALS AND ALLOYS

Classification of Engineering materials Ferrous metals Plain carbon steel (low carbon, medium carbon and high carbon steels), microstructure/composition, properties, applications Alloy steels, effect of alloying additions on steels, stainless steels, HSLA, maraging, tool steels - Cast iron (grey, white, malleable, sphreoidial cast iron), microstructure, properties, applications Non-ferrous metals (Ni, Cu, Ti, Al, Mg, Zn alloys), microstructure/composition, properties and applications Bearing materials

UNIT IV **9 Hours**

INTRODUCTION TO POLYMERS AND ENGINEERING CERAMICS

Polymers Types of polymers Thermoplasts and thermosets -Properties and applications of engineering polymers Rubber and its types, Ceramics Classification, types and applications

UNIT V **9 Hours**

MECHANICAL PROPERTIES AND MATERIALS TESTING

Elastic and plastic deformation, slip and twinning Tensile test, stress-strain behavior of ductile and brittle materials - Stress-strain behavior of elastomers Viscoelasticity - Compression test - Hardness and testing methods - Impact test - Fatigue test, S-N curve, endurance limit, factors affecting fatigue - Creep test, creep curves Types of fracture.

FOR FURTHER READING

Introduction to Super alloys, Shape memory alloys, Composites Case studies in Metallurgical failure analysis Importance of surface properties of materials (corrosion and wear).

Total: 45 Hours

Reference(s)

1. Sydney H. Avner, Introduction to Physical Metallurgy, Tata McGraw-Hill Publishing Company Pvt Ltd., New Delhi, 2010
2. William D.Callister, Material Science and Engineering, John Wiley and Sons, Singapore, 2010
3. Kenneth G.Budinski and Michael K.Budinski, Engineering Materials,Prentice Hall of India Learning. Ltd.,New Delhi, 2010.
4. V. Raghavan, Materials Science and Engineering, Prentice Hall of India Learning. Ltd., New Delhi, 2009.
5. O.P.Khanna, Material Science and Metallurgy, Dhanpat Rai Publications (P) Ltd, New Delhi, 2013
6. G. E. Dieter, Mechanical Metallurgy, Tata McGraw-Hill Publishing Company Pvt Ltd, New Delhi, 2007

15MC004 PRODUCT DESIGN AND COSTING 3 0 0 3

Course Objectives

- To study about the concept of product costing, patenting and manufacturing economics in product design
- Understand the relationship between customer desires, functional requirements, product materials, product design, and manufacturing process selection

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 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.
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.

Course Outcomes (COs)

1. Identify the customer requirements to start new project and carryout product planning.
2. Generate and select suitable ideas to pursue successful design
3. Estimate the manufacturing process and cost to make well defined component
4. Explain the process of patenting the Intellectual property
5. Apply economic reasoning to analysis the contemporary problem for newly developed product

Articulation Matrix

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

UNIT I **10 Hours**

PRODUCT PLANNING FOR CUSTOMER NEEDS

Product Planning Process- Identifying Opportunities- Evaluating and Prioritizing Projects- Allocating Resources and Timing- Pre-Project Planning-Reflect on the Results and the Process-Identifying Customer Needs- Raw Data from Customers- Interpreting Raw Data in Terms of Customer Needs-Organizing the Needs into a Hierarchy-Establishing the Relative Importance of the Needs-Reflecting on the Results and the Process

UNIT II **9 Hours**

PRODUCT SPECIFICATIONS AND CONCEPT GENERATION

Specifications - Specifications Established - Establishing Target Specifications-Setting the Final Specifications-Concept Generation-The Activity of Concept Generation-Clarify the Problem- Search Externally-Search Internally-Explore Systematically- Reflect on the Results and the Process.

UNIT III **9 Hours**

DESIGN FOR MANUFACTURING COST

DFM Cross functional team-Estimate the manufacturing cost, Reduce the Cost of components, Reduce the cost of assembly, Rescue the cost of supporting production-Impact of DFM decisions-Development time, Development cost, Product quality, External factors.

UNIT IV **7 Hours**

PATENTS AND INTELLECTUAL PROPERTY

Overview of patents, Utility patents, Preparing a disclosure - Formulate strategy plan- Study of prior invention - Outline claims - Description of inventions - Refine claims - Pursue application - Reflect of result and process.

UNIT V **10 Hours**

PRODUCT DEVELOPMENT ECONOMICS

Elements of economic analysis -Quantitative analysis, Qualitative analysis - Building a Base-Case Financial Model - Sensitivity analysis-Development cost and time with examples - Project tradeoffs - Six potential interactions, Tradeoff rules, Limitations - Influence of qualitative factor on project success - Qualitative analysis

FOR FURTHER READING

Understanding and Representing tasks, Base line project planning, Accelerating projects, Project execution, Postmortem Project evaluation

Total: 45 Hours

Reference(s)

1. Karl T. Ulrich and Stephen D. Eppinger, Product Design and Development, McGraw-Hill Book Company, New Delhi, 2009.
2. George E. Dieter, Engineering Design - Materials and Process Approach, Tata McGraw-Hill Publishing Company Limited, New Delhi, 2008.
3. S. Dalela and MansoorAli, Industrial Engineering and Management Systems, Standard Publishers Distributors Pvt. Ltd., New Delhi, 2006.
4. Harry Nystrom, Creativity and Innovation, John Wiley and Sons Pvt. Ltd., Singapore, 1988
5. Benjamin W. Niebeland Alanb.Draper, Product Design and Process Engineering, Tata McGraw-Hill Publishing Company Ltd, New Delhi, 1976.

15MC005 RAPID PROTOTYPING 3 0 0 3

Course Objectives

- To provide knowledge of methods for the manufacturing of prototypes from computer based models
- To understand the entire process of direct manufacturing from the creation of computer based models to their physical realization
- To understand the various methods of manufacturing and their merits, demerits and applications
- To impart students to convert CAD models in to real life engineering components

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. Exemplify the need and role of rapid prototyping in product development
2. Summarize the principle and process parameters of liquid based RP process.
3. Choose the solid based RP process for a given applications
4. Apply the powder based RP process to create a prototype for a new product
5. Apply rapid tooling techniques in manufacturing process and exemplify the applications of RP process in various sectors.

Articulation Matrix

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

UNIT I **9 Hours**

INTRODUCTION

Need for time compression in product development, Product development-conceptual design - development - detail design- prototype -RP Data Formats - Information flow in a RP system - Generation of STL file- Steps in RP- Factors affecting RP process- Materials for RP- applications of RP- RP in Indian scenario

UNIT II **9 Hours**

STEREOLITHOGRAPHY

Classification of RP systems, Stereolithography systems - Principle- process parameters - process details - machine details, Applications - Direct Metal Laser Sintering (DMLS) system -Principle - process parameters -process details - machine details, Applications

UNIT III **9 Hours**

FDM AND LOM

Fusion Deposition Modeling -Principle- process parameters - process details - machine details, Applications - Laminated Object Manufacturing- Principle - process parameters - process details - machine details, Applications

UNIT IV **9 Hours**

SGC, 3DP AND LENS METHODS

Solid Ground Curing- Principle-process parameters -process details- machine details, Applications. 3 - Dimensional printers - Principle - process parameters - process details - machine details, Applications, and other concept modelers like thermo jet printers, Sander-s model maker, JP system 5, Object Quadra system. Laser Engineering Net Shaping (LENS) - Ballistic Particle Manufacturing (BPM) - Principle

UNIT V **9 Hours**

RAPID TOOLING AND APPLICATIONS OF RPT

Introduction to rapid tooling - Direct and indirect method - Software for RP -STL files, Magics, Mimics. Application of Rapid prototyping in Medical field, manufacturing and automotive industries

FOR FURTHER READING

Application of stereolithography in bio-medical engineering- application of to geometric modeling - wireframe, surface and solid modeling - Case study on FDM in evaluation and testing of sukhoi super jet landing gear - Manufacturing RC car parts with 3D printing - Rapid prototyping finishing processes

Total: 45 Hours

Reference(s)

1. Chua Chee Kai, Leong Kah Fai and Lim Chu Sing, Rapid Prototyping: Principles and Applications, World Scientific Publishing Company, Singapore, 2010
2. D. T. Pham and S. S. Dimov, Rapid Manufacturing, Springer-Verlag, London, 2001.
3. Paul F. Jacobs: Stereo Lithography and other RP & M Technologies, SMENY, 1996.
4. Frank W. Liou, Rapid Prototyping and Engineering Applications: A toolbox for prototype development CRC Press- Technology and Engineering, 2007
5. Terry Wohlers, Wohlers Report 2000, Wohlers Associates, USA, 2000
6. J. G. Conley, Rapid Prototyping and Solid Free Form Fabrication, Journal of Manufacutring Science and Engineering, vol. 19, Nov 1997, pp 811-815

15MC006 DIGITAL SIGNAL PROCESSING 3 0 0 3

Course Objectives

- To introduce the concept of analyzing discrete time signals and systems in the time and frequency domain
- To study various transformation techniques and their computation.
- To study the concept, design and implementation of filters.

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. Interpret the characterization and classification of signals and concepts of signal processing
2. Analyze discrete time signals and systems in time and frequency domain
3. Infer analog and discrete signals in frequency domain using fourier transforms
4. Explain various transformations and their computation of continuous signals.
5. Design and analyse the analog filters and digital signal architecture for IIR and FIR filters

Articulation Matrix

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

UNIT I **9 Hours**

INTRODUCTION

Characterization and classification of signals - examples of signals - multichannel - multi-dimensional continuous versus discrete - analog versus digital - concept of frequency. Concepts of signal processing - typical applications.

UNIT II **9 Hours**

DISCRETE TIME SYSTEMS

Representations - classifications - time domain and frequency domain characterization - transfer functions Z- transform and applications.

UNIT III **9 Hours**

FREQUENCY ANALYSIS OF SIGNALS

Analysis of analog and discrete signals - using Fourier series, Fourier transform, Fourier transform of discrete sequence and discrete Fourier transform -computation of discrete Fourier transforms.

UNIT IV **9 Hours**

DIGITAL PROCESSING OF CONTINUOUS SIGNALS

Radix 2. FFT algorithms. Sampling of continuous signals - anti aliening filters - sample and hold circuit reconstructing filters - analog to digital and digital to analog converters

UNIT V **9 Hours**

DIGITAL FILTERS

Discretization of analog filters - direct discrete design - window functions -filter realization - introduction to digital signal architecture-IIR and FIR structures.

FOR FURTHER READING

Quantization noise - Derivation for quantization noise power Over flow error - Truncation error - Limit cycle oscillation - Signal scaling - Interpolation and Decimation , Decimation by an integer factor - Interpolation by an integer factor - Sampling rate conversion by a rational factor. Applications: Signal processing- Spectral estimation, enhancement.

Total: 45 Hours

Reference(s)

1. S. K. Mitra, Digital Signal Processing - A computer based approach, Tata McGraw-Hill Publishing Company Ltd, New Delhi, 2011.
2. Joyce Van de Vegte, Fundamentals of Digital Signal Processing, Prentice Hall of India Learning. Ltd., New Delhi, 2001.
3. Alan V. Oppenheim and Ronald W. Schafer, Discrete Time Signal Processing, Pearson Education,New Delhi, 2010.
4. R. G. Lyons, Understanding Digital Signal Processing, Addison Wesley Publishing Company, India, 2004.

15MC007 SOFT COMPUTING 3 0 0 3

Course Objectives

- To provide an overview of soft computing techniques
- To provide a strong foundation of neural networks
- To introduce the applications of Fuzzy and Genetic algorithm

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.

Course Outcomes (COs)

1. Compare and Contrast various soft computing techniques.
2. Explain the pattern association algorithm
3. Familiar with ART and neural networks.
4. Understand the fuzzy logic concepts
5. Apply genetic algorithm in real time problems

Articulation Matrix

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

UNIT I **9 Hours**

INTRODUCTION TO NEURAL NETWORKS

Differences between Biological and Artificial Neural Networks - Typical Architecture, Common Activation Functions, McCulloch - Pitts Neuron, Linear Separability - Hebb Net, Perceptron, Adaline, Madaline - Architecture, algorithm, and Simple Applications.

UNIT II **9 Hours**

PATTERN ASSOCIATION

Training Algorithms for Pattern Association - Hebb rule and Delta rule, Heteroassociative, Auto associative and Iterative Auto associative Net, Bidirectional Associative Memory - Architecture, Algorithm.

UNIT III **9 Hours**

ADAPTIVE RESONANCE AND BACKPROPAGATION NEURAL NETWORKS

ART1 and ART2 - Basic Operation and Algorithm, derivation of earning Rules, Boltzmann Machine Learning - Architecture, Algorithm and Simple Applications.

UNIT IV **9 Hours**

CLASSICAL, FUZZY SETS AND RELATIONS

Properties and Operations on Classical and Fuzzy Sets, Crisp and Fuzzy Relations - Cardinality, Properties and Operations, Composition, Tolerance and Equivalence Relations.

UNIT V **9 Hours**

GENETIC ALGORITHM

Working principles, Coding, fitness function, GA operators, Differences and similarities between GAs and traditional methods, GAs for constrained optimization, Real-coded GAs.

FOR FURTHER READING

Simple Neural Nets for Pattern Classification - Simple Applications in pattern associations - Standard Backpropagation Architecture - Simple Problems on Classical, Fuzzy Sets and Relations - Advanced GAs.

Total: 45 Hours

Reference(s)

1. S.N.Sivanandam and S.N.Deepa, Principles of Soft Computing, Wiley India(P) Ltd,2011
2. Timothy J.Ross, Fuzzy Logic with Engineering Applications, McGraw-Hill, 2000
3. Davis E.Goldberg, Genetic Algorithms: Search, Optimization and Machine Learning, Addison Wesley, N.Y., 1989
4. Jang.J.S.R., Sun.C.T.and Mizutami.E, Neuro fuzzy and Soft computing, Prentice Hall, New Jersey-2010

15MC008 LINEAR INTEGRATED CIRCUITS 3 0 0 3

Course Objectives

- To study the IC fabrication procedure.
- Study the characteristics, realize circuits, design for signal analysis using Op-amp ICs.
- To study the applications of Op-amp.
- To study internal functional blocks and the applications of special ICs like Timers, PLL circuits, regulator circuits, ADCs.

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. Classify the ICs and examine the processes involved in IC fabrication
2. Analyse the DC & AC Characteristic of OPAMP and specify the application of OPAMP
3. Design the circuits using OP-AMP for various linear and nonlinear applications
4. Analyse the characteristics and applications of special ICs like Timers, PLL circuits, and regulator circuits.
5. Analyse the function of different of voltage regulators and infer the need for Optocoupler.

Articulation Matrix

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

UNIT I **9 Hours**

IC FABRICATION

IC classification, fundamental of monolithic IC technology, epitaxial growth, masking, diffusion of impurities, Realization of monolithic ICs and packaging.

UNIT II **9 Hours**

CHARACTERISTICS OF OPAMP

Ideal OP-AMP characteristics, DC characteristics, AC characteristics, offset voltage and current: voltage series feedback and shunt feedback amplifiers, differential amplifier; frequency response of OP-AMP; Basic applications of op-amp.

UNIT III **9 Hours**

APPLICATIONS OF OPAMP

Instrumentation amplifier, first and second order active filters, V/I and I/V converters, comparators, multivibrators, waveform generators, clippers, clampers, S/H circuit, D/A converter (R-2R ladder and weighted resistor types), A/D converter - Dual slope, successive approximation and flash types.

UNIT IV **9 Hours**

SPECIAL ICS

555 Timer circuit Functional block, characteristics and applications, 566-voltage controlled oscillator circuit; 565-phase lock loop circuit functioning and applications, IC L8038 function generator, IC 723 general purpose regulator.

UNIT V **9 Hours**

APPLICATION ICS

IC voltage regulators - LM317, 723 regulators, switching regulator, MA 7840, LM 380 power amplifier, ICL 8038 function generator IC, isolation amplifiers, opto coupler.

FOR FURTHER READING

Etching, summer, differentiator and integrator, peak detector, Analog multiplier ICs, opto electronic ICs.

Total: 45 Hours

Reference(s)

1. Ramakant A. Gayakward, Op-amps and Linear Integrated Circuits, Pearson Education, New Delhi, 2009.
2. D. Roy Choudhury and Sheil B. Jani, Linear Integrated Circuits, New Age International, New Delhi, 2010.
3. Jacob Millman and Christos C.Halkias, Integrated Electronics - Analog and Digital Circuits System, Tata McGraw-Hill Publishing Company Limited, New Delhi, 2003.
4. Robert F. Coughlin and Fredrick F. Driscoll, Op-amp and Linear ICs, Pearson Education, New Delhi, 2008.
5. David A. Bell, Op-amp and Linear ICs, Prentice Hall of India Learning. Ltd., New Delhi, 2007.

15MC009 INDUSTRIAL ELECTRONICS 3 0 0 3

Course Objectives

- To learn industrial electronics in applied manner with perspective of mechatronics engineering.
- To introduce the design philosophy for mechanical processes control based on analog and digital electronics and electrical machines.
- To focus on integration of the marketing, design, and manufacturing functions of the firm in creating a new product.

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. Acquire basic knowledge on power semiconductor device and its characteristics.
2. Understand the different types of converters.
3. Understand the concepts of speed control of DC motor using solid state devices.
4. Understand the concepts of speed control of AC motor using solid state devices.
5. Gain the knowledge on the application of industrial electronics.

Articulation Matrix

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

UNIT I **9 Hours**

THYRISTORS AND THEIR APPLICATIONS

Introduction - Applications - Principle of Operating of an SCR - Two- Transistor Analogy of SCR - DIAC - TRIAC - GTO - IGBT - MCT - Basic Triggering circuits for Thyristors -Rectifier Circuits using SCR.

UNIT II **9 Hours**

INVERTERS, CHOPPERS AND CONVERTERS

Commutation Circuits - Inverters - series and parallel - VSI - Choppers: Step up, Morgan's, Jone's - Single phase and Three phase Converters, Fly-back convertors, Buck-Boost convertors - Introduction to cycloconverters and ac controllers

UNIT III **9 Hours**

SOLID STATE CONTROL OF DC MOTORS

Introduction - Advantage of Electronic Control - D.C. Motor Speed Control - Speed Control of DC Shunt Motors using Thyristor Technology - Overvoltage Protection of DC Motors.

UNIT IV **9 Hours**

SOLID STATE CONTROL OF AC MOTORS

Introduction - A.C. Motor control - Speed control motors - Speed control A.C. shunt motors using thyristors, Speed - torque characteristic of induction motor - V/f control Static rotor resistance control - Slip power recovery scheme.

UNIT V **9 Hours**

APPLICATIONS

Electronic timers - Digital counters - Voltage regulators - Voltage doubler - Online and offline ups - Switched mode power supply - Principle and application of induction and dielectric heating.

FOR FURTHER READING

Protection of power devices - Dual converters - Closed Loop control - Self control of synchronous motor - Static stator voltage control.

Total: 45 Hours

Reference(s)

1. Frank D. Petruzella, Industrial electronics, McGraw Hill, 1996.
2. Mohammed H. Rashid, Power Electronics: Circuits, Devices and Applications, Pearson Education India, 2003.
3. Terry Baltelt, Industrial electronics, devices, systems and applications, Delmar publishers, 1997.
4. Bhattacharya / S Chatterjee.S.K, Industrial Electronics and Control, Tata McGraw-Hill, 1998.
5. James T. Humphries, Leslie P.,Industrial Electronics, Delmar Publications, 1993.

15MC010 FUZZY LOGIC AND NEURAL NETWORKS

3 0 0 3

Course Objectives

- To make the students to understand Fuzzy logic and Neural Network concepts
- To equip the students with the latest application of soft computing

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. Implement machine learning through neural networks
2. Interpret the concept of artificial neural networks and their control applications
3. Explain the concept of fuzzy set theory and its architectures.
4. Make use of the knowledge based rules and its controller types
5. Apply the fuzzy knowledge representation and multi objective decision making controllers

Articulation Matrix

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

UNIT I **9 Hours**

ARTIFICIAL NEURAL NETWORK

Introduction -biological neuron and their artificial models - neuron modelling- learning rules - types of neural networks - single layer - multi layer feed forward network - back propagation - learning factors

UNIT II **9 Hours**

NEURAL NETWORKS IN CONTROL APPLICATIONS

Feedback networks Hopfield networks applications of neural networks process identification artificial neuro controller for inverted pendulum

UNIT III **9 Hours**

FUZZY LOGIC SYSTEMS

Classical sets-fuzzy sets- fuzzy operation -fuzzy relations - fuzzification - defuzzification - if-then rules- Fuzzy functions

UNIT IV **9 Hours**

FUZZY RULES AND LOGIC

Membership function-knowledge base - data base - rule base -decision-making logic -fuzzy logic controller: Mamdani and Sugeno-Takagi architecture

UNIT V **9 Hours**

FUZZY SYSTEMS

Representation of fuzzy knowledge - fuzzy inference systems - Fuzzy decision making - Multi Objective Decision Making

FOR FURTHER READING

Fuzzy controller for inverted pendulum, image processing, blood pressure during anaesthesia ÃƒÂ¢??Introduction to neuro-fuzzy controllers

Total: 45 Hours

Reference(s)

1. Jacek M. Zurada, Introduction to Artificial Neural Systems, Jaico Publishing House, New Delhi,2006
2. John Yen, Reza Langari, Fuzzy logic Intelligence, control and Information, Pearson Education,1999
3. C T Jang, J S R Sun and E Mizutani , Neuro Fuzzy and Soft computing, Pearson Education ,2004
4. Laurene Fauseett: Fundamentals of Neural Networks, PHI,1994
5. Timothy J.Ross: Fuzzy Logic Engineering Applications, McGrawHill, 1997
6. B. Yagnanarayanan, Artificial Neural Networks, Prentice Hall of India Ltd .,New Delhi.2012

15MC011 BIOMEDICAL INSTRUMENTATION 3 0 0 3

Course Objectives

- The intention and purpose of this course is to a make the students to understand the role of instrumentation in bio medical applications
- The intention and purpose of this course is to a make the students to gain adequate knowledge on ECG, EEG and EMG
- The intention and purpose of this course is to a make the students to analyze parameters of medical imaging and its measurements

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.
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.
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. Compare the construction, working and function of ECG, EEG, EMG and EOG machines
2. Classify the different sensors and transducers used to acquire signals related to biomedical engineering
3. Relate the working of different operational amplifier, biomedical recorders and writing systems used for biomedical signal conditioning system
4. Outline the construction and working of various medical measurement and patient monitoring systems
5. Determine the need for biomedical diagnostic instruments

Articulation Matrix

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

UNIT I **9 Hours**

INTRODUCTION

Cell structure - electrode - electrolyte interface, electrode potential, resting and action potential - electrodes for their measurement, ECG, EEG, EMG and EOG - machine description - methods of measurement, Stem cells.

UNIT II **9 Hours**

BIO MEDICAL SENSORS AND TRANSDUCERS

Basic transducer principles Types - source of bio electric potentials - resistive, inductive, capacitive, fiber-optic, photoelectric, chemical, active and passive transducers and their description and feature applicable for biomedical instrumentation.

UNIT III **9 Hours**

SIGNAL CONDITIONING, RECORDING AND DISPLAY

Input isolation, DC amplifier, instrumentation, charge amplifier, power amplifier, and differential amplifier - feedback, op Amp - Electrometer amplifier, carrier Amplifier - instrument power supply. Oscillagraphic - Galvanometric - XY, magnetic recorder, storage oscilloscopes - electron microscope - PMMC writing systems - Telemetry principles.

UNIT IV **9 Hours**

MEDICAL MEASUREMENT AND MONITORING SYSTEMS

Blood pressure measurement: by ultrasonic method - plethysonography - blood flow measurement by electromagnetic flow meter cardiac output measurement by dilution method - phonocardiography - vector cardiography. Heart lung machine - artificial ventilator - Anesthetic machine - Basic ideas of CT scanner - MRI and ultrasonic scanner - laser equipment and application - cardiac pacemaker - DC - defibrillator patient safety - electrical shock hazards.

UNIT V **9 Hours**

BIO MEDICAL DIAGNOSTIC INSTRUMENTATION

Introduction - computers in medicine - basis of signal conversion and digital filtering, data reduction technique - time and frequency domain technique, Biomatics.

FOR FURTHER READING

Equipment failures and troubleshooting - ECG Analysis - Centralized patent monitoring system - Bio telemetry - Bio, Nano sensors and application.

Total: 45 Hours

Reference(s)

1. R. S. Khandpur, Handbook of Biomedical Instrumentation, Tata McGraw-Hill Publishing Company Limited, New Delhi, 2011.
2. Cromwell, Weibell and Pfeiffer, Biomedical Instrumentation and Measurements, Prentice Hall of India Learning. Ltd., New Delhi, 2011.
3. L. A. Geddes and Baker, L.E., Principles of Applied Bio-medical Instrumentation, John Wiley and Sons Publishing Company, New York, 1995.
4. W. J. Tompkins, Biomedical Digital Signal Processing, Prentice Hall of India Learning. Ltd., New Delhi, 2000.

15MC012 PROCESS CONTROL 2 0 2 3

Course Objectives

- To obtain the mathematical models for first order and higher order real-time systems and also understand the concept of self-regulation
- To get adequate knowledge about the characteristics of various controller modes and controller tuning methods
- To understand how to apply the control schemes for various applications

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 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. Solve the mathematical models for first order real time systems.
2. Understand the characteristics of various control modes and the concept of various control schemes.
3. Understand the various controller tuning methods to tune the controller.
4. Know the construction, characteristics and applications of different type of actuators.
5. Apply the process control knowledge on Industrial environment.

Articulation Matrix

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

UNIT I **6 Hours**

INTRODUCTION

Need for process control continuous and batch process mathematical model of first order level, pressure and thermal processes interacting and non-interacting systems servo and regulator operation self-regulation

UNIT II **6 Hours**

CONTROLLER CHARACTERISTICS

Basic control actions characteristics of On-Off, proportional, integral and derivative control modes composite control modes: P+I, P+D and P+I+D control modes selection of control mode for different processes typical control schemes for level, flow, pressure and temperature processes.

UNIT III **6 Hours**

TUNING OF CONTROLLERS AND MULTI-LOOP CONTROL

Optimum controller settings Evaluation criteria-IAE, ISE and ITAE decay ratio Tuning of controllers by process reaction curve method damped oscillation method Ziegler-Nichol's tuning Feed forward control - ratio control cascaded control averaging control inferential and split range control.

UNIT IV **6 Hours**

FINAL CONTROL ELEMENT

Pneumatic and electric actuators valve positioner control valve characteristics of control valves type of valves: globe, butterfly, diaphragm, ball valves control valve sizing cavitation and flashing in control valves. Response of control valves, electric and electro pneumatic valves Selection of control valves

UNIT V **6 Hours**

SELECTED UNIT OPERATIONS

Distillation column control of top and bottom product compositions reflux ratio. Case study: control of CSTR, control of heat exchanger, Steam boiler: drum level control and combustion control.

FOR FURTHER READING

Interacting and non interacting system-Cascade control for level process-temperature process station.

1 **6 Hours**

EXPERIMENT 1

Characteristics of interacting and non-interacting systems.

2 **6 Hours**

EXPERIMENT 2

Closed loop response of temperature process station

3 **6 Hours**

EXPERIMENT 3

I / P to P / I Converter

4 **6 Hours**

EXPERIMENT 4

Tuning of PID using different techniques

5 **6 Hours**

EXPERIMENT 5

Implementation of cascade control scheme for level process

Total: 60 Hours

Reference(s)

1. George Stephanopoulos, Chemical Process Control, Prentice Hall of India learning Pvt. Ltd., New Delhi, 2012
2. B. Wayne Bequette, Process Control: modeling, design, and simulation, Prentice Hall of India Learning Pvt.Ltd., New Delhi, 2008
3. Donald P. Eckman, Automatic Process Control, Wiley-India Pvt. Ltd., New Delhi, 2009
4. Dale E. Seborg, D. A. Mellichamp and Thomas F Edgar, Process Dynamics and Control, Wiley-India, 2010.
5. Peter Harriott, Process Control, Tata McGraw-Hill Publishing Co. Ltd., New Delhi, 2008
6. S B Thakore and B I Bhatt, Introduction to Process Engineering and Design, Tata McGraw-Hill PublishingCo. Ltd., New Delhi, 2008.

15MC013 INDUSTRIAL ENGINEERING 3 0 0 3

Course Objectives

- To understand the use of forecasting, control of inventory, process of routing and scheduling for improving productivity
- To build and solve linear programming problem
- To analyse deterministic and probabilistic models of problems related to networks and queuing

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 ways of improving productivity by job design, work study, ergonomics, forecasting techniques and following safety.
2. Explain inventory control techniques and the need for material requirement planning.
3. Solve sequencing of jobs with two and more machines and also compute the characteristics of single server queuing models.
4. Formulate linear programming problems and find the optimum solution.
5. Construct the network model and identify the critical path of deterministic and probabilistic models

Articulation Matrix

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

UNIT I **9 Hours**

PRODUCTION PLANNING AND CONTROL

Productivity - Productivity index -Productivity measurement - Job design - Job standard - Work study - Method study - Operation process chart - Motion study - Motion econoomy - SIMO chart - Work measurement - PMTS - Ergonomics - Industrial safety: losses due to accidents, causes, preventive measures

Forecasting - Types - Accuracy of forecast -Sales forecasting techniques - Time series method: simple moving average, weighted moving average, exponential smoothing

UNIT II **9 Hours**

INVENTORY CONTROL

Inventory control - Purpose - Inventory costs - EOQ - Deterministic models - Shortage model - Classification: ABC analysis, FSN analysis - Material Requirement Planning (MRP)

UNIT III **9 Hours**

SCHEDULING AND QUEUING

Introduction -Rules - Factors affecting - Master schedule - Gantt chart - Sequencing problem: Models with n jobs with 2 machines Models with n jobs with 3 machines Queuing models - Queuing systems and structures - Notation - Parameter - Poisson input - Exponential service - Constant rate service - Infinite population - Single server models

UNIT IV **9 Hours**

LINEAR PROGRAMMING

Introduction - Formulation - Graphical method, Simplex method Artificial Variable techniques: Big M method - Transportation Problems: North West corner method, Least cost method, Vogel's approximation method - MODI method - Assignment problems with Hungarian algorithm

UNIT V **9 Hours**

NETWORK MODELS

Network models - Shortest route - Minimal spanning tree - Maximum flow models - Project network - CPM and PERT networks - Critical path scheduling

FOR FURTHER READING

Simulation Process - Stochastic Simulation - Monte Carlo Sampling Process, Random Process Generatiion - Simulation of Queuing System

Total: 45 Hours

Text Book(s)

1. T. R. Banga, N. K. Agarwal and S. C. Sharma, "Industrial Engineering and Management Science", Khanna Publishers, Delhi, 1996.
2. Prem Kumar Gupta and D. S. Hira, "Operations Research", S. Chand and Co., New Delhi, 2014.

Reference(s)

1. S. B. Srivastava, "Industrial Management", I. K. International Publishing House Pvt. Ltd., New Delhi, 2012.
2. Hamdy A. Taha, , "Operation Research: An introduction", Pearson Publications., New Delhi, 2010.
3. Frederick S. Hiller and Gerald J. Liberman, Operations Research: Concepts and cases, Tata McGraw-Hill Publishing Company Pvt Ltd., New Delhi, 2010.

15MC014 EMBEDDED SYSTEM DESIGN 3 0 0 3

Course Objectives

- Ability to understand comprehensively the technologies and techniques underlying in building an embedded solution to a wearable, mobile and portable 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 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.

Course Outcomes (COs)

1. Analyse the characteristics of an embedded system and its applications
2. Differentiate the various embedded processor based on its internal memory
3. Design an interfacing circuit using I/O devices and network protocols
4. Select a suitable mechanisms for RTOS applications
5. Design an embedded system for real time applications based on fault tolerance and reliability evaluation techniques

Articulation Matrix

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

UNIT I **7 Hours**

INTRODUCTION TO EMBEDDED SYSTEM

System Design: Definitions, Classifications and brief overview of micro-controllers, Microprocessors and DSPs. Embedded processor architectural definitions. Typical Application scenarios of embedded systems.

UNIT II **10 Hours**

PROCESSOR AND MEMORY ORGANIZATION

Bus Organization, Memory Devices and their Characteristics, Instruction Set Architecture [RISC,CISC], Basic Embedded Processor/Microcontroller Architecture [8051, ARM, DSP, PIC],memory system architecture [cache, virtual, MMU and address translation], DMA, Co-processor and Hardware Accelerators, pipelining

UNIT III **10 Hours**

I/O DEVICES AND NETWORKS

I/O Devices[Timers, Counters, Interrupt Controllers, DMA Controllers, A/D and D/A Converters, Displays, Keyboards, Infrared devices], Memory Interfacing, I/O Device Interfacing [GPIB, FIREWIRE, USB, IRDA], Networks for Embedded systems (CAN, I2C, SPI, USB, RS485, RS 232), Wireless Applications [Bluetooth, Zigbee].

UNIT IV **9 Hours**

OPERATING SYSTEMS

Basic Features of an Operating System, Kernel Features [polled loop system, interrupt driven system, multi rate system], Processes and Threads, Context Switching, Scheduling[RMA, EDF, fault tolerant scheduling], Inter-process Communication, real Time memory management [process stack management, dynamic allocation], I/O[synchronous and asynchronous I/O, Interrupts Handling, Device drivers], RTOS [VxWorks, RT-LINUX].

UNIT V **9 Hours**

EMBEDDED SYSTEM DEVELOPMENT

Design Methodologies[UML as Design tool, UML notation, Requirement Analysis and Use case Modeling], Design Examples [Telephone PBX, Inkjet Printer, PDA, Elevator Control System, ATM System], Fault-tolerance Techniques, Reliability Evaluation Techniques.

FOR FURTHER READING

Discussion of specific examples of complete embedded systems using mc68 HC11, mc8051, ADSP2181,Arduino microcontroller, Raspberry Pi, PIC series of microcontroller

Total: 45 Hours

Reference(s)

1. Wayne Wolf Computers as components: Principles of Embedded Computing System. design The Morgan Kaufmann Series in Computer Architecture and Design, 2008
2. Jane W. S., Liu, Real time systems, Pearson Education, 2000
3. Raj Kamal, Embedded systems Architecture, Programming and design, Second Edition, 2008
4. Robert Ashby, Ã¢??Designer's Guide to the Cypress PSoCÃ¢?? Newnes, 2005
5. Microblaze processor Reference guide, Xilinx
6. NIOS II Processor reference Handbook, ALTERA

15MC015 CAM AND FACTORY AUTOMATION 3 0 0 3

Course Objectives

- To impart knowledge about latest machine vision techniques
- To develop programming skill in CNC and in robotics.
- To teach various automatic material handling 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.
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. Understand the basic structure & working of machine vision system
2. Comprehend the working and importance of lighting system
3. Develop knowledge based on image processing
4. Gather knowledge about AS/RS and AGVs
5. Learning on application of computers in manufacturing scenario

Articulation Matrix

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

UNIT I **9 Hours**

INTRODUCTION AND FUNDAMENTALS OF VISION SYSTEM

Vision system human vision, disadvantages - machine vision, advantages components and working principles of MVS - fundamental of Imaging MVS specifications design requirements Human machine interfaces MVS Integration of Mechanical, Electrical, Optical, Software, Mechatronics engineering.

UNIT II **9 Hours**

LIGHTING SYSTEM

Importance of Illumination Light and light perception - light characteristics Light sources monochromatic light, white light, UV, IR LED and Laser polarized lighting , filtered lighting - types of illuminators illumination techniques factors to be considered in design of Lighting of a MVS

UNIT III **9 Hours**

IMAGE ANALYSIS AND IMAGE PROCESSING

Introduction to digital images Image analysis Basic, scalar, arithmetic - Image enhancement Thresholding ,Histogram , line profile , intensity measurement Image processing lookup tables(LUT),

Morphology , spatial filters, Frequency domain processing - Blob analysis, Particle measurement, Dimension measurement Edge detection , alignment, Pattern matching.

UNIT IV **9 Hours**

AUTOMATED MATERIAL HANDLING AND INSPECTION

Introduction to Automated Guided Vehicle (AGV) Systems and Automated Storage and retrieval system (AS/RS) - basic components, types and its application. Automated inspection principles- Off line and on line inspection, distributed inspection and final inspection

UNIT V **9 Hours**

COMPUTER AIDED MANUFACTURING AND GROUP TECHNOLOGY

Introduction to CAM- Manufacturing planning, manufacturing control- Computer integrated manufacturing, Flexible manufacturing systems -Components, Types of systems, FMS layout and FMS benefits. Computer aided process planning: Retrieval CAPP systems and generative CAPP systems, benefits of CAPP. Group Technology Part families

FOR FURTHER READING

Pneumatic and hydraulic control system-Interfacing of components of CNC system-Part programming examples-Features of CAM packages-Sensor technologies for automated inspection and Shop floor control-Parts classification and coding- Benefits of group technology

Total: 45 Hours

Text Book(s)

1. Harley R . Myler , Fundamentals of Machine Vision , Prentice - Hall
2. Louis J Galbiati , Image Processing Fundamentals, Prentice Ã¢?? Hall
3. D. Richard Klafter, Thomas A Cmielewski and Michael Negin, Robotc Engineering, An Integrated Approach, Prentice Hall of India, New Delhi, 1999
4. M. P. Groover, Mitchell Weiss, N.Roger Nagel and G. Odrey, Industrial Robotics, Tata McGraw-Hill Publishing Company Pvt. Ltd., New Delhi, 2005
5. Yoram Koren, Computer Control of Manufacturing Systems, Tata McGraw-Hill Publishing Company Pvt. Ltd., New Delhi, 2005

Reference(s)

1. P. Radhakrishnan , Computer Numerical Control Machines and Computer Aided Manufacture, New Central Book Agency Pvt. Ltd., India, 2012.

15MC016 INDUSTRIAL METROLOGY 3 0 0 3

Course Objectives

- To study the concepts of measurement and characteristics of instruments
- To learn the procedure for various linear and angular measurements
- To provide knowledge on measurement of gear and thread terminologies using Suitable instruments
- To study the use of laser and advances in metrology for linear geometric dimensions
- To expose the measuring procedure to measure the mechanical parameters using suitable instruments

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. Understand the basic concept of measurement and characteristics of instrument
2. Measure the linear and angular dimensions using suitable instruments
3. Measure the gear and thread terminologies using suitable instruments
4. Understandtheuse of laser and advances in metrology for linear geometric dimensions
5. Measure the mechanical parameters using suitable instruments

Articulation Matrix

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

UNIT I **9 Hours**

LIMITS, FITS AND TOLERANCE

Systems of Limits and Fits: Introduction, normal size, tolerance limits, deviations, allowance, fits and their types - unilateral and bilateral tolerance system, hole and shaft basis systems - interchangebility and selective assembly. Indian standard Institution system - International Standard system for plane and screwed work.

UNIT II **9 Hours**

LINEAR AND ANGULAR MEASUREMENTS

Linear Measurement: Length standard: line and end standard, slip gauges - calibration of slip gauges, Dial indicator, micrometers.Measurement of Angles and Tapers: Different methods - Bevel protractor - angle slip gauges - spirit levels - single bar - Sine plate used to determine the tappers.Limit Gauges: Taylor's principle - GO and NO GO gauge, plug, ring, snap, taper, profile and position gauges.

UNIT III **9 Hours**

OPTICAL MEASUREMENT DEVICES

Optical Measuring Instruments: Tool maker's microscope and its uses Ã¢?? Auto collimators, optical profile projector - optical flats and their uses, interferometer.Flat Surface Measurement: Measurement of flat surfaces - instruments used; straight edges, surface plates.

UNIT IV **9 Hours**

LASER AND ADVANCES IN METROLOGY

Interferometer: NPL Flatness, Laser, Michelson-Computer Aided Inspection-Digital Devices-Machine Vision System-Coordinate Measuring Machine: Basic concept, Types, Constructionalfeatures, Probes, Accessories-Surface Roughness Measurement-Straightness Measurement-Squareness Measurement-Machine Tool Metrology.

UNIT V **9 Hours**

FORM MEASUREMENT

Measurement Through Comparators: Comparators: Types and their uses in mass production. Screw Thread Measurement: Element of measurement - errors in screw threads - measurement of effective diameter, angle of thread and thread pitch, profile thread gauges. Machine Tool Alignment Tests: Requirement of Machine Tool Alignment Tests, Alignment tests on lathe, milling, drilling machine tools, Preparation of acceptance charts.Gear Measurement: Gear measuring instruments, Gear tooth profile measurement, Measurement of diameter, pitch pressure angle and tooth thickness.

FOR FURTHER READING

Angle measurement of V-groove-Checking of angle of taper hole-Tool Maker's microscope for Gear Measurement-Thread Measurement using Profile Projector-Industrial expansion thermometers

Total: 45 Hours

Reference(s)

1. Bewoor, Vinay Kulkarni, Metrology& Measurement, Tata McGraw Hill Publishing CompanyPvt. Ltd., New Delhi, 2009
2. Alan S. Morris, The Essence of Measurement, Prentice Hall of India, New Delhi,2001
3. R. K. Jain, Engineering Metrology, Khanna Publishers, New Delhi, 2009
4. A. K. Jayal, Instrumentation and Mechanical Measurements, Galgotia Publications, New Delhi2000
5. T. G. Beckwith, N. Lewis Buck, Mechanical Measurements, Addison Wesley, New Delhi2008

15MC017 OPTIMAL CONTROL SYSTEM 3 0 0 3

Course Objectives

- Optimal control fundamentals
- Dynamic programming for optimal control & constrained optimal 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 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.

Course Outcomes (COs)

1. Compute the mathematical modelling and to provide solution for an optimal control problem
2. Determine the optimal control system using dynamic programming
3. Compare the linear regulatory approach with variational approach for optimal control
4. Determine the linear tracking problem and Pontryagin's principle for different constraints
5. Generate the minimum time control problem for simple practical dynamic systems

Articulation Matrix

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

UNIT I **9 Hours**

INTRODUCTION

Problem formulation Mathematical model Physical constraints Performance measure: Form of optimal control - Performance measures for optimal control problem Selecting a performance measure

UNIT II **9 Hours**

CALCULUS OF VARIATIONS

Fundamental concepts Functionals - Piecewisesmooth extremals - Constrained extreme. Optimal control law Principle of optimality - An optimal control system Interpolation - a recurrence relation of dynamic programming computational procedure Characteristics of dynamic programming solution.

UNIT III **9 Hours**

LINEAR REGULATOR

Hamilton Jacobi Bellman equation - Continuous linear regulator problems - Variational approach to optimal control problems: Necessary conditions for optimal control.

UNIT IV **9 Hours**

OPTIMAL REGULATOR

Linear regulator problems - Linear tracking problems -Pontryagins minimum principle and state inequality constraints.

UNIT V **9 Hours**

OPTIMAL TIME

Minimum time problems Minimum control effort problems- Singular intervals in optimal control problems

Total: 45 Hours

Reference(s)

1. Donald E. Kirk, Optimal Control Theory: An Introduction, Prentice-Hall networks series, 2006
2. Desineni Subbaram Naidu, Ã*f*Â¢??Optimal Control Systems, CRC Press, 2003
3. Frank Lewis, Draguna L. Vrabie, Vassilis L. Syrmos, Ã¢??Optimal ControlÃ¢??, 3rd edition, John Wiley & Sons, Inc., Hoboken, New Jersey, 2012
4. Sage A. P, White .C. C, Ã¢??Optimum Systems ControlÃ¢??, 2nd Edition, Prentice Hall, 1977

15MC018 INDUSTRIAL DRIVES AND CONTROL 2 0 2 3

Course Objectives

- To understand the working principle and performance characteristics of 3-Phase Induction motor
- To determine the operation, characteristics and performance parameters of converters
- To describe feedback control and basic components of control drive 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 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.

Course Outcomes (COs)

1. Understand the various types of drive system with gear arrangement
2. Understand the construction and working principle of asynchronous and asynchronous machine
3. Interpret the operation and characteristics of invertors and its related techniques
4. Acquire the knowledge on various types of frequency pattern and control modes
5. Write the integrate positioning programming for various types of application

Articulation Matrix

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

UNIT I **6 Hours**

BASICS OF DRIVE SYSTEM AND GEARS

Drive system introduction Comparison of drives Characteristic curves Gears introduction Gears sizes and Gear ratio Various types

UNIT II **6 Hours**

BASICS OF ASYNCHRONOUS

Design and theory of operation Motor poles Construction - Enclosure Torque Vs Speed characteristics curve Brakes & Brake rectifiers Encoder theory of operation Various types

UNIT III **6 Hours**

BASICS OF FREQUENCY INVERTERS

Block diagram Components of inverter Brake chopper & 4 quadrant operation accessories of invertors Energy recovery EMC effects Various communication types.

UNIT IV **6 Hours**

FREQUENCY PATTERNS

Introduction to the V/f characteristic curve- 50Hz pattern 70Hz pattern 87Hz pattern Open loop control modes (V/F & VFC) closed loop control modes (VFCN & CFC)

UNIT V **6 Hours**

IPOS PROGRAMMING, PARAMETER SET

Basics of IPOS programming commands Sample programs Touch probe Compiler specific information Various parameter sets Various fault codes & its description.

FURTHER READING

Application modules- Extended Positioning via bus-Modulo Positioning- Drive sync via S- Bus

1 **2 Hours**

EXPERIMENT 1

Working with Motion studio operating software

2 **2 Hours**

EXPERIMENT 2

Startup with Keypad and Motion Studio software for open loop drive

3 **3 Hours**

EXPERIMENT 3

Parameterization and operating mode- open loop system.

4 **2 Hours**

EXPERIMENT 4

Startup with Keypad and Motion Studio software for closed loop drive

5 **3 Hours**

EXPERIMENT 5

Parameterization and operating mode- Closed loop system

6 **2 Hours**

EXPERIMENT 6

Frequency pattern and fault code diagnosis

7 **3 Hours**

EXPERIMENT 7

IPOS program - Write a program to change the travel speed during movement.

8 **3 Hours**

EXPERIMENT 8

IPOS program - Write a program for table positioning.

9 **3 Hours**

EXPERIMENT 9

IPOS program - Write a program using touch probe function

10 **2 Hours**

EXPERIMENT 10

Application Module - Extended positioning via bus

11 **2 Hours**

EXPERIMENT 11

Application Module - Module Positioning.

12 **3 Hours**

EXPERIMENT 12

Application Module - Drive sync via S-bus

Total: 60 Hours

Reference(s)

1. Muhammad H. Rashid, Power Electronics - Circuits, Devices and Applications, Prentice Hall of India Learning. Ltd., New Delhi, 2004
2. G. K. Dubey, Fundamentals of Electrical Drives, Wiley Eastern Ltd., New Delhi, 2007
3. D.P.Kothari and J.J.Nagrath, Electric Machines, Tata McGraw-Hill Publishing Company Ltd, New Delhi, 2010
4. J. Nagrath and M. Gopal, Control System Engineering, New Age International Publisher, New Delhi, 2011
5. SEW Study materials, practical workbooks.

15MC019 ROBOTICS - PREHENSION AND PROGRAMMING

3 0 0 3

Course Objectives

- Understand the definitions, anatomy and basic terminologies of robots.
- Understand the working of various types of grippers
- Understand the robot 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.
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.

Course Outcomes (COs)

1. explain the basics of robot
2. explain the classifications of the robot grippers
3. choose the right grippers for the respective applications
4. program the robot for the given applications
5. explain the types of robot cell layouts

Articulation Matrix

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

UNIT I **9 Hours**

INTRODUCTION

Definition of a robot - History of industrial robots - laws of Robots - Robot Components Robot Coordinates - Robot Reference Frames - Robot Degrees of freedom Robot Joints - specification of robots: Robot workspace - Reach resolution - repeatability and accuracy of manipulator

UNIT II **9 Hours**

PREHENSION TECHNOLOGY

Grippers for Mechanization and Automation Definitions and Basic concepts Grasping in natural systems Historical Overview of Technical hands Automatic Prehension: Active pair mating, Strategy

and procedures, Gripper Classification, Requirements and Gripper Characteristics, Planning and selection of grippers Impactive Mechanical Grippers: Gripper drives, Design of Impactive grippers Ingressive Grippers: Flexible materials, Pinch mechanisms, Intrusive mechanisms, Non-Intrusive mechanisms

UNIT III **9 Hours**

SMALL AND SPECIAL GRIPPER DESIGNS

Impactive microgrippers: Electromechanically driven, Thermally driven, Electro-statically driven, Astrictive microgrippers, Vacuum microgrippers, Electro adhesive microgrippers, Constitutive Microgrippers Special Designs: Clasping Grippers, Anthropomorphic grippers, Joined finger grippers, Jointless finger grippers, Dextrous hands.

UNIT IV **9 Hours**

ROBOT PROGRAMMING

Methods of robot programming Lead through Programming Robot program as a path in space Motion Interpolation Wait, Signal and Delay commands Branching - Textual Robot Languages: generation of robot programming languages - Robot language structure Motion commands Endeffector and Sensor Commands - Program control and Subroutines Communications and Data Processing Sample programs (lab component)

UNIT V **9 Hours**

APPLICATIONS ENGINEERING FOR INDUSTRIAL ROBOTS

Robot cell layouts: Types, multiple robots and machine interference, considerations in work cell design, work cell control, interlocks, and Robot cycle time analysis Economic analysis of robots - Application of robots in machining: Welding, Assembly, Material handling, Loading and Unloading

Total: 45 Hours

Reference(s)

1. Gareth J. Monkman, Stefan Hesse, Ralf Steinmann, Henrik Schunk, Robot Gripper, John Wiley & Sons, 2007
2. Saeed B. Niku, Introduction to Robotics analysis, control and Applications, Second edition, reprint 2016, Wiley India Pvt. Ltd, New Delhi
3. M. P. Groover, Industrial Robotics - Technology, Programming and Applications, Tata McGraw-Hill Publishing Company. Ltd., New Delhi, 2011

15MC020 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
- To apply the quality concepts in product design, manufacturing etc in order to maximize customer satisfaction

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

Course Outcomes (COs)

1. Understand the total quality management concept and its values for an organization
2. Apply total quality management principles towards an organisation
3. Apply statistical approach for quality control
4. Apply major tools available to achieve total quality management
5. Analyse quality standards used in product design, manufacturing in order to maximize customer satisfaction

Articulation Matrix

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

UNIT I **9 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 OSHA standards

UNIT II **9 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 **9 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

UNIT IV **9 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

FURTHER READING

Supplier certification - Application of PoissonÃ¢??s distribution- Failure rate- Benefits of EMS

Total: 45 Hours

Reference(s)

1. D R Kiran. Total quality management, Butterworth-Heinemann,2016.
2. Dale H. Besterfiled, Total Quality Management, Pearson Education Inc., New Delhi, 2010
3. N. Gupta and B. Valarmathi, Total Quality Management, Tata McGraw-Hill Publishing Company Pvt. Ltd., New Delhi, 2009.
4. James R. Evans and William M. Lidsay, The Management and Control of Quality, South-Western Publishing Company, USA, 2002.
5. S. Kumar, Total Quality Management, Laxmi Publications Ltd., New Delhi 2006.

15MC0YA FUNDAMENTALS OF AUTOMATION 3 0 0 3

Course Objectives

- To impart fundamental knowledge in the areas of robotic system
- To apply fundamental knowledge hydraulic and pneumatic system
- To use the Microprocessor and PLC in various applications
- To apply the basic principles of mechatronics in various fields

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 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.

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. Identify the various configurations of robot and Construct the simple automation sequence and simple robot
2. Distinguish sensor and transducer, and measure the different parameters using various sensors.
3. Characterize the components and design the Hydraulic and Pneumatic circuit for industrial applications
4. Analyze the characteristics of actuators and select the suitable actuator for applications.
5. Develop the simple programmable logic controller and distinguish between relay logic with ladder logic.

Articulation Matrix

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

UNIT I **9 Hours**

INTRODUCTION TO MECHATRONICS AND ROBOTICS

Introduction - Systems - Open loop system-closed loop system, Basic elements, sequential controller and Microprocessor based controllers. Industrial Robot: Definition, laws of robots- Robot Anatomy - Robot configurations - motions - work volume - drive system - Types of Robot Controls - Precision of movement - Application

UNIT II **8 Hours**

SENSORS AND TRANSDUCERS

Introduction to sensors and transducers , Types-Displacement, position and proximity - velocity and motion - force - fluid pressure - liquid flow and level - Temperature - Light - Selection of sensors

UNIT III **10 Hours**

HYDRAULICS AND PNEUMATICS SYSTEM

Pneumatic and hydraulic systems: Actuation system - Direction Control Valves - Pressure Control Valves-Cylinders - Cylinder Sequencing - Servo and Proportional Control Valves - Process Control Valves - Rotary Actuator

UNIT IV **9 Hours**

MECHANICAL AND ELECTRICAL ACTUATION SYSTEMS

Mechanical actuation System: Mechanical system - types of motion - Kinematic chain - cams - Gear Trains - Ratchet and pawl - Belt and chain drives - Bearings - Mechanical aspects of Motor selection. Electrical actuation system: Electrical Systems - Mechanical switches - Solid state switches - Solenoids - Stepper motor

UNIT V **9 Hours**

PROGRAMMABLE LOGIC CONTROLLER

Introduction - Basic structure - input/output processing - programming - mnemonics - Timers, relays and counters - shift registers - Data handling - Analogue input/output - Selection of PLC - Simple problems

FOR FURTHER READING

Application of PLC - elevator control, traffic light control, sensors in automobiles, ATM & mobiles phones, introduction to Smart Sensors (basics only)

Total: 45 Hours

Reference(s)

1. W. Bolton, Mechatronics: electronic control systems in mechanical and electrical engineering, Pearson Education (Singapore) Pvt. Ltd., New Delhi, 2013
2. Devdas Shetty, Richard A. Kolk, Mechatronics System Design, Cengage Delmar Learning India Pvt Learning, 2012
3. Mikell P.Groover, Automation, Production Systems and Computer Integrated Manufacturing, Prentice Hall of India Private Limited, New Delhi, 2008
4. Mikell P.Groover, Mitchall Lueiss, Roger N. Nagel and Nicholas G.Odery, Industrial Robotics Technology, Programming and Application, McGraw Hill Book Company, Singapore, 1996
5. V. S. Bagad, Mechatronics, Technical Publication, Pune, 2009

15MC0YB ROBOTICS 3 0 0 3

Course Objectives

- To analyze robot manipulators in terms of their kinematics, control
- Enable to program and control an industrial robot system that performs a specific task
- To discuss various applications of industrial robot 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 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.
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. Identify the configuration of a robot
2. Analyze the kinematics and control of robots
3. Understand different robot sensors and vision system
4. Perform simple programming of robot
5. Identify a suitable robot for a given application

Articulation Matrix

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

UNIT I **8 Hours**

INTRODUCTION

Definition of a robot - scope of industrial robots, Robot anatomy - robotics and automation, law of robots, specification of robots, resolution, repeatability and accuracy of manipulator. Classification of robots and justifying the use of robots. Drive mechanisms - hydraulic, electrical, pneumatic drives

UNIT II **10 Hours**

ROBOT CONTROL AND KINEMATICS

Power transmission systems and control - mechanical transmissions method- Rotary to rotary, rotary to linear conversions - rotary problem- remote centered compliance devices. End effectors - vacuum, magnetic and air operated grippers. Robot Kinematics- Forward Kinematics, Inverse Kinematics and

Differences -Forward Kinematics and Reverse Kinematics of Manipulators with Two, Three Degrees of Freedom (In 2 Dimensional), Four Degrees of Freedom (In 3 Dimensional) -DH matrices

UNIT III **9 Hours**

ROBOT SENSORS AND VISION SYSTEMS

Sensors - types - tactile sensors, proximity and range sensors, contact and non-contact sensors, velocity sensors, touch and slip sensors, force and torque sensors. Robotic vision systems, imaging components, image representation - picture coding, object recognition and categorization, visual inspection, robot cell, design and control layouts

UNIT IV **9 Hours**

ROBOT PROGRAMMING AND ARTIFICIAL INTELLIGENCE

Robotics programming: Teach Pendant Programming, Lead through programming, Robot programming Languages - VAL Programming - Motion Commands, Sensor Commands, End effector commands, and Simple programs. Basics - Goals of Artificial Intelligence

UNIT V **9 Hours**

INDUSTRIAL APPLICATIONS

Application of robots in machining - Welding - Assembly - Material handling - Loading and unloading-CIM-hostile and remote environments. Inspection and future application-safety, training, maintenance and quality. Economic analysis of robotics. SCARA robots, wheeled robots, Bipedal robots (humanoid robots), hexapod robots

FOR FURTHER READING

Economic and social issues - Micro motor and micro gripper - Performance characteristics of a robot - Simple programs for drilling operations using VAL - Robot cell

Total: 45 Hours

Reference(s)

1. M. P. Groover, Industrial Robotics - Technology, Programming and Applications, Tata McGraw-Hill Publishing Company. Ltd., New Delhi, 2011
2. K. S. Fu, R. C. Gonzalez and C. S. G. Lee, Robotics Control, Sensing, Vision and Intelligence, Tata McGraw-Hill Publishing Company Pvt. Ltd., New Delhi, 2003
3. D. Richard, Klafter A. Thomas, Chmielewski and Michael Negin, Robotics Engineering â€“ An Integrated Approach, Prentice Hall of India, New Delhi, 2009
4. Ramesh Jain, Machine Vision, Tata McGraw-Hill Publishing Company Pvt. Ltd., New Delhi, 1995
5. Yoram Koren, Robotics for Engineers, Tata McGraw-Hill Publishing Company Pvt. Ltd., New Delhi, 2004
6. James G. Keramas, Robot Technology Fundamentals, Cengage Learning India Pvt. Ltd., New Delhi, 2011

15MC0YC MICRO ELECTRO MECHANICAL SYSTEMS

3 0 0 3

Course Objectives

- To acquire a knowledge about fabrication process in MEMS
- To know about various etching techniques in micromachining
- To have a knowledge about applications in micromachining 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.
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.
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. Know the scaling laws that are used extensively in the conceptual design of micro-devices and able to use materials for common micro-components and devices
2. Select a fabrication process suitable for production of a MEMs device
3. Choose a micromachining technique, such as bulk micromachining and surface micromachining for a specific MEMS fabrication process
4. Understand the working principles of micro-sensors, actuators, valves, pumps, and fluidics used in Microsystems
5. Acquire knowledge on micro system packaging and design

Articulation Matrix

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

UNIT I **9 Hours**

INTRODUCTION

Introduction to MEMS: Introduction to Microsystems and micro electronics - Market scenario for MEMS. Working principle: Trimmers scaling vector and scaling laws - scaling in geometry - scaling in rigid body dynamics- scaling in electrostatic forces - scaling in electricity - scaling in fluid mechanics - scaling in heat transfer. Materials for MEMS: Silicon as a MEMS material - Crystal structure of silicon - Miller indices - silicon compounds - SiO2, SiC, Si3N4 and polycrystalline silicon - silicon piezo-resistors - Gallium arsenide - polymers for MEMS -quartz.

UNIT II **9 Hours**

FABRICATION OF MEMS

Clean room technology - Substrates and wafer - single crystal silicon wafer formation - ideal substrates - mechanical properties - Processes for bulk micromaching - Wet Vs dry etching -

Chemical etching of Silicon - etchant systems and etching process - Reactive ion etching and DRIE - mask layout design. Processes for Surface micromaching - Deposition processes - ion implantation - Diffusion - oxidation - chemical vapor deposition -physical vapor deposition - deposition by epitaxy - photolithography and photoresists. Limitations of Bulk and surface micromachining - LIGA, SLIGA and other micromolding processes such as HeXIL

UNIT III **9 Hours**

DESIGN CONSIDERATIONS BASED ON MICROMECHANICS

Micromechanics considerations - static bending of thin plates - circular plates with edge fixed - rectangular plate with all edges fixed - square plate with all edges fixed - mechanical vibration - resonant vibration - micro accelerometers - design theory and damping coefficients - thermo mechanics - thermal stresses - fracture mechanics - stress intensity factors - fracture toughness - and interfacial fracture mechanics

UNIT IV **9 Hours**

MEMS DEVICES

Micro actuation techniques - piezoelectric crystals - Shape memory alloys - bimetallics - conductive polymers. Micro motors - micro grippers - Microfluidic devices - Micro pumps - mechanical and nonmechanical micropumps - micro valves - valveless micropumps - Lab on Chip. Types of micro sensors - Microaccelerometer - Micropressure sensors, MEMS switches/resonators, MEMS reliability.

UNIT V **9 Hours**

MICROSYSTEM PACKAGING AND DESIGN

Micro system packaging - materials die level device level - system level - packaging techniques - die preparation - surface bonding - wire bonding - sealing - Case studies. Design considerations - process design - mechanical design - applications of micro system in automotive - bio medical - aerospace - telecommunication industries

FOR FURTHER READING

Use of gold and other metals in MEMS- MEMS devices for automotive application-MEMS device for the same purpose may be manufactured by different types of processes-Need for micromechanics considerations in MEMS design- Optical MEMS devices- Use of MEMS devices in cell phones, robots, automobiles, etc

Total: 45 Hours

Reference(s)

1. Mohamed Gad-el-Hak, The MEMS Handbook, CRC Press Publishers, India, 2002
2. Tai Ran Hsu, MEMS and Micro Systems Design and Manufacture, Tata McGraw-Hill Publishing Company Ltd, New Delhi, 2008
3. Nadim Maluf, An Introduction to Micro Electro Mechanical System Design, Artech House Publishers, London, 2004
4. Chang Liu, Foundations of MEMS, Pearson Education, New Delhi, 2011.James J. Allen, Micro Electro Mechanical System Design, CRC Press Publishers, India, 2005
5. Julian w. Gardner, Vijay K. Varadan and Osama O. Awadelkarim, Micro sensors MEMS and smart Devices, John Wiley and Sons Ltd., England, 2002
6. E.H. Tay, Francis and W.O.Choong, Micrfluids and Bio MEMS applications, Springer, 2002

15MC0YD SENSORS AND SIGNAL CONDITIONING 3 0 0 3

Course Objectives

- To make the students to gain a clear knowledge of the basic laws governing the operation of electrical instruments and the measurement techniques
- Emphasis is laid on the meters used to measure current & voltage
- Detailed study of resistance, inductance and capacitance measuring methods
- Detailed study of display and recording devices
- To get adequate knowledge about virtual instrumentation

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.
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.
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. Understand the different measurement standards and different kinds of errors
2. Choose use appropriate sensors for mechanical measurements
3. Understand different devices available for electrical measurements
4. Design a signal conditioning circuit and data acquisition system
5. Develop Lab VIEW programs for various applications and to know the use of DAQ card

Articulation Matrix

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

UNIT I **9 Hours**

SCIENCE OF MEASUREMENT

Units and Standards - International standards of measurement. Generalized Measurement System. Static and dynamic characteristics of transducers.- Errors in Measurements - Gross errors, Systematic errors, Random errors. Calibration techniques. Generalized Performance of Zero Order and First Order Systems - Response of transducers to different time varying inputs. Classification of transducers

UNIT II **8 Hours**

MECHANICAL MEASUREMENTS

Temperature measurement - Filled thermometer - Bimetallic thermometer. Pressure measurement - manometers - Bourdon gauge - bellows - diaphragm - McLeod gauge - thermal conductivity gauge. Flow measurement - Rotameter, orifice, venturi. Level measurement - Float gauge, capacitance and ultrasonic. Control of flow and pressure monitoring with PID controls

UNIT III **10 Hours**

ELECTRICAL MEASUREMENTS

Potentiometer. Temperature measurement - RTD - Thermistor - Thermocouple - Pyrometers. LVDT - RVDT - Capacitive transducers - Piezo electric transducer - Strain gauges - load cell - Hall effect transducers -Photoelectric transducers - Fiber optic transducers - electromagnetic - Anemometers - Variable reluctance type transducers and Hygrometer

UNIT IV **9 Hours**

SIGNAL CONDITIONING AND DATA ACQUISITION PRESENTATION

Wheatstone and Schering bridges - Amplification - Filtering - V/I, I/V and I/P converters - Sample and Hold circuits - D/A converter (R -2R ladder and weighted resistor types), A/D converter, Dual slope, successive approximation and flash types - Data logging - Display devices: CRO, LED and LCD

UNIT V **9 Hours**

VIRTUAL INSTRUMENTATION

VI - Graphical user interfaces - Data types - Data flow programming - Graphical programming palettes and tools - Front panel objects - Functions and libraries. FOR Loops, WHILE Loops, CASE Structure - Arrays and Clusters - Attribute modes Local and Global variables - Data acquisition using DAQ card

FOR FURTHER READING

Transducer - Application of Sensor and Actuator. Applications of Rotameter - Application of LVDT - Application of Wheatstone bridge - Advantages of Virtual Instruments over conventional instruments

Total: 45 Hours

Reference(s)

1. A. K. Sawhney and P. Sawhney, A Course on Mechanical Measurement Instrumentation and Control, Dhanpat Rai and Co, New Delhi, 2011
2. Garry M. Johnson, Labview Graphical Programming, Tata McGraw-Hill Publishing Company Limited, New Delhi, 2006
3. D. Patranabis, Principles of Industrial Instrumentation, Tata McGraw Hill Publishing Company Limited, New Delhi, 2011
4. J. P. Bentley, Principles of Measurement Systems, Addison Wesley Longman Ltd., UK, 2005
5. K.Krishnaswamy and S.Vijayachitra, Industrial Instrumentation, New age International Private limited, 2005
6. E. O. Doeblin, Measurement Systems: Applications and Design, Tata McGraw-Hill Publishing Company Limited, 2003

15MC0YE MECHATRONICS 3 0 0 3

Course Objectives

- To provide a basic background to mechatronics and link to more specialized skills
- To develop the mix of skills in mechanical engineering, electronics and computing
- To familiarize about sensors and control system used in mechatronics
- To develop confidence and competence in designing mechatronics 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 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.
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.

Course Outcomes (COs)

1. Identify the Mechatronics system based on sensor and transducer; analyze the sensors for Particular applications.
2. Characterize the components and design the Hydraulic and Pneumatic circuit for Industrial applications.
3. Analyze the characteristics of actuators and select the suitable actuator for applications.
4. Develop the simple programmable logic controller and differentiate relay logic with ladder logic.
5. Develop the mechatronics system design and implement the Process parameters for given application.

Articulation Matrix

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

UNIT I **9 Hours**

MECHATRONICS

Introduction to Mechatronics Systems - Measurement Monitoring Systems Automation - Control Systems -Microprocessor based Controllers. Sensors and Transducers - Performance Terminology - Sensors for Displacement, Position and Proximity; Velocity, Motion, Force, Fluid Pressure, Liquid Flow, Liquid Level, Temperature, Light Sensors - Selection of Sensors

UNIT II **8 Hours**

ACTUATION SYSTEMS

Pneumatic and Hydraulic Systems - Directional Control Valves - Rotary Actuators. Mechanical Actuation Systems - Cams - Gear Trains - Ratchet and pawl - Belt and Chain Drives - Bearings. Electrical Actuation Systems - Mechanical Switches - Solid State Switches - Solenoids - D.C Motors - A.C Motors - Stepper Motors -Servomotors.

UNIT III **10 Hours**

SYSTEM MODELS AND CONTROLLERS

Building blocks of Mechanical, Electrical, Fluid and Thermal Systems, Rotational - Translational Systems, Electromechanical Systems - Hydraulic - Mechanical Systems. Continuous and discrete process Controllers - Control Mode - Two - Step mode - Proportional Mode - Derivative Mode - Integral Mode - PID Controllers - Digital Controllers - Velocity Control - Adaptive Control - Digital Logic Control - Micro Processors Control

UNIT IV **9 Hours**

PROGRAMMABLE LOGIC CONTROLLERS

Programmable Logic Controllers - Basic Structure - Input / Output Processing -Programming - Mnemonics - Timers, Internal relays and counters - Shift Registers - Master and Jump Controls - Data Handling - Analogue Input / Output - Selection of PLC

UNIT V **9 Hours**

DESIGN OF MECHATRONICS SYSTEM

Stages in designing Mechatronics Systems - Traditional and Mechatronic Design - Possible Design Solutions Case Studies of Mechatronics Systems, Automatic washing Machine - Automatic Camera - Pick and place robot - Automatic Car Park Systems - Engine Management Systems

FOR FURTHER READING

Smart sensors - Hybrid motor - Advanced Controllers - PLC in Mechatronics - Fault finding

Total: 45 Hours

Reference(s)

1. W. Bolton, Mechatronics: Electronic control systems in Mechanical and Electrical Engineering, Pearson Education, New Delhi,2013
2. David G. Alciature and Michael B. Histand, Introduction to Mechatronics and Measurement Systems, Tata McGraw Hill Publishing Company Pvt Ltd., New Delhi,2007
3. Nitaigour Premchand Mahalik, Mechatronics : Principles, Concepts and Applications, Tata McGraw Hill Publishing Company Pvt Ltd., New Delhi,2008
4. M. D. Singh, and J. G. Joshi, Mechatronics, Prentice Hall of India, New Delhi,2009
5. K. P. Ramachandran, G. K. Vijayaraghavan, and M. S. Bala-Sundram, Mechatronics : Integrated Mechanical Electronic Systems, Wiley India Pvt. Ltd.,New Delhi 2008
6. Newton C. Braga, Mechatronic Source Book, Delmar Cengage Learning, 2009

15MC0YF MACHINE VISION 3 0 0 3

Course Objectives

- To impart basic knowledge of robot vision, image processing and its applications

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 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.

Course Outcomes (COs)

1. Basic principle of image acquisition and imaging components
2. Fundamentals of image processing and image enhancement
3. Object recognition and feature detection
4. Thinning and propagation algorithm
5. Various application of robot vision system

Articulation Matrix

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

UNIT I **9 Hours**

IMAGE ACQUISITION AND IMAGING COMPONENTS

The Nature of Vision- Robot vision Need, Applications - image acquisition illumination techniques- Point sensor, line sensor, planar sensor, camera transfer characteristic, Raster scan, Image capture time, volume sensors, Image representation, picture coding techniques.

UNIT II **9 Hours**

ELEMENTS OF IMAGE PROCESSING TECHNIQUES

Discretization, Neighbours of a pixel-connectivity- Distance measures - preprocessing Neighbourhood averaging, Median filtering. Smoothening of binary Images- Image Enhancement- Histogram Equalization-Histogram Specification Ã¢??Local Enhancement- Edge detection- Gradient operator

UNIT III **9 Hours**

OBJECT RECOGNITION AND FEATURE EXTRACTION

Image segmentation- Edge linking-Boundary detection-Region growing-Region splitting and merging- Boundary Descriptors-Freeman chain code-Regional Descriptors- recognition-structural methods- Recognition procedure

UNIT IV **9 Hours**

COLLISON FRONTS ALGORITHM

Introduction, skeleton of objects. Gradients, propagation, Definitions, propagation algorithm, Thinning Algorithm, Skeleton lengths of Top most objects.

UNIT V **9 Hours**

ROBOT VISION APPLICATION

Case study-Automated Navigation guidance by vision system vision based depalletizing- line tracking-. Automatic part Recognition. Image processing techniques implementation through Image Processing software-MATLAB/OPENCV

Total: 45 Hours

Reference(s)

1. Janaki Raman .P.A, Robotics and Image Processing an Introduction, Tata Mc Graw Hill Publishing company Ltd., 1995.
2. Richard D. Klafter, Thomas .A, Chri Elewski, Michael Negin, Robotics Engineering an Integrated Approach, Phi Learning, 2009
3. Mikell P Groover & Nicholas G Odrey, Mitchel Weiss, Roger N Nagel, Ashish Dutta, Industrial Robotics, Technology Programming and Applications, Tata McGraw-Hill Education, 2011.
4. John J. Craig, Introduction to Robotics Mechanics and Control, Third Edition, Pearson, 2008
5. Bijay K. Ghosh, Ning Xi, Tarn .T.J, Control in Robotics and Automation Sensor Based integration, Academic Press, 1999.
6. Deb .S.R, Robotics Technology and flexible automation, Tata McGraw-Hill Education., 2009

15MC0XA INDUSTRIAL HYDRAULICS 1 0 0 1

Course Objectives

- To study the various standards and principles in hydraulics and pneumatics
- To understand the real time application in hydraulics and pneumatics
- To practically study the various hydraulics and pneumatics components and their manufactures

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 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. Choose specific hydraulic application related to the need
2. Find easy to Control various valves and accessories in hydraulic systems
3. Undergo maintenance activities related to hydraulics

Articulation Matrix

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

UNIT I **15 Hours**

INDUSTRIAL HYDRAULICS

An Introduction to Hydraulics and its Principles - Hydraulic Fluids: Contamination control and fluid conductors - Hydraulic actuators and its use - Hydraulic cylinders - Hydraulic Motors - Hydraulic control elements - Hydraulic Pumps - Directional control valves - Pressure control Valves - Flow Control Valves - Cartridge Valves - Proportional and Servo Valves - Hydraulic Accessories - Accumulator and its application - Intensifiers - Pressure switches and Pressure gauges - Measuring equipments: Flow , Temp , Oil level - Sound Dampening devices - Filters and other Tank Accessories - Oil coolers - Hydraulic Symbols - Designing of a Hydraulic Systems and Circuit design - Calculations for designing a Hydraulic Systems - Analyzing the Hydraulic circuits - Basics to be considered while Assembling the Hydraulic systems - Standards for Hydraulics - Trouble shooting in Hydraulic Systems - Maintenance requirements in Hydraulic Systems - Application and usage of Hydraulics in Industries - Manufacturers of Hydraulic elements - Manufacturers of Hydraulic Machines - Scope and Future for Hydraulic Industry

Total: 15 Hours

Reference(s)

1. Henry M. Morris and James M. Wiggert., "Applied Hydraulics in Engineering", John Wiley & Sons Publications., New York, 1972.
2. John H. Pippenger, Tyler G. Hicks., "Industrial Hydraulics", Gregg Division McGraw-Hill., New York, 1979
3. Majumdar .S.R., "Oil Hydraulic Systems: Principles and Maintenance"., McGraw-Hill Education, New York 2003

15MC0XB AC/DC DRIVES 1 0 0 1

Course Objectives

- To study the various power electronics devices and their characteristics
- To understand the real time application in AC/DC DRIVES
- To practically study the various AC/DC Drives foe speed control application

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 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. Choose the devices for application they need
2. Find easy to Control the various speed control AC/DC Drives

Articulation Matrix

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

UNIT I **15 Hours**

AC/DC DRIVES

Brief Basic Power Electronics (including Thyristors, Power-Transistors & IGBTs). DC Motor Basics (construction, principle of operation, T-N Characteristic etc). DC Drives Basics (Block diagram, 1Q-4Q principle of operation, T-N Curves etc) Selections, Calculations & applications of typical DC drives. Siemens DC Drives (6RA70) - Ratings, Specs, features, options & applications. AC Motor Basics (construction, principle of operation, T-N Characteristic etc). AC Drives Basics (Block diagram, 1Q-4Q principle of operation, T-N Curves etc) Selections, Calculations & applications of typical AC drives. AC Drives (Micromaster-MM4)-Ratings, Specs, features, options & applications. AC Drives (Master Drive-VC): Ratings, Specs, features, options & applications. AC Drives (Sinamics-G)-Ratings, Specs, features, options & applications in brief. MEDIUM VOLTAGE (MV Drives & Motors): MV Motor types & Fundamentals (including starting methods, options/features), MV Motor offers from Germany (separately for Induction & Synchronous Motor), MV Converter Basics & types (Voltage, Current Source & Cyclo-converters), Siemens MV Converters (Sinamics GM, Simovert-S and Perfect Harmony), Selection, configuration & Applications of MV Drive systems

Total: 15 Hours

Reference(s)

1. G. K. Dubey, Fundamentals of Electrical Drives, Wiley Eastern Ltd., New Delhi, 2007.
2. S. K. Pillai, A First Course on Electrical Drives, New Age International Pvt. Ltd., New Delhi, 2012.
3. Vedam Subrahmaniam, Electric Drives (concepts and applications), Tata McGraw-Hill Publishing Company Ltd, New Delhi, 2007.

15MC0XF TOOLING FOR CNC MACHINING 1 0 0 1

Course Objectives

- To understand the industrial part drawing
- To make process planning for CNC machining
- To learn the concepts involved in jig and fixture design

UNIT I **15 Hours**

CNC MACHINING

Introduction - Study of industrial drawings in detail - Part drawings - Processing of two different industrial part drawings in detail in the area of CNC lathe and in machining centre. Manufacturing area -Functions of different departments in an industry - Process planning - Part - Product - CNC programming - Basic commands - Types of codes - G codes (Preparatory functions) - M codes (Miscellaneous functions) - processing - planning - Tool planning & sequence of operations - Tool planning Tooling list preparation and planning inspection requirements - Importance of tooling - Jigs and Fixtures and production systems - Flexible Manufacturing Systems, Flexible Fabrication Systems for different types of components in mass production areas.Sequence of operation for manufacturing - Jigs and Fixtures - Study of cutting tools - Processing in conventional & CNC machines

Total: 15 Hours

Reference(s)

1. S. K. Sinha, CNC Programming, Galgotia Publications, New Delhi, 2011
2. N. K. Mehta, Metal Cutting and Design of Cutting Tools - Jigs and Fixtures, McGraw Hill Education, First Edition, New York, 2014
3. Agarwal, CNC Fundamentals and Programming, Charotar Publishing House Pvt. Ltd, New Delhi, Second Edition, 2014.

15MC0XG PRODUCT LIFE CYCLE MANAGEMENT 1 0 0 1

Course Objectives

- Explain the need, opportunities, applications and importance of product life cycle management
- Summarize the steps in implementing product data management
- Develop CAD model and interface with product life cycle management tool

UNIT I **15 Hours**

PRODUCT LIFE CYCLE MANAGEMENT

Introduction to Product Life Cycle Management (PLM) - Definition, PLM Lifecycle model, Threads of PLM - Need - Opportunities and benefits - Views, Components and Phases of PLM - feasibility study visioning - Concepts, processes and workflow - Characteristics of PLM - Environment driving PLM Elements and Drivers - Conceptualization, Design, Development, Validation, Production and Support of PLM. Product Data Management (PDM) - Process and Workflow - PDM systems and importance - reason for implementing a PDM system - financial justification of PDM implementation. Versioning - check-in and checkout - views, metadata, lifecycle, and workflow - Applied problems and solution on PDM processes and workflow - Collaborative product development - Engineering vaulting, product reuse, smart parts and engineering change management - Bill of materials and process consistency - Digital mock-up and prototype development, design for environment, virtual testing and validation, marketing collateral - Knowledge and optimization of design products - Know how, best practices, parameterization of design, Applied problems and solution on optimization of products using power copy, publication, parameters, formula, rule, check, design table, configuration, reaction. Tools of Communication for collaborative work - Creation of 3D CAD drawing using software - Creation of an animation for assembly instructions on light weight and 3D document - CAD data interface with PLM Tool - Lifecycle of the product.

Total: 15 Hours

Reference(s)

1. John Stark, Product Lifecycle Management Paradigm for century Product Realization, Springer-Verlag, 21st, London, 3rd printing, 2006
2. Ibrahim Zeid, CAD/CAM Theory and Practice, McGraw Hill Education, 1991.
3. Mark Henderson, Philip Wolfe and Bedworth, Computer Integrated Design and Manufacturing, McGraw Hill Education, 1991.

15MC0XH DESIGN AND ASSEMBLY OF ELECTRONICS COMPONENTS IN PCB

1 0 0 1

Course Objectives

- To study various standards and principles related with Electronics Manufacturing Service Industries.
- To understand the process methodologies and safety pre-cautions in EMS industries.
- To acquire practical knowledge about various electronic components, Printed Circuit Boards, assembly of Components, Inspection, Testing and Packing standards.

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 the public health and safety, and the cultural, societal, and environmental considerations.

Course Outcomes (COs)

1. Students can choose various components with suitable packages and Printed Circuit Boards suitable for a Project / Product
2. Students will understand manufacturing, testing and Inspection process in EMS
3. Students can understand IPC standards to be followed in EMS industries.

Articulation Matrix

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

UNIT I **15 Hours**

DESFIGN AND ASSEMBLY OF ELECTRONIC COMPONENTS

Introduction to EMS companies Operating Principles of machines in EMS - Electronics component SMT components - THT components other packages. Process methodologies - flowchart for solder paste and SMD glue with through hole component. THT electronics assembly floor: pre-forming cutting placing smaller and bigger components wave soldering fluxing pre heating lead bathing. SMD solder paste process kitting storage screen printing PCB with Solder paste SMD component stuffing or placement pre soldering inspection and correction reflow soldering post soldering inspection rework SMD glue with through hole components - kitting storage screen printing PCB with Solder paste SMD component stuffing or placementpre soldering inspection and correction glue curing glue curing inspection correction through hole stuffing through hole inspection correction wave soldering post soldering inspection and correction cleaning final inspection and correction SMD electronics assembly floor: Kitting stacking of PCBs in PCB loader printing using stencils role of stencils use of glue and solder paste selection criteria pick and place machine - automatic component health monitoring and rejection of defective components introduction to magazines and feeders role of colour in feeders (yellow, red and white) oven reflow ramp stage soak stage TAL stage cleaning materials used in cleaning.

Inspection standards in ems need for such standards - IPC standards (Institute for Printed Circuits) - MDA testing automated optical inspection X ray inspection Testing methods and process - functional testing cleanliness testing workmanship standards - IPC A 610 - Packing and shipping anti static

packaging Code of conduct - Nature of job for electronics / Mechatronics engineers in EMS companies- skills set expected in EMS industries from fresh engineering graduates.

Total: 15 Hours

Reference(s)

1. Documents available at http://www.ipc.org - Ã¢??IPC - The global trade association serving the printed board and electronics assembly industries, their customers and suppliersÃ¢??.
2. Handbook - The Course of IPC-A-610 and IPC-J-STD-001 -Standard for Electronics Assemblies from IPC.
3. Handbook Ã¢?? In-Plant Training at Electronic Manufacturing Service Industries by Sanjay Technologies, Coimbatore Ã¢?? Private Circulation.

15MC0XJ SMART FACTORY 1 0 0 1

Course Objectives

- Understand and explain the relevance of automation in manufacturing industries
- Summarize the machine to machine communications and how it enables efficiency and accuracy
- Analyze and provide solution on automation for a given industrial problem

UNIT I **3 Hours**

SMART FACTORY THE NEXT INDUSTRIAL REVOLUTION

Manufacturing Life cycle model, Growth of automation in manufacturing industry, Need for automation, Smart Factory Relevance to manufacturing, Opportunity and Benefits

UNIT II **3 Hours**

SMART FACTORY COMPONENTS AND PROCESSES

Concept of machine communication, Fundamentals, Variables and Drivers in Smart Factory, Characteristics, Development of automation industry, Process Flow

UNIT III **3 Hours**

PROCESSING OF DATA IN AUTOMATION ENVIRONMENT

Infrastructure needs in Smart Factory, Data parameters, Data Quantum, Data Usage & Flow in Industrial environment, Data Storage, Data Analytics, Feedback mechanism

UNIT IV **3 Hours**

MACHINE LEARNING IN SMART FACTORY

Conceptualization of Machine Learning, Elements and Drivers, Application of Machine learning in Smart Factory, Predictive Maintenance, Efficiency & Accuracy, Development of machine learning concepts

UNIT V **3 Hours**

DIGITAL INDIA FOR SMART FACTORY

Digital India Initiatives, Infrastructure needed towards connectivity, Role of Digital India in Smart Factory, Scalability of resources

UNIT VI **3 Hours**

SMART FACTORY APPLICATION

Adoption of automation in industries, Scale-up of industry for automation, Modern Technologies for automation, R&D Orientation towards Smart Factory

UNIT VII **2 Hours**

SMART FACTORY SCOPE

Industrial scenario in 2050, Concept of Re-skilling, Scaling towards Global needs, Development of individual towards future

Total: 20 Hours

Reference(s)

1. Shiyong Wang, Jiafu Wan, Di Li, Chunhua Zhang, Implementing Smart Factory of Industrie 4.0: An Outlook, 2016
2. Manojit Bose, SKILLS ARE THE KEY TO UNLOCKING DIGITAL INDIA POTENTIAL: INDIA INC., 2015
3. Elvis Hozdi, SMART FACTORY FOR INDUSTRY 4.0: A REVIEW, Researchgate, 2015

4. Dominik Lucke, Carmen Constantinescu, Engelbert Westk Ã*f*? mper, Smart Factory - A Step towards the Next Generation of Manufacturing, 2008

15MC0XK ADVANCED METROLOGY AND QUALITY CONTROL

1 0 0 1

Course Objectives

- Understand and explain the relevance of metrology in industries
- Recapitulate the need of various measuring instruments and the way it supports accuracy
- Examine and provide solution on measurements for a given industrial part/component

UNIT I **20 Hours**

ADVANCED METROLOGY AND QUALITY CONTROL

Advanced measuring machines, CNC systems, Laser vision, In-process gauging, 3D metrology, metrology softwares, Nano technology instrumentation, stage position metrology, testing and certification services, optical system design, lens design, coating design, precision lens assembly techniques, complex opto mechanical assemblies, contact bonding and other joining technologies. Statistical Methodologies: Graphical methods, Statistical control charts, Regression analysis, Analysis of variance, Sampling and acceptance. Quality and Calibration Techniques : Size and scale, Predictable accuracy, Trace-ability of measurement, Measurement uncertainty, surface texture, roundness. Metrology of machine tools: Alignment and practical tests. Case studies: Inspection and Validation practices adopted in various industries.

Total: 20 Hours

Reference(s)

1. Kalpakjian, S. and Steven R. Schmid, Manufacturing, Engineering & Technology, Pearson.
2. G. T. Smith, Industrial Metrology, Springer, ISBN: 9781852335076, 2012.
3. D. J. Whitehouse, Hand book of surface and nanometrology, 2nd Edition, CRC Press, ISBN: 9781420082012, 2012.
4. John W. Greve, Frank W. Wilson, Hand book of industrial metrology, PHI Publisher, New Delhi
5. Khare MK, Dimensional Metrology, OXFORD-IBH Publishers

15MC0XL PRODUCTION AUTOMATION 1 0 0 1

Course Objectives

- Double or triple the speed of the any business process
- Build quality into workplace systems
- Eliminate the huge costs of hidden waste
- Turn every employee into a quality control inspector

UNIT I **15 Hours**

PRODUCTION AUTOMATION

Concept and scope of industrial automations automation strategies-Types of automations- semi automats-fully automate and transfer lines. History of Manufacturing management Push and pull systems-Just in time Kanban Systems-Principles of Toyota production systems Lean manufacturing systems-Relationship among JIT ,TPS and Lean Manufacturing- seven deadly wastes- 4P model of manufacturing production systems-Continual improvement methods 5S practices implementing in production line- Synchronization in productions.

Total: 15 Hours

Reference(s)

1. Scrope Kalpakjian,, Manufacturing processes for Engineering Materials, Addision Wesley,1997.
2. The Toyato way 14 management principles by Jeffery K Liker.

15MC0XM CNC SERVICING 1 0 0 1

Course Objectives

- Understand and explain the System Configuration of CNC Machine System
- Analyze the root cause for the machine failures.
- Evaluate and rectify the failures occurred in various Machine Functions
- Generate the safety instructions in handling CNC Machine

UNIT I **4 Hours**

CNC SYSTEM CONFIGURATION

Manufacturing CNC Machine Structures, CNC State Display, Configuration Screens- Software, Module, ID Information, Alarm history, Maintenance Information screen, Color and Contrast Setting, Periodic Maintenance Screen

UNIT II **4 Hours**

CNC HARDWARE

Hardware Configuration, Connection diagrams, Mounting and De mounting -Connectors, Card and Power supply, DIMM module, PCBs Replacement procedure- Battery, LCD, Fuses.

UNIT III **4 Hours**

DIAGNOSIS FUNCTIONS

Diagnostic display, Servo Parameter alarm, Machine position, Reference Position, position Deviation, Displacement Detection, Motor temperature.

UNIT IV **4 Hours**

TROUBLE SHOOTING

Causes and Remedies for failures Machine position, Reference Position, Manual operation, Automatic operation, Jog Operation, Feed rate, Spindle Speed , LCD Display, Abnormal Servo System.

UNIT V **4 Hours**

SAFETY PRECAUTIONS

Warnings-Check operation, Replacement, Parameters, Daily Maintenances - Caution, Note, Alarms, Maintenance Parts, Parameters.

Total: 20 Hours

Reference(s)

1. Daniel D Nelson, The CNC Toolbox: Top Service for Machine Tools, Aero Publishing, 2nd Edition 1999
2. Fanuc Series oi-Model C, Maintenance Manual, Fanuc Series, 2016.
3. B S Pabla and M Adithan, CNC Machines, New age International Publishers, 2005.

15MC0XN INTEGRATED PRODUCT DESIGN IN VALVES

1 0 0 1

Course Objectives

- To determine the selection of components for a particular applications
- To compare the working of different types of industrial valves
- To outline the different aspects of product management

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 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.

Course Outcomes (COs)

1. Select a suitable valve for a specific application
2. Justify the others aspects of product design, development and management

Articulation Matrix

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

UNIT I **15 Hours**

VALVES DESIGN AND DEVELOPMENT

Overview of integrated product design - General product developments processes, product planning, identifying customer needs, concept generation and concept selection. Basics of industrial valves - valves application, types of valves, constructional details, valves testing and standards overview. Valve automations - Why automation? Types of actuations, valve sizing, electrical actuation and pneumatic actuation. Essence of product development - marketing strategy, product quality and competitiveness. Product management - product data management, product life cycle management and change management.

Total: 15 Hours

Reference(s)

1. Edward B. Magrab, Integrated Product and Process Design and Development: The Product Realization Process, CRC Press, 2009
2. Peter Smith, Valve Selection Handbook: Engineering Fundamentals for Selecting the Right Valve Design for Every Industrial Flow Application, 5th Edition, Elsevier Science Publishers, 2004.
3. Chris Warnett, Valve Actuators: A Comprehensive Introduction to the Design, Selection, Sizing and Application of Valve and Damper Actuators, CPLLoyd Consulting Inc. 2015.