B.E. (Biomedical Engineering)

2022 Regulations, Curriculum & Syllabi

BANNARI AMMAN INSTITUTE OF TECHNOLOGY
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BANNARI AMMAN INSTITUTE OF TECHNOLOGY, SATHYAMANGALAM

REGULATIONS 2022

(CHOICE BASED CREDIT SYSTEM)

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

Regulations 2022 have been prepared in accordance with the guidelines given by the University Grants Commission, All India Council for Technical Education and affiliating Universities incorporating the features of the Choice Based Credit System (CBCS). The Regulations 2022 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 2022-2023 for Regular admission (Academic Year 2023-2024 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 (DoTE) 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 / 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 DoTE from time to time.

(or)

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 DoTE 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

1. Biomedical Engineering
2. Civil Engineering
3. Computer Science and Design
4. Computer Science and Engineering
5. Electrical and Electronics Engineering
6. Electronics and Communication Engineering
7. Electronics and Instrumentation Engineering
8. Information Science and Engineering
9. Mechanical Engineering
10. Mechatronics

B. Tech. Programmes

1. Agricultural Engineering
2. Artificial Intelligence and Data Science
3. Artificial Intelligence and Machine Learning
4. Biotechnology

5. Computer Science and Business Systems
6. Computer Technology
7. Fashion Technology
8. Food Technology
9. Information Technology
10. Textile Technology

3. STRUCTURE OF THE PROGRAMME

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

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

Engineering Science (ES) courses including Engineering Graphics, Basics of Electrical / Electronics / Civil / Mechanical, Engineering Mechanics and Computer Programming.

Humanities and Social Sciences (HSS) courses including Language Courses, Management Courses, Soft Skills and Professional Ethics.

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

Employability Enhancement Courses (EEC) includes Project Work, Mini Project and /or Internship, Seminar, Industrial /Practical Training, Startup Management, Value Added, and Certificate Courses.

The medium of instruction is English for all the Courses (except Tamil), 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 based on the following.

Contact period per week	Credit(s)
1 Lecture / 1 Tutorial period	1
2 laboratory Periods (Laboratory / Seminar / Project Work / etc.)	1

3.3 All the B.E. / B.Tech. Students will study Communicative English I during the firstsemester. In the second semester, they will be provided an option to enroll and study Communicative English II / German / Japanese / French / Hindi. while the lower segment will study Communicative English II.

3.4 Every student shall be required to opt for 10electives from the list of electives. Students can opt for the electives (Core / Professional) from his / her own discipline courses, during IV to VII Semesters, if he/she satisfies the prerequisite for that particular course.

3.5 However, out of ten electives, every student shall be required to opt for, a minimum of one and subject to a maximum of three courses as open electives from the list of electives of the branch / branches other than his / her branch of specialization, if he/she satisfies the prerequisite for that particular course. The course / content should not be covered in their own curriculum and syllabi.

3.6 Students can also opt for **one-credit courses** of 15 to 20 hours 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 VI 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 prerequisites or the courses that may not require any prerequisites. Under no circumstances, the same one credit course shall be repeated in subsequent semesters in any department / centre for the same batch of the students and a maximum batch size for a given course shall not exceed 40. In case of disciplines with multiple divisions (intake more than 60) multiple batches/ 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 VII, he / she can do so by exercising his / her option in writing to the respective Head of the Department during the beginning of the VII semester, following the equivalence norm, that one **regular elective** (in the **VII Semester**) is equivalent to **three one-credit courses** completed by the student during the previous semesters, III to VI. 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 II semesters shall be maintained in the Grade sheet as “Additional credits earned” (not considered for the computation of SGPA/CGPA).

3.7 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.

3.8 A Student may be permitted to credit three online courses with the approval of the Departmental Consultative Committee constituted by the Head of the Department, subject to a maximum of 9 credits. The Head of the Institution shall form a 3-member committee with one of the members as HoD and two senior faculty members to ensure that the student has not studied such courses and would not repeat it again as Professional Core/Professional Elective/Open Elective courses. A student can get exemption for a maximum of 9 credits (refer amendments of R2022 approved in 29th ACM) during the entire programme (in lieu of core elective or open elective). These online courses shall be chosen from the SWAYAM NPTEL platform, provided the offering organisation conducts regular examination and provides marks. The credits earned shall be transferred and the marks earned shall be converted into grades and transferred, provided the student has passed in the examination as per the norms of the offering organisation.

For online courses the following grading pattern is applicable in case of credit transfer and CGPA calculations

Range of percentage of total marks	Letter Grade	Grade Point
91 - 100	O	10
81 - 90	A+	9
71 - 80	A	8
61 - 70	B+	7
51 - 60	B	6
40-50	C	5
< 40	U	0

3.9 Industrial Training / Internship

The students may undergo Industrial training / Internship optionally for a period as specified in the table during summer / winter vacation and the credits earned will be indicated in the grade sheet. If the student earns three credits in Industrial Training / Internship, the student may drop Professional Elective subjected to a maximum of one. In such cases, Industrial Training / Internship need to be undergone continuously from one organization only. However, if the number of credits earned is 1 or 2, these credits shall not be considered for classification of the degree. The students may also undergo Internship at Research organization / University (after due approval from the Department Consultative Committee) during summer / winter vacation.

Duration of Training / Internship	Credit(s)
2 Weeks	1
4 Weeks	2
6 Weeks	3

3.10 Socially Relevant Projects

A student may be permitted to carry out socially relevant projects during semester II to semester VI in consultation with the faculty guide and submit the project report, in the prescribed format, at the end of the Semester for valuation.

On successful completion of socially relevant project work, one credit will be indicated in the grade sheet (Additional credits), but these credits will not be considered for computing the CGPA.

3.11 Mandatory courses

The student shall study the mandatory courses prescribed by the institute which will be mentioned in the Grade Sheet. However, it will not be considered for computation of CGPA.

For the students who complete the Mandatory Course satisfying the attendance requirement, the title of the Mandatory Course will be mentioned in the Grade Sheet.

3.12 Choice of Professional Elective Courses

The professional Elective Courses are listed in the Curriculum in Table format as verticals (Specialisation groups). A student can choose all the Professional Elective

Courses either from one of the verticals or a combination of courses from all verticals in a semester. However, students irrespective of enrolling for additional Insertion of New Clause 6.3 are not permitted to choose more than one course from a row. Students are permitted to enroll in more than one elective course from the same vertical in a semester. In the subsequent semesters students are permitted to enroll one more course in a row, provided if he/she has cleared the earlier course of the same row. For a professional elective course and open elective course, the minimum number of students enrolment permitted shall be 10. However, the minimum number is not applicable for students enrolling B.E. / B. Tech. (Hons) and B.E. / B. Tech. Minor. For the offer of each professional elective at least two choices shall be offered.

4. VALUE ADDED COURSES

A student can opt for the Value Added Courses offered by the various departments from semester II to VII.A separate certificate will be issued on successful completion of the value added course by the competent authority.

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 75 working days. Head of the Department shall ensure that every faculty member teaches the course as prescribed in the approved curriculum and syllabi.

5.4 Special Theory / Practical Sessions may be conducted for students who require additional inputs (remedial classes) over and above the number of periods normally specified, 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 Each student shall register for all courses to be undergone in the curriculum of a particular semester (with the facility to drop courses to a maximum of 8 credits (vide clause 6.6)). The courses dropped in earlier semesters can be registered in the subsequent semesters when offered.

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

6.3 The courses that a student registers in a particular semester may include

i. Courses of the current semester.

ii. Courses dropped in the lower semesters

6.4 The maximum number of credits that can be registered in a semester is 30. However, this does not include the number of Re-appearance (RA) and Withdrawal (W) courses registered by the student for the appearance of the examination.

6.4.1 From the V to VIII semesters, the student has the option of registering for additional courses in a semester. With regard to enrolling for B.E. / B. Tech. (Hons) or B.E. / B. Tech. Minor. Maximum number of credits enrolled in a semester (Honours and Minor) shall not exceed 36. The online courses registered for B.E. / B. Tech. (Hons.) and B.E. / B. Tech. minor shall be over and above this 36 credits.

6.5 Flexibility to Drop Courses

6.5.1 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.

6.5.2 From the III to VII semesters (from IV to VII semesters in case of lateral entry students), the student has the option for dropping existing courses. The number of courses a student can drop is limited to 2 in a given semester. The student is permitted to drop the course(s) within 30 days of the commencement of the academic schedule. In such cases, the attendance requirement as stated in Clause 7 is mandatory.

6.5.3 The student shall register Project work I in semester VII and Project work II in semester VIII only.

6.6 Reappearance Registration

6.6.1 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.

6.6.2 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.

6.6.3 If the theory course, in which the student has failed, is either a professional elective or an open elective, the student may register for Semester End Examinations of the same professional elective or open elective course, respectively in the subsequent semesters.

6.6.4 In this case (Clause 6.6.3), the student shall attend the classes, satisfy the attendance requirements (vide Clause 7), earn Continuous Assessment marks and appear for the Semester End Examination.

6.6.5 The student who fails in any continuous assessment courses shall register for the same in the subsequent semesters or when offered next, and **repeat** the course as per Clause 6.6.4.

6.6.6 If a student is prevented from writing the Semester End Examination of courses due to lack of attendance, the student has to repeat the semester when it is offered next time.

7. REQUIREMENTS FOR APPEARING FOR THE SEMESTER END EXAMINATIONS 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 Semester End 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% overall attendance.

7.2 If a student, secures overall attendance between 70% and less than 80%) 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 Institution (along with condonation form). Such certificates along with the condonation forms shall be forwarded to the Office of 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.

7.3 A student shall normally be permitted to appear for Semester End 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% overall attendance would not be permitted to move to the higher semester and has to repeat the current semester in the next academic year as per the norms prescribed.

7.5 In the case of reappearance (Arrear) registration for a course, the attendance requirement as mentioned in Clauses 7.1 - 7.3 is not applicable. However, 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. The faculty advisor also discusses with or informs the parents about the progress / performance of the students concerned.

The responsibilities of the faculty advisor are:

- To inform the students about the various facilities and activities available to enhance the student's curricular and co-curricular activities.
- To guide student enrolment and registration of the courses.
- To authorize the final registration of the courses at the beginning of each semester.

- To monitor the academic and general performance of the students including attendance and to counsel them accordingly.

9. COMMITTEES

9.1 Common Course Committee

9.1.1 A theory course handled by more than one faculty member 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 to this, Common Course Committee (without the student representatives) shall meet to ensure uniform evaluation through the common question papers during continuous assessment and Semester End 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) Semester End Examination at the end of the semester for the regular courses or as given in the Clause 17.

10.2 Each course, both theory, theory with lab component and laboratory including project work, shall be evaluated as per the scheme of assessment given in Clause 17.

10.3 The Semester End Examinations shall normally be conducted after satisfying the Clause 5.2.

10.4 For the Semester End Examinations, both theory, theory with lab component the internal and external examiners (from Academia) shall be appointed by the Controller of Examinations as per the guidelines given by the Examination cum Evaluation committee of the Institute.

11. PASSING REQUIREMENTS AND PROVISIONS

11.1 The Passing requirement for a student in a course is determined based on the marks obtained both in continuous assessment and Semester End Examinations. A student who secures not less than 50% of total marks prescribed for the course [Continuous Assessment + Semester End Examinations] with a minimum of 45% of the marks prescribed for the Semester End Examinations, shall be declared to have passed the course and acquired the relevant number of credits.

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 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’.

Continuous Assessment (CA) marks obtained by the student in the first appearance shall be retained and considered valid for one subsequent attempt, except Clause 6.6.4, 6.6.5, 6.6.6 and 6.6.7. However, from the third attempt onwards, the student shall be declared to have passed the course if he/she secures a minimum of 50% in the course prescribed during the Semester End Examinations.

11.2 If a candidate fails in the seventh semester examinations of Project work I, he/she has to resubmit the Project Report within 30 days from the date of declaration of the results. If he / she fails in the Semester End examination of Project work II, he/she shall resubmit the Project Report within 60 days from the date of declaration of the results. The resubmission of the project report and the subsequent viva-voce examination will be considered as reappearance with payment of exam fee. In case a student fails in the resubmission of a project report and subsequent viva-voce examination, the student shall register for the course again, when offered next.

11.3 The passing requirement for the courses which are assessed only through continuous assessment (Laboratory and EEC courses except project work), shall be fixed as minimum 50% and the remaining grades are decided as per clause 12.4. If a candidate fails in EEC courses (Except Project work), he/she has to register and repeat the course within 30 days from the date of declaration of the results. In case a student fails to register within 30 days, he/she shall register for the course again, when offered next.

11.4 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		
Biomedical Engineering	163	121
Civil Engineering	164	122
Computer Science and Design	163	119
Computer Science and Engineering	163	119
Electrical and Electronics Engineering	163	121
Electronics and Communication Engineering	163	121
Electronics and Instrumentation Engineering	163	121
Information Science and Engineering	162	118
Mechanical Engineering	164	122
*Mechatronics / #Mechatronics Engineering	165	123
B.Tech. Programmes		
Artificial Intelligence and Data Science	165	121
Artificial Intelligence and Machine Learning	163	119
Biotechnology	165	123

Computer Science and Business Systems	163	123
Computer Technology	163	119
Fashion Technology	163	121
Food Technology	163	121
Information Technology	163	119
Textile Technology	163	121

*-applicable to candidates admitted during the AY.:2022-2023

#-applicable to candidates admitted during the AY.:2023-2024 onwards

11.5 Total number of credits to be earned by the student shall be more than or equal to the total number of credits prescribed in the curriculum in force. If the credit assigned for L T P of the courses are not same in two Regulations under consideration, then equivalence shall be arrived as per the credit assignment followed in the Regulations in force.

11.6 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 the Institution, if a student migrates from other affiliated institutions to Bannari Amman Institution of Technology or rejoins from previous regulation to this regulation.

11.7 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 Semester End Examinations and/or Continuous Assessments, carrying marks as specified in Clause 17. Letter Grades (based on Credits and Grades) are awarded to the students based on the performance in the evaluation process.

12.2 Credit Point is the product of Grade Point and the number of credits for a course and Grade Point is a numerical weight allotted to each letter grade on a 10-point scale (as specified in Clause 12.4), while the Letter Grade is an index of the performance of a student in a said course.

12.3 Condition for Relative Grading

The students' strength is greater than 30, the relative grading method shall be adopted. If the students' strength is less than or equal to 30 then the absolute grading system shall be followed with the grade range as specified below. The relative grading system shall not be applicable for laboratory, project works and continuous assessment courses.

O	A+	A	B+	B	C	U
91-100	81- 90	71- 80	61-70	56- 60	50–55	<50

12.4 The performance of a student will be reported using Letter Grades, each carrying certain points as detailed below: A student who earns a minimum of 5 grade points in a course is declared to have successfully passed the course.

Description	Letter Grade	Grade Points
Outstanding	O	10
Excellent	A +	9
Very Good	A	8
Good	B +	7
Average	B	6
Satisfactory	C	5
Reappearance	U	0
Withdrawal	W	0
Absent	AB	0
Shortage of Attendance	SA	0

'U' ---Reappearance is required for that particular course

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

12.5 After completion of the evaluation process, Semester Grade Point Average (SGPA), and the Cumulative Grade Point Average (CGPA) are calculated using the formula:

$$SGPA/CGPA = \frac{\sum_{1}^{n} C_i * g_i}{\sum_{1}^{n} C_i}$$

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 SGPA and all the semesters, under consideration, in the case CGPA.

RA grades will be excluded for calculating SGPA and CGPA.

12.6 A student who does not appear for the Semester End 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).

12.7 For the non-credit courses grades shall be indicated as given in Clause 17 and shall not be counted for the computation of SGPA/CGPA.

For the co-curricular activities such as NCC / NSS / NSO / YRC etc.., a completed status will appear in the grade sheet. Every student shall put in a minimum of 75% attendance in the training and attend the camp compulsorily. The training and camp shall be completed before registering for the fifth semester courses. A completed status in the co-curricular activities is compulsory for the award of a degree.

12.8 **Revaluation:** A student, who seeks the revaluation of the answer script, is directed to apply through proper application to the Office of the Controller of Examinations in the prescribed format through the Head of the Department. The Office of the Controller of Examinations shall arrange for the revaluation and declare the results. Revaluation is not permitted for 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.

12.9 **Eligibility for the Award of Degree**

A student shall be declared to be eligible for the award of the B.E. / B.Tech. degree provided the student has

i. Successfully gained the required number of total credits as specified in the curriculum corresponding to the student's programme within the stipulated time.

ii. Successfully completed the course requirements, appeared for the Semester End Examinations and passed all the courses prescribed in all the 8 semesters within a maximum period of 7 years for regular / 6 years for lateral reckoned from the commencement of the first semester to which the candidate was admitted.

iii. Successfully completed the NCC / NSS / NSO / YRC / Extra-curricular/ Co-curricular requirements.

iv. No disciplinary action is pending against the student.

v. The award of degree must have been approved by the Syndicate of the University.

12.10 Conduct of Academic Audit

The purpose of the academic audit is to encourage departments to evaluate the quality of their education processes, thereby assure and regularly improve the quality of teaching learning process and the outputs. A regular academic audit is conducted in the Institute to evaluate the performance of various departments so that the issues that need attention can be identified to improve the overall quality of curriculum design, teaching learning process, and evaluation. The academic audits are conducted by internal and external academic experts.

12.11 Conduct of Special Examination

The special or makeup exams may be conducted for the students who missed the regular examination due to participation / representing the institute in various activities and the schedule may be included in the academic calendar. The special or makeup exams may be conducted after the completion of Semester End Examinations and prior to publishing the results of semester end examinations.

12.12 In the consolidated grade sheet the CGPA earned shall be convertedinto Percentage of marks as follows: Percentage of Marks = CGPA × 10

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 of 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 satisfies the following conditions shall be declared to have passed the examination in **First class with Distinction**:

- Should have passed the examination in all the courses of all the eight semesters (six semesters for lateral entry students) in the student’s First Appearance within five years / four years for lateral, which includes authorised break of study of one year. Withdrawal from examination (vide Clause 15) will not be considered as an appearance.

- Should have secured a CGPA of **not less than 8.50**
- Should **NOT** have been prevented from writing Semester End Examination due to lack of attendance.

13.2 **First Class:** A student who satisfies the following conditions shall be declared to have passed the examination in **First class**:

- Should have passed the examination in all the courses of all eight semesters (six semesters for lateral entry students) within five years / four years for lateral, which includes one year of authorized break of study (if availed) or prevention from writing the Semester End Examination due to lack of attendance (if applicable).
- Should have secured a CGPA of **not less than 6.50**

13.3 **Second Class:** All other students (not covered in clauses 13.1 and 13.2) who qualify for the award of the degree shall be declared to have passed the examination in **Second class.**

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. The application shall be sent to the office of the Controller of Examinations through the Head of the Institution with required documents.

14.2 Withdrawal application shall be valid only, if the student is eligible to write the examination as per Clause 7 and, if it is made within 10 working days before the commencement of the Semester End Examination in that course or courses and also recommended by the Head of the Department.

14.3 Notwithstanding the requirement of mandatory 10 working days notice, applications for withdrawal for special cases under extraordinary conditions will be considered on the merit of the case.

14.4 If a student withdraws a course or courses from writing Semester End Examinations, he/she shall register the same in the subsequent semester and write the Semester End Examination(s).

14.5 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.

14.6 Withdrawal is permitted for the Semester End Examinations in the final semester, only if the period of study of the student concerned does not exceed 5 years (for regular) / 4 years (for lateral) as per clause 13.1 & 13.2.

15. AUTHORIZED BREAK OF STUDY FROM A PROGRAMME

15.1 A student is permitted to go on break of study for a fixed period of one year as a single break in the entire course of study.

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. 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 re-join the programme after the break / prevention due to lack of attendance, shall be governed by the curriculum and regulations in force at the time of rejoining. The students re-joining in new regulations shall apply to the Academic In charge in the prescribed format through the Head of the Department at the beginning of the readmitted semester itself for prescribing additional/equivalent courses, if any, from any semester of the regulations in force, so as to bridge the curriculum in force and the old curriculum.

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 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 student's name shall be permanently deleted from the college enrollment. Such students are not entitled to seek readmission under any circumstances.

16. IMPLEMENTATION OF HONOURS / MINOR DEGREE

16.1 B.E. / B.Tech. (Hons.)

- The students should have earned additionally a minimum of 18 credits from more than one vertical of the same programme.
- Should have passed all the courses in the first attempt.
- Should have earned a minimum CGPA of 7.50.

16.2 B.E. / B.Tech. Minor in another discipline

The student should have earned additionally a minimum of 18 credits in any one of the verticals of other B.E/B.Tech. programmes.

- B.E / B.Tech. (Hons.) and B.E./B.Tech. Minor in another discipline will be optional for students and the students shall be permitted to select any of them only.
- B.E/B.Tech. (Hons.) or B.E./ B.Tech. Minor shall be offered by the Department irrespective of the number of students enrolled.

If the student has failed in the additional courses or faced a shortage of attendance, they will not be printed in the grade sheet and will not be considered for CGPA calculation and classification of degree.

16.3 Students can earn a maximum of 6 credits in online mode (SWAYAM NPTEL platform), out of these 18 credits with the approval of the Departmental Consultative Committee constituted by the Head of the Department.

16.4 B.E./ B. Tech. (Honours) in the same discipline, B.E. / B.Tech. Honours and B.E. / B.Tech. Minor in another discipline degrees will be optional for students.

16.5 For category 16.1, the students will be permitted to register for the courses from V Semester onwards provided the CGPA earned by the students until semester III should be of 7.50 and above and cleared all the courses in the first attempt.

16.6 For category 16.2, the students will be permitted to register the courses from semester V onwards provided the CGPA earned by the students until semester III is 7.50 and above.

16.7 If a student decides not to opt for Honours, after completing a certain number of additional courses, the additional courses studied shall be considered instead of the professional elective courses which are part of the curriculum. If the student has studied more number of such courses than the number of Professional Elective courses required as per the curriculum, the courses with higher grades shall be considered for the calculation of CGPA. Remaining courses shall be printed in the grade sheet, however, they will not be considered for the calculation of CGPA.

16.8 If a student decides not to opt for Minor degree, after completing a certain number of courses, the additional courses studied shall be considered instead of open elective courses which are part of the curriculum. If the student has studied more of such courses than the number of open electives required as per the curriculum, the courses with higher grades shall be considered for calculation of CGPA. Remaining courses shall be printed in the grade sheet, however, they will not be considered for the calculation of CGPA.

16.9. If a student successfully completes all the requirements of the programme and also meets the requirements of B.E. / B. Tech. (Hons) or B.E. / B. Tech. Minor but desires not to opt for the additional qualification, then he/she has to submit a declaration with regard to the same 30 days before the completion of VIII semester.

16.10 Classification of the Degree Awarded

The conditions for First Class with Distinction, First Class, and Second Class are the same as Clause 13.1, 13.2 and 13.3 except the following classification.

First Class: A student who satisfies the following conditions shall be declared to have passed the examination in First class for the purpose of the 'Award of Degree', of **B.E. / B.Tech.** Honors should have secured a CGPA of not less than 7.50.

17. SCHEME OF ASSESSMENT

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

I CO- CURRICULAR /EXTRACURRICULAR ACTIVITY

a. CO-CURRICULAR ACTIVITY

Component	Applicable from academic year 2024-2025 onwards
	Marks
Continuous Internal Assessment (CIA)	**100**
Distribution of marks for CIA	
Programme Organization / Participation	20
Member of Technical society (International / National repute like IEEE, IET etc.)	20
Brief Report of event	20
Sharing of Views / Presentation / Seminar	20
Attendance	10
Coordinator Assessment	10
Total Marks	**100**

b. EXTRACURRICULAR ACTIVITY (NCC/NSS/ NON-TECHNICAL CLUBS)

Component	Applicable from academic year 2024-2025 onwards
	Marks
Continuous Internal Assessment (CIA)	**100**
Distribution of marks for CIA	
Activity plan and Programme Organization	20
Participation (National / State / Regional /Institute)	20
Activity Report	20
Achievements	20
Attendance	10
Coordinator Assessment	10
Total Marks	**100**

c. EXTRA CURRICULAR ACTIVITY (SPORTS AND GAMES)

Component	**Applicable from academic year 2024-2025 onwards**
	Marks
Continuous Internal Assessment (CIA)	**100**
Distribution of marks for CIA	
Participation (National / State / Regional /Institute)	20
Regular practice	20
Skill Development	20
Sportsmanship (sports ethics) and Teamwork	20
Achievements	10
Coordinator Assessment	10
Total Marks	**100**

II COMPREHENSIVE WORK

Component	**Applicable till academic year 2022-2023**
	Marks
Concept Application	50
Comprehensive Interview	50
Total Marks	**100**

III ENGINEERING DRAWING

Component	**Applicable till academic year 2023-2024**	**Applicable from academic year 2024-2025 onwards**
	Marks	**Marks**
Continuous Internal Assessment (CIA)	**100**	**50**

Distribution of marks for CIA		
Exercise (Minimum 10 Exercises /Modelling)	60	-
Model Examinations	40	25
Class work	-	05
Assignments (Minimum 8)	-	20
Semester End Examinations (SEE)	**-**	**50**
Total Marks	**100**	**100**

IV ENVIRONMENTAL SCIENCE

Component	**Applicable till academic year 2023-2024**	**Applicable from academic year 2024-2025 onwards**
	Marks	**Marks**
Continuous Internal Assessment (CIA)	**100**	**100**
Distribution of marks for CIA		
Periodical Test I	25	25
Periodical Test II	25	25
Innovative Practices / Case studies (50)	50	-
Assignments / Case studies	-	50
Total Marks	**100**	**100**

V HOSPITAL TRAINING

Component	**Applicable till academic year 2023-2024**	**Applicable from academic year 2024-2025 onwards**
	Marks	**Marks**
Continuous Internal Assessment (CIA)	**100**	**60**
Distribution of marks for CIA		
Assessment by Industry	30	-

Viva-voce	20	-
Presentation	30	-
Case Study / Report	20	-
Daily Work log	-	30
Workplace learning report (1 page)	-	10
Trainer Assessment	-	20
Semester End Examinations (SEE) *a. Presentation* *b. Report* *c. Viva voce*	-	**40** *20* *10* *10*
Total Marks	**100**	**100**

VI HUMAN VALUES AND ETHICS

Component	**Applicable till academic year 2023-2024**	**Applicable from academic year 2024-2025 onwards**
	Marks	**Marks**
Continuous Internal Assessment (CIA)	**100**	**40**
Distribution of marks for CIA		
Periodical Test I	25	15
Periodical Test II	25	15
Innovative Practices / Case studies	50	-
Assignments / Case studies	-	10
Semester End Examinations (SEE)	-	**60**
Total Marks	**100**	**100**

VII INDUSTRIAL TRAINING/ INTERNSHIP

Component	**Marks**
Midterm Review	30
Final Presentation	30
Viva-voce	20

Case Study / Report	20
Total Marks	**100**

VIII LABORATORY COURSES

Component	**Applicable till academic year 2023-2024**	**Applicable from academic year 2024-2025 onwards**
	Marks	**Marks**
Continuous Internal Assessment (CIA)	**100**	**60**
Distribution of marks for CIA		
Preparation	20	10
Experiment and Analysis of Results	20	10
Record	10	10
Test – Cycle I	25	15
Test – Cycle II	25	15
Semester End Examinations (SEE)	-	**40**
Total Marks	**100**	**100**

IX LANGUAGE COURSES

a. LANGUAGE ELECTIVES - COMMUNICATIVE ENGLISH II / HINDI / GERMAN / JAPANESE / FRENCH)

Component	**Applicable till academic year 2023-2024**	**Applicable from academic year 2024-2025 onwards**
	Marks	**Marks**
Continuous Internal Assessment (CIA)	**100**	**50**
Distribution of marks for CIA		
Test1 *a. Listening* *b. Speaking* *c. Reading* *d. Writing*	**25** *5* *10* *5* *5*	**25** *5* *5* *5* *10*
Test 2	**25**	**25**

a. Listening *b. Speaking* *c. Reading* *d. Writing*	*5* *10* *5* *5*	*5* *5* *5* *10*
Oral Exam	**50**	**-**
Semester End Examinations (SEE)	**-**	**50**
Total Marks	**100**	**100**

b. TAMIL COURSES

Component	**Applicable till academic year 2023-2024**	**Applicable from academic year 2024-2025 onwards**
	Marks	**Marks**
Continuous Internal Assessment (CIA)	**100**	**40**
Distribution of marks for CIA		
Periodical Test	50	**-**
Quiz/ Assignment	50	20
Case study report	**-**	20
Semester End Examinations (SEE)	**-**	**60**
Total Marks	**100**	**100**

c. FOUNDATIONAL ENGLISH / SOFT SKILLS & EFFECTIVE COMMUNICATION / ADVANCED ENGLISH AND TECHNICAL EXPRESSION

Component	**Applicable till academic year 2023-2024**	**Applicable from academic year 2024-2025 onwards**
	Marks	**Marks**
Continuous Internal Assessment (CIA)	**100**	**60**
Distribution of marks for CIA		
Test	**50**	**-**
Quiz/ Assignment	**50**	**-**
Test 1 *a. Listening* *b. Speaking*	**-**	**30** *5* *10*

c. Reading *d. Writing*		*5* *10*
Test 2 *a. Listening* *b. Speaking* *c. Reading* *d. Writing*	**-**	**30** *5* *10* *5* *10*
Semester End Examinations (SEE)	**-**	**40**
Total Marks	**100**	**100**

d. BUSINESS COMMUNICATION AND VALUE SCIENCE COURSES

Component	Applicable from academic year 2024-2025 onwards
	Marks
Continuous Internal Assessment (CIA)	**50**
Distribution of marks for CIA	
Periodical Tests	25
Laboratory Assessment	25
Semester End Examinations (SEE) *Laboratory Assessment only*	**50**
Total Marks	**100**

X MINI PROJECT I & II

Component	Applicable till academic year 2023-2024	Applicable from academic year 2024-2025 onwards
	Marks	**Marks**
Continuous Internal Assessment (CIA)	**100**	**60**
Distribution of marks for CIA		
Review I	25	30
Review II	25	30
Final Presentation and Viva-voce	30	**-**
Report	20	

Semester End Examinations (SEE) *a. Report* *b. Presentation & Viva Voce*	**-**	**40** *20* *20*
Total Marks	**100**	**100**

XI PROJECT WORK I

Component	Applicable till academic year 2023-2024	Applicable from academic year 2024-2025 onwards
	Marks	**Marks**
Continuous Internal Assessment (CIA)	**50**	**60**
Distribution of marks for CIA		
Review I *a. Literature Survey* *b. Identification of topic and Justification* *c. Work plan* *d. Problem Statement and Literature Survey* *e. Contribution to the work* *f. Viva voce*	**20** *5* *5* *10* - - -	**30** - - *10* *5* *10* *5*
Review II *a. Approach & Results* *b. Conclusion* *c. Methodology & Results* *d. Conclusion with report* *e. Publication* *f. Viva voce*	**30** *15* *15* - - - -	**30** - - *10* *10* *5* *5*
Semester End Examinations (SEE) *a. Report* *b. Presentation* *c. Viva voce*	**50** *20* *20* *10*	**40** *15* *15* *10*
Total Marks	**100**	**100**

XII PROJECT WORK II

Component	Applicable till academic year 2023-2024	Applicable from academic year 2024-2025 onwards
	Marks	**Marks**
Continuous Internal Assessment (CIA)	**50**	**60**

Distribution of marks for CIA		
Review I *a. Progress* *b. Problem Statement and Literature Survey* *c. Methodology* *d. Work Contribution* *e. Viva voce*	**10** *10* - - - -	**20** - *5* *5* *5* *5*
Review II *a. Approach & Results* *b. Work Contribution* *c. Viva voce*	**10** *10* - -	**20** *10* *5* *5*
Review III *a. Conclusion & Final Presentation* *b. Report* *c. Publication of Paper in Conferences / Journals* *d. Results & Discussions* *e. Report and Contribution* *f. Publication* *g. Viva voce*	**30** *10* *15* *5* - - - -	**20** - - - *5* *5* *5* *5*
Semester End Examinations (SEE) *a. Presentation* *b. Viva voce* *c. Report*	**50** *30* *20* -	**40** *15* *10* *15*
Total Marks	**100**	**100**

XIII SOCIALLY RELEVANT PROJECT

Component	**Applicable from academic year 2024-2025 onwards**
	Marks
Continuous Internal Assessment (CIA)	**100**
Distribution of marks for CIA	
Field Survey	20
Problem Statement / Problem Identification and Social Relevance	20
Approach to the Problem / Methodology	20
Presentation / Seminar	10
Sustainable solutions and Future Plans	10
Report	10

Novelty	10
Total Marks	**100**

XIV STARTUP MANAGEMENT

Component	**Applicable till academic year 2023-2024**	**Applicable from academic year 2024-2025 onwards**
	Marks	**Marks**
Continuous Internal Assessment (CIA)	**100**	**50**
Distribution of marks for CIA		
Conduct of Fieldwork / Case Studies & Report	60	25
Model Examination	40	-
Assignments / Experiments & Report	-	25
Semester End Examinations (SEE)	**-**	**50**
Total Marks	**100**	**100**

XV THEORY COURSES

Component	**Marks**
Continuous Internal Assessment (CIA)	**40**
Distribution of marks for CIA	
Periodical Test I	12
Periodical Test II	12
Innovative Practices	16
Semester End Examinations (SEE)	**60**
Total Marks	**100**

XVI THEORY COURSES WITH LAB COMPONENT

Component	Applicable till academic year 2023-2024*	Applicable from academic year 2024-2025 onwards#
	Marks	**Marks**
Continuous Internal Assessment (CIA)	**50**	**50**
Distribution of marks for CIA		
Periodical Test I	15	25
Periodical Test II	15	
Innovative Practices *(Laboratory Assessment & Report)*	20	25
Semester End Examinations (SEE) * *(QP pattern as per (I))*	**50**	**50**
Semester End Examinations (SEE) # ***Courses with L T P C: 2 0 2 3*** *a. Theory Examinations* *b. Laboratory Assessment*	**-**	25 25
Semester End Examinations (SEE) # ***Courses with L T P C: 3 0 2 4, 2 1 2 4, 3 1 2 5*** *a. Theory Examinations* *b. Laboratory Assessment*	**-**	35 15
Total Marks	**100**	**100**

XVII VALUE-ADDED / CERTIFICATE COURSES

Component	Marks
Daily Assessment	50
Final Evaluation / Test	50
Total Marks	**100**

Optional Test: A student becomes eligible to appear for an 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 conducted for the courses under the categories I and II courses listed above.

18. FIELD / INDUSTRIAL VISIT / INTERNSHIP

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

19. 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. The attendance of the personality and character development courses / events shall be maintained on the regular basis by the club coordinator and made available in the Office of the Controller of Examinations before the commencement of Semester examinations of Semester I to Semester IV.

20. 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 Semester End Examination / Continuous Assessments, he / she shall be liable for punitive action as prescribed by the Institution / University from time to time.

21. REVISION OF REGULATIONS, CURRICULUM AND SYLLABI

The Institution reserves the right to revise/amend/change the Regulations, Curriculum, Syllabi, Scheme of Examinations through the Academic Council.

CONTENTS

VISION OF THE DEPARTMENT

Department of Biomedical Engineering envisages to propel creative engineering knowledge and advancements in biomedical technology to improve the healthcare conditions for the benefit of mankind.

MISSION OF THE DEPARTMENT

1. To focus on healthcare engineering that includes the study and understanding of biological systems.
2. To emphasize quantitative analysis and directly tying concepts with healthcare and diagnostics.
3. To encourage entrepreneurship in Biomedical Engineering fostering innovations in healthcare.
4. To inculcate interdisciplinary work and focus on research and development in Biomedical Engineering.

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)

I. Engage in professional development or post-graduate education for continuing self-development in biomedical engineering or other related fields.

II. Pursue a wide range of career options, including those in industry, academia, and medicine.

III. Practice professionally as biomedical engineers and/or biomedical scientists in the, field of health care sector for the wellbeing of humankind.

IV. Build careers addressing human health problems within a multidisciplinary, global industry.

PROGRAMME OUTCOMES (POs)

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

2. **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.

3. **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.

4. **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.

5. **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.

6. **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.

7. **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.

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

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

10. **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.

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

12. **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.

PROGRAMME SPECIFIC OUTCOMES (PSOs)

1. Apply knowledge on foundation in Life Science, engineering, mathematics and current biomedical engineering practices with an ability to demonstrate advanced knowledge of a selected area within Biomedical Engineering.

2. Critically analyse the current healthcare systems and develop innovative solutions effectively through problem specific design and development using modern hardware and software tools.

3. Hands-on knowledge on cutting edge hardware and software tools to acquire real time data, model and simulate physiological processes and analyse limitations on real time implementations.

MAPPING OF PEOs AND POs

POs	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
PEO1	X						X					X	X		
PEO2						X	X	X	X	X					X
PEO3		X	X	X	X								X	X	
PEO4						X			X		X			X	X

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Department of Biomedical Engineering envisages to propel creative engineering knowledge and advancements in biomedical technology to improve the healthcare conditions for the benefit of mankind.

MISSION OF THE DEPARTMENT

1. To focus on healthcare engineering that includes the study and understanding of biological systems.
2. To emphasize quantitative analysis and directly tying concepts with healthcare and diagnostics.
3. To encourage entrepreneurship in Biomedical Engineering fostering innovations in healthcare.
4. To inculcate interdisciplinary work and focus on research and development in Biomedical Engineering.

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)

I. Engage in professional development or post-graduate education for continuing self-development in biomedical engineering or other related fields.

II. Pursue a wide range of career options, including those in industry, academia, and medicine.

III. Practice professionally as biomedical engineers and/or biomedical scientists in the, field of health care sector for the wellbeing of humankind.

IV. Build careers addressing human health problems within a multidisciplinary, global industry.

PROGRAMME OUTCOMES (POs)

Engineering Graduates will be able to:

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

2. **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.

3. **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.

4. **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.

5. **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.

6. **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.

7. **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.

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

10. **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.

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

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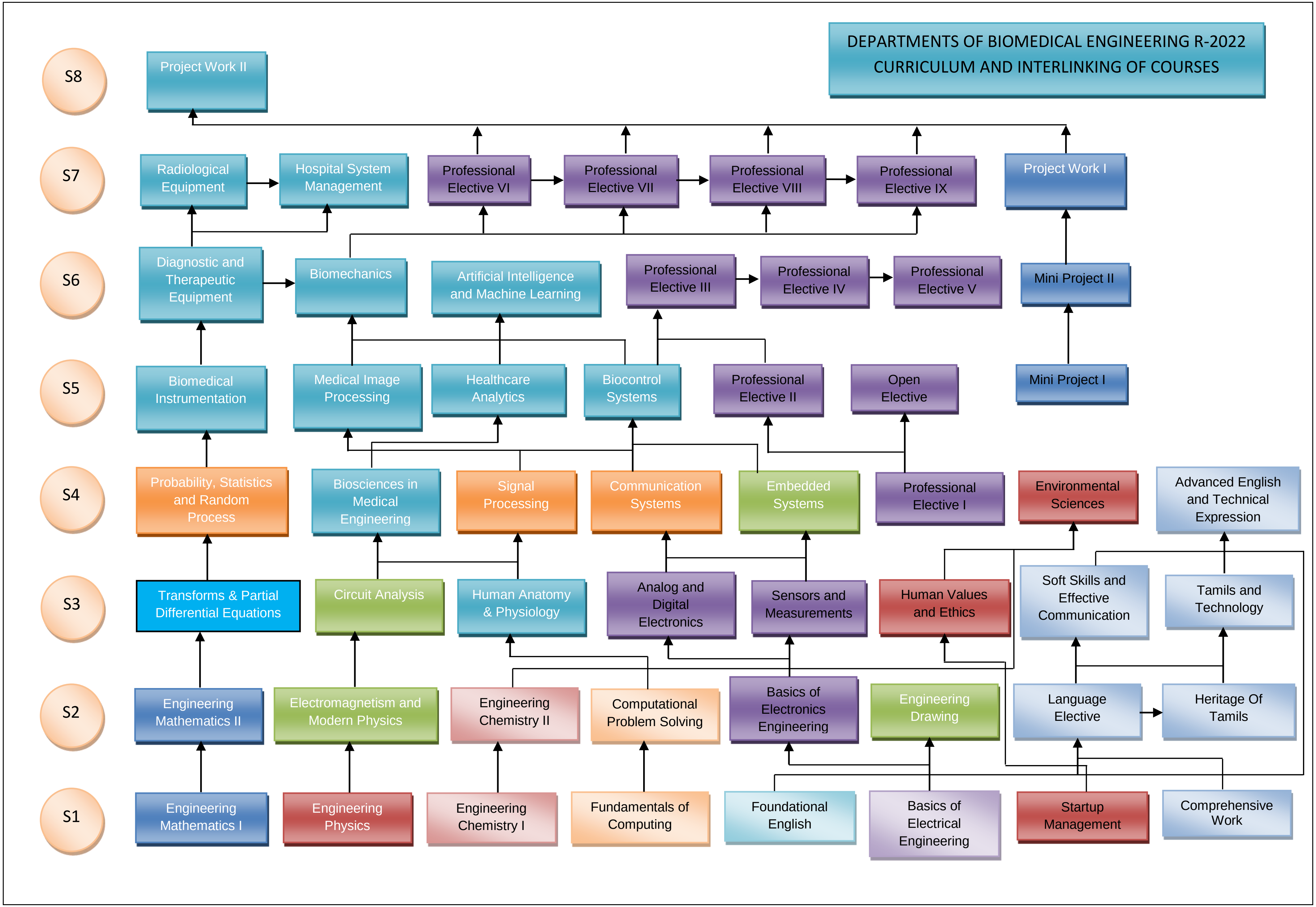
MAPPING OF PEOs AND POs

POs	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
PEO1	X						X					X	X		
PEO2						X	X	X	X	X					X
PEO3		X	X	X	X								X	X	
PEO4						X			X		X			X	X


DEPARTMENTS OF BIOMEDICAL ENGINEERING R-2022
CURRICULUM AND INTERLINKING OF COURSES
S8
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S7
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Advanced English and Technical Expression
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Transforms & Partial Differential Equations
Circuit Analysis
Human Anatomy & Physiology
Analog and Digital Electronics
Sensors and Measurements
Human Values and Ethics
Soft Skills and Effective Communication
Tamils and Technology
S2
Engineering Mathematics II
Electromagnetism and Modern Physics
Engineering Chemistry II
Computational Problem Solving
Basics of Electronics Engineering
Engineering Drawing
Language Elective
Heritage Of Tamils
S1
Engineering Mathematics I
Engineering Physics
Engineering Chemistry I
Fundamentals of Computing
Foundational English
Basics of Electrical Engineering
Startup Management
Comprehensive Work

(Candidates admitted during the Academic Year 2023-2024)

DEPARTMENT OF BIOMEDICAL ENGINEERING
Minimum Credits to be Earned : 163

I SEMESTER

Code No.	Course	L	T	P	C	Hours/ Week	Maximum Marks			Category
							CIA	SEE	Total	
22MA101	ENGINEERING MATHEMATICS I	3	1	0	4	4	40	60	100	BS
22PH102	ENGINEERING PHYSICS	2	0	2	3	4	50	50	100	BS
22CH103	ENGINEERING CHEMISTRY I	2	0	2	3	4	50	50	100	BS
22GE001	FUNDAMENTALS OF COMPUTING	3	0	0	3	3	40	60	100	ES
22HS001	FOUNDATIONAL ENGLISH	1	0	2	2	3	100	0	100	HSS
22GE003	BASICS OF ELECTRICAL ENGINEERING	2	0	2	3	4	50	50	100	ES
22HS002	STARTUP MANAGEMENT	1	0	2	2	3	100	0	100	EEC
22HS003	தமிழர் மரபு HERITAGE OF TAMILS#*	1	0	0	1	1	100	0	100	HSS
22BM108	COMPREHENSIVE WORK$	0	0	2	1$	2	100	0	100	EEC
Total		**15**	**1**	**10**	**21**	**26**	-	-	-	-

II SEMESTER

Code No.	Course	L	T	P	C	Hours/ Week	Maximum Marks			Category
							CIA	SEE	Total	
22MA201	ENGINEERING MATHEMATICS II	3	1	0	4	4	40	60	100	BS
22PH202	ELECTROMAGNETISM AND MODERN PHYSICS	2	0	2	3	4	50	50	100	BS
22CH203	ENGINEERING CHEMISTRY II	2	0	2	3	4	50	50	100	BS
22GE002	COMPUTATIONAL PROBLEM SOLVING	3	0	0	3	3	40	60	100	ES
22GE004	BASICS OF ELECTRONICS ENGINEERING	2	0	2	3	4	50	50	100	ES
22GE005	ENGINEERING DRAWING	1	0	2	2	3	100	0	100	ES
	LANGUAGE ELECTIVE	1	0	2	2	3	100	0	100	HSS
22HS006	தமிழரும் ததொழில்நுட்பமும் TAMILS AND TECHNOLOGY^*	1	0	0	1	1	100	0	100	HSS
Total		**15**	**1**	**10**	**21**	**26**	-	-	-	-

* The lateral entry students have to complete these courses during III and IV semester.
# Students admitted during academic year 2022-2023 studied this course in semester II.
^ Students admitted during academic year 2022-2023 studied this course in semester III.
$ Applicable only for the students admitted during academic year 2022-2023.

III SEMESTER										
Code No.	**Course**	**L**	**T**	**P**	**C**	**Hours/ Week**	**Maximum Marks**			**Category**
							CIA	**SEE**	**Total**	
22BM301	TRANSFORMS AND PARTIAL DIFFERENTIAL EQUATIONS	3	1	0	4	4	40	60	100	BS
22BM302	CIRCUIT ANALYSIS	3	1	0	4	4	40	60	100	ES
22BM303	HUMAN ANATOMY AND PHYSIOLOGY	3	0	2	4	5	50	50	100	PC
22BM304	ANALOG AND DIGITAL ELECTRONICS	3	0	2	4	5	50	50	100	PC
22BM305	SENSORS AND MEASUREMENTS	3	0	2	4	5	50	50	100	PC
22HS004	HUMAN VALUES AND ETHICS	2	0	0	2	2	40	60	100	HSS
22HS005	SOFT SKILLS AND EFFECTIVE COMMUNICATION	0	0	2	1	2	60	40	100	EEC
Total		**17**	**2**	**8**	**23**	**27**	-	-	-	-

IV SEMESTER										
Code No.	**Course**	**L**	**T**	**P**	**C**	**Hours/ Week**	**Maximum Marks**			**Category**
							CIA	**SEE**	**Total**	
22BM401	PROBABILITY, STATISTICS AND RANDOM PROCESS	3	1	0	4	4	40	60	100	BS
22BM402	BIOSCIENCES IN MEDICAL ENGINEERING	3	0	2	4	5	50	50	100	ES
22BM403	SIGNAL PROCESSING*	3	1	0	4	4	40	60	100	PC
22BM404	COMMUNICATION SYSTEMS	3	0	0	3	3	40	60	100	PC
22BM405	EMBEDDED SYSTEMS	3	0	2	4	5	50	50	100	PC
	PROFESSIONAL ELECTIVE I	3	0	0	3	3	40	60	100	PE
22HS007	ENVIRONMENTAL SCIENCE	2	0	0	NC	2	100	0	100	HSS
22HS008	ADVANCED ENGLISH AND TECHNICAL EXPRESSION	0	0	2	1	2	60	40	100	HSS
Total		**20**	**2**	**6**	**23**	**28**	-	-	-	-

* LTPC for this course is 3 0 0 3 for the students admitted during academic year 2022-2023.

V SEMESTER										
Code No.	**Course**	**L**	**T**	**P**	**C**	**Hours/ Week**	**Maximum Marks**			**Category**
							CIA	**SEE**	**Total**	
22BM501	BIOMEDICAL INSTRUMENTATION	3	0	2	4	5	50	50	100	PC
22BM502	MEDICAL IMAGE PROCESSING	3	0	2	4	5	50	50	100	PC
22BM503	HEALTHCARE ANALYTICS	3	0	0	3	3	40	60	100	PC
22BM504	BIO CONTROL SYSTEMS	3	1	0	4	4	40	60	100	PC
	PROFESSIONAL ELECTIVE II	3	0	0	3	3	40	60	100	PE
	OPEN ELECTIVE	3	0	0	3	3	40	60	100	PE
22BM507	MINI PROJECT I	0	0	2	1	2	60	40	100	EEC
Total		**18**	**1**	**6**	**22**	**25**	-	-	-	**-**

VI SEMESTER										
Code No.	**Course**	**L**	**T**	**P**	**C**	**Hours/ Week**	**Maximum Marks**			**Category**
							CIA	**SEE**	**Total**	
22BM601	DIAGNOSTIC AND THERAPEUTIC EQUIPMENT	3	0	2	4	5	50	50	100	PC
22BM602	BIOMECHANICS	3	0	2	4	5	50	50	100	PC
22BM603	ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING	3	0	2	4	5	50	50	100	PC
	PROFESSIONAL ELECTIVE III	3	0	0	3	3	40	60	100	PE
	PROFESSIONAL ELECTIVE IV	3	0	0	3	3	40	60	100	PE
	PROFESSIONAL ELECTIVE V	3	0	0	3	3	40	60	100	PE
22BM607	MINI PROJECT II	0	0	2	1	2	60	40	100	EEC
Total		**18**	**0**	**8**	**22**	**26**	-	-	-	**-**

VII SEMESTER											
Code No.	**Course**	**L**	**T**	**P**	**C**	**Hours/ Week**	**Maximum Marks**			**Category**
							CIA	**SEE**	**Total**	
22BM701	RADIOLOGICAL EQUIPMENT	3	0	0	3	3	40	60	100	PC
22BM702	HOSPITAL SYSTEM MANAGEMENT	3	0	2	4	5	50	50	100	PC
	PROFESSIONAL ELECTIVE VI	3	0	0	3	3	40	60	100	PE
	PROFESSIONAL ELECTIVE VII	3	0	0	3	3	40	60	100	PE
	PROFESSIONAL ELECTIVE VIII	3	0	0	3	3	40	60	100	PE
	PROFESSIONAL ELECTIVE IX	3	0	0	3	3	40	60	100	PE
22BM707	PROJECT WORK I	0	0	4	2	4	60	40	100	EEC
Total		**18**	**0**	**6**	**21**	**24**	-	-	-	**-**

VIII SEMESTER										
Code No.	**Course**	**L**	**T**	**P**	**C**	**Hours/ Week**	**Maximum Marks**			**Category**
							CIA	**SEE**	**Total**	
22BM801	PROJECT WORK II	0	0	20	10	20	60	40	100	EEC
Total		**0**	**0**	**20**	**10**	**20**	-	-	-	**-**

ELECTIVES										
LANGUAGE ELECTIVES										
Code No.	**Course**	**L**	**T**	**P**	**C**	**Hours /Week**	**Maximum Marks**			**Category**
							CIA	**SEE**	**Total**	
22HS201	COMMUNICATIVE ENGLISH II	1	0	2	2	3	100	0	100	HSS
22HSH01	HINDI	1	0	2	2	3	100	0	100	HSS
22HSG01	GERMAN	1	0	2	2	3	100	0	100	HSS
22HSJ01	JAPANESE	1	0	2	2	3	100	0	100	HSS
22HSF01	FRENCH	1	0	2	2	3	100	0	100	HSS

PROFESSIONAL ELECTIVES										
VERTICAL I - SIGNALS AND IMAGE PROCESSING										
22BM001	SPEECH AND AUDIO SIGNAL PROCESSING	3	0	0	3	3	40	60	100	PE
22BM002	BIOMETRIC SYSTEMS	3	0	0	3	3	40	60	100	PE
22BM003	PATTERN RECOGNITION TECHNIQUES	3	0	0	3	3	40	60	100	PE
22BM004	BRAIN COMPUTER INTERFACE	3	0	0	3	3	40	60	100	PE
22BM005	ADVANCED MEDICAL IMAGE ANALYSIS	3	0	0	3	3	40	60	100	PE
22BM006	MACHINE VISION	3	0	0	3	3	40	60	100	PE
22BM007	DEEP LEARNING TECHNIQUES	3	0	0	3	3	40	60	100	PE
VERTICAL II -ADVANCED HEALTHCARE DEVICES										
22BM008	BIOMATERIALS AND ASSISTIVE DEVICES	3	0	0	3	3	40	60	100	PE
22BM009	BIO MEMS AND NANO TECHNOLOGY	3	0	0	3	3	40	60	100	PE
22BM010	VIRTUAL INSTRUMENTATION	3	0	0	3	3	40	60	100	PE
22BM011	REHABILITATION AND ROBOTICS ENGINEERING	3	0	0	3	3	40	60	100	PE

22BM012	CRITICAL CARE EQUIPMENT	3	0	0	3	3	40	60	100	PE
22BM013	NUCLEAR MEDICINE	3	0	0	3	3	40	60	100	PE

VERTICAL III -TECHNOLOGY IN BIOMEDICINE										
22BM014	CELL BIOLOGY	3	0	0	3	3	40	60	100	PE
22BM015	TISSUE ENGINEERING	3	0	0	3	3	40	60	100	PE
22BM016	GENETIC ENGINEERING	3	0	0	3	3	40	60	100	PE
22BM017	CANCER BIOLOGY	3	0	0	3	3	40	60	100	PE
22BM018	BIO COMPUTATIONAL TECHNIQUES	3	0	0	3	3	40	60	100	PE
22BM019	NEUROSCIENCE	3	0	0	3	3	40	60	100	PE
VERTICAL IV -BIOMECHANICS										
22BM020	CARDIOVASCULAR ENGINEERING	3	0	0	3	3	40	60	100	PE
22BM021	PHYSIOLOGICAL MODELLING	3	0	0	3	3	40	60	100	PE
22BM022	PROSTHETIC AND ORTHOTIC DEVICES	3	0	0	3	3	40	60	100	PE
22BM023	REGENERATIVE MEDICINE AND ERGONOMICS	3	0	0	3	3	40	60	100	PE
22BM024	FINITE ELEMENT ANALYSIS	3	0	0	3	3	40	60	100	PE
22BM025	HAPTICS	3	0	0	3	3	40	60	100	PE
VERTICAL V -COMMUNICATION IN HEALTHCARE										
22BM026	MEDICAL TEXTILES	3	0	0	3	3	40	60	100	PE
22BM027	WEARABLE SYSTEMS AND BODY AREA NETWORKS	3	0	0	3	3	40	60	100	PE
22BM028	TELEMEDICINE AND IOT	3	0	0	3	3	40	60	100	PE
22BM029	BIOINFORMATICS	3	0	0	3	3	40	60	100	PE
22BM030	VIRTUAL AND AUGMENTED REALITY IN HEALTHCARE	3	0	0	3	3	40	60	100	PE
22BM031	MEDICAL OPTICS	3	0	0	3	3	40	60	100	PE

VERTICAL VI -HEALTHCARE MANAGEMENT										
22BM032	MEDICAL WASTE MANAGEMENT	3	0	0	3	3	40	60	100	PE
22BM033	MEDICAL ETHICS	3	0	0	3	3	40	60	100	PE
22BM034	PATIENT SAFETY AND STANDARDS	3	0	0	3	3	40	60	100	PE
22BM035	MEDICAL DEVICE REGULATIONS	3	0	0	3	3	40	60	100	PE
22BM036	FORENSIC SCIENCE IN HEALTHCARE	3	0	0	3	3	40	60	100	PE
22BM037	CLINICAL ENGINEERING	3	0	0	3	3	40	60	100	PE
VERTICAL VII -MEDICAL DEVICE DESIGN AND DEVELOPMENT										
22BM038	MEDICAL DEVICE DESIGN	3	0	0	3	3	40	60	100	PE
22BM039	MEDICAL EQUIPMENT MAINTENANCE AND TROUBLESHOOTING	3	0	0	3	3	40	60	100	PE
22BM040	ADVANCED BIOSENSORS	3	0	0	3	3	40	60	100	PE
22BM041	DRUG DELIVERY SYSTEM	3	0	0	3	3	40	60	100	PE
22BM042	ELECTROMAGNETIC INTERFERENCE AND COMPATIBILITY	3	0	0	3	3	40	60	100	PE
22BM043	INTERVENTIONAL AND DIAGNOSTIC RADIOLOGY	3	0	0	3	3	40	60	100	PE
VERTICAL VIII –DIVERSIFIED ELECTIVES										
22BM044	MULTIMEDIA COMPRESSION TECHNIQUES	3	0	0	3	3	40	60	100	PE
22BM045	PCB DESIGN AND FABRICATION	3	0	0	3	3	40	60	100	PE
22BM046	HEALTH CARE MANAGEMENT	3	0	0	3	3	40	60	100	PE

22BM047	EMBEDDED C PROGRAMMING	3	0	0	3	3	40	60	100	PE
HONOURS VERTICAL COURSES - HEALTHCARE MANAGEMENT										
22BMH32	MEDICAL WASTE MANAGEMENT	3	0	0	3	3	40	60	100	PE
22BMH33	MEDICAL ETHICS	3	0	0	3	3	40	60	100	PE
22BMH34	PATIENT SAFETY AND STANDARDS	3	0	0	3	3	40	60	100	PE
22BMH35	MEDICAL DEVICE REGULATIONS	3	0	0	3	3	40	60	100	PE
22BMH36	FORENSIC SCIENCE IN HEALTHCARE	3	0	0	3	3	40	60	100	PE
22BMH37	CLINICAL ENGINEERING	3	0	0	3	3	40	60	100	PE

MINOR VERTICAL COURSES - HEALTHCARE MANAGEMENT										
22BMM32	MEDICAL WASTE MANAGEMENT	3	0	0	3	3	40	60	100	PE
22BMM33	MEDICAL ETHICS	3	0	0	3	3	40	60	100	PE
22BMM34	PATIENT SAFETY AND STANDARDS	3	0	0	3	3	40	60	100	PE
22BMM35	MEDICAL DEVICE REGULATIONS	3	0	0	3	3	40	60	100	PE
22BMM36	FORENSIC SCIENCE IN HEALTHCARE	3	0	0	3	3	40	60	100	PE
22BMM37	CLINICAL ENGINEERING	3	0	0	3	3	40	60	100	PE
OPEN ELECTIVES										
22OCE01	ENERGY CONSERVATION AND MANAGEMENT	3	0	0	3	3	40	60	100	OE
22OCS01	OBJECT ORIENTED PROGRAMMING	3	0	0	3	3	40	60	100	OE
22OCS02	JAVA FUNDAMENTALS	3	0	0	3	3	40	60	100	OE

22OCS03	KNOWLEDGE DISCOVERY IN DATABASES	3	0	0	3	3	40	60	100	OE
22OCS04	E-LEARNING TECHNIQUES	3	0	0	3	3	40	60	100	OE
22OCS05	SOCIAL TEXT AND MEDIA ANALYTICS	3	0	0	3	3	40	60	100	OE
22OEC04	PRINCIPLES OF COMPUTER COMMUNICATION AND NETWORKS	3	0	0	3	3	40	60	100	OE
22OEI01	PROGRAMMABLE LOGIC CONTROLLER	3	0	0	3	3	40	60	100	OE
22OME01	DIGITAL MANUFACTURING	3	0	0	3	3	40	60	100	OE
22OME02	INDUSTRIAL PROCESS ENGINEERING	3	0	0	3	3	40	60	100	OE
22OME03	MAINTENANCE ENGINEERING	3	0	0	3	3	40	60	100	OE
22OBT01	BIOFUELS	3	0	0	3	3	40	60	100	OE
22OFD01	TRADITIONAL FOODS	3	0	0	3	3	40	60	100	OE
22OFD02	FOOD LAWS AND REGULATIONS	3	0	0	3	3	40	60	100	OE
22OFD03	POST HARVEST TECHNOLOGY OF FRUITS AND VEGETABLES	3	0	0	3	3	40	60	100	OE
22OFD04	CEREAL, PULSES AND OIL SEED TECHNOLOGY	3	0	0	3	3	40	60	100	OE
22OFT01	FASHION CRAFTSMANSHIP	3	0	0	3	3	40	60	100	OE
22OFT02	INTERIOR DESIGN IN FASHION	3	0	0	3	3	40	60	100	OE
22OFT03	SURFACE ORNAMENTATION	3	0	0	3	3	40	60	100	OE
22OPH05	PHYSICS OF SOFT MATTER	3	0	0	3	3	40	60	100	OE
22OCH01	CORROSION SCIENCE AND ENGINEERING	3	0	0	3	3	40	60	100	OE
22OCH02	POLYMER SCIENCE	3	0	0	3	3	40	60	100	OE
22OCH03	ENERGY STORING DEVICES	3	0	0	3	3	40	60	100	OE

22OMA01	GRAPH THEORY AND COMBINATORICS	3	0	0	3	3	40	60	100	OE
22OGE01	PRINCIPLES OF MANAGEMENT	3	0	0	3	3	40	60	100	OE
22OGE02	ENTREPRENEURSHIP DEVELOPMENT I	3	0	0	3	3	40	60	100	OE
22OGE03	ENTREPRENEURSHIP DEVELOPMENT II	3	0	0	3	3	40	60	100	OE
22OGE04	NATION BUILDING, LEADERSHIP AND SOCIAL RESPONSIBILITY	3	0	0	3	3	40	60	100	OE
22OAI01	FUNDAMENTALS OF DATA SCIENCE	3	0	0	3	3	40	60	100	OE
22OIT01	DATA STRUCTURES	3	0	0	3	3	40	60	100	OE
22OIT02	C++ PROGRAMMING	2	0	2	3	3	50	50	100	OE
22OIT03	PROGRAMMING IN JAVA	2	0	2	3	3	50	50	100	OE
22OIT04	FUNDAMENTALS OF DATABASE MANAGEMENT	2	0	2	3	3	50	50	100	OE
22OAG01	RAINWATER HARVESTING TECHNIQUES	3	0	0	3	3	40	60	100	OE
22OEE01	VALUE ENGINEERING	3	0	0	3	3	40	60	100	OE

22OEE02	ELECTRICAL SAFETY	3	0	0	3	3	40	60	100	OE
22OCB01	INTERNATIONAL BUSINESS MANAGEMENT	3	0	0	3	3	40	60	100	OE
ONE CREDIT COURSE										
22BM0XA	REAL TIME BIOSENSORS INTERFACING	1	0	0	1	-	100	0	100	EEC
22BM0XB	EMBEDDED C FOR BIOMEDICAL DEVICE DESIGN	1	0	0	1	-	100	0	100	EEC
22BM0XC	MEDICAL CODING – CONCEPTS AND PRACTICE	1	0	0	1	-	100	0	100	EEC

22BM0XD	TRACEABILITY AND UNCERTAINTY CHALLENGES IN MEDICAL DEVICE CALIBRATION	1	0	0	1	-	100	0	100	EEC

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	10	10	4	4	-	-	-	-	28	17	15%	20%
2	ES	6	8	4	4	-	-	-	-	22	14	15%	20%
3	HSS	3	3	2	1	-	-	-	-	9	6	5%	10%
4	PC	-	-	12	11	15	12	7	-	57	35	35%	45%
5	PE	-	-	-	3	6	9	12	-	30	18	15%	20%
6	EEC	2	-	1	-	1	1	2	10	17	10	5%	10%
Total		21	21	23	23	22	22	21	10	163	100	-	-

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

22MA101 ENGINEERING MATHEMATICS I 3 1 0 4

Course Objectives

- To impart mathematical modeling to describe and explore real-world phenomena and data.
- To provide basic understanding on Linear, quadratic, power and polynomial, exponential, and multi variable models
- Summarize and apply the methodologies involved in framing the real world problems related to fundamental principles of polynomial equations

Program Outcomes (POs)

PO1. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. 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.

PSO1. Apply knowledge on foundation in Life Science, engineering, mathematics and current biomedical engineering practices with an ability to demonstrate advanced knowledge of a selected area within Biomedical Engineering.

Course Outcomes (COs)

1. Implement the concepts of mathematical modeling based on linear functions in Engineering.
2. Formulate the real-world problems as a quadratic function model
3. Demonstrate the real-world phenomena and data into Power and Polynomial functions
4. Apply the concept of mathematical modeling of exponential functions in Engineering
5. Develop the identification of multivariable functions in the physical dynamical problems

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	1	2	−	−	−	−	−	−	−	−	−	−	1	−	−
2	2	2	−	−	−	−	−	−	−	−	−	−	1	−	−
3	2	1	−	−	−	−	−	−	−	−	−	−	1	−	−
4	2	2	−	−	−	−	−	−	−	−	−	−	1	−	−
5	1	2	−	−	−	−	−	−	−	−	−	−	1	−	−

UNIT I 9 Hours

MATHEMATICS MODELING OF LINEAR FUNCTIONS

The geometry of linear equations - Formation of linear equations: Method of least squares and method of regression - Vector spaces: Basic concepts with examples - Linear combination - Eigen values and vectors

UNIT II 9 Hours

MATHEMATICAL MODELING OF QUADRATIC FUNCTIONS

General form of a quadratic function - Basic relationships between the equation and graph of a quadratic function - Sum of squares error and the quadratic function of best fit - Quadratic forms: Matrix form - Orthogonality - Canonical form and its nature

UNIT III **9 Hours**

MATHEMATICAL MODELING OF POWER AND POLYNOMIAL FUNCTIONS

Characteristics of the graphs of power and polynomial functions - Fitting of power and polynomial functions using the method of least squares - Local maxima and local minima of power and polynomial functions - Power series of functions with real variables, Taylors series, radius and interval of convergence - Tests of convergence for series of positive terms - comparison test, ratio test

UNIT IV **9 Hours**

MATHEMATICAL MODELING OF EXPONENTIAL FUNCTIONS

Concept of exponential growth - Graphs of exponential functions - Relationship between the growth factor and exponential growth or decline - Exponential equations have a variable as an exponent and take the form y = abx through least square approximation - Calculus of exponential functions - Exponential series - Characteristics

UNIT V **9 Hours**

MATHEMATICAL MODELING OF MULTIVARIABLE FUNCTIONS

Graphing of functions of two variables - Partial derivatives - Total derivatives - Jacobians - Optimization of multivariable functions with constraints - Optimization of multivariable functions without constraints

Tutorial:15 Hours
Total: 60 Hours

Reference(s)

1. Erwin Kreyszig, Advanced Engineering Mathematics, Tenth Edition, Wiley India Private Limited, New Delhi 2016
2. B. S. Grewal, Numerical Methods in Engineering & Science: With Programs in C, C++ & MATLAB, Khanna, 2014
3. S.C. Gupta, V.K. Kapoor, Fundamentals of Mathematical Statistics, Sultan Chand & Sons2020
4. Thomas and Finney, Calculus and analytic Geometry, Fourteenth Edition, By Pearson Paperback, 2018

22PH102 ENGINEERING PHYSICS **2 0 2 3**

Course Objectives

- Understand the concept and principle of energy possessed by mechanical system
- Exemplify the propagation and exchange of energy
- Identify the properties of materials based on the energy possession

Program Outcomes (POs)

PO1 Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems

PO2 Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3 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.

PO4 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.

PO9 Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings

PO12 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.

PSO1 Able to apply the concepts of Electronics, Communication, Signal processing and VLSI in the design and implementation of application oriented engineering systems.

Course Outcomes (COs)

1. Illustrate the concept and principles of energy to understand mechanical systems
2. Exemplify the types of mechanical oscillations based on vibrational energy
3. Infer the concept of propagation of energy as transverse and longitudinal waves
4. Analyze the exchange of energy and work between the systems using thermodynamic principles
5. Apply the concept of energy and entropy to understand the mechanical properties of materials

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	2	1	1	−	−	−	−	2	−	−	1	–	−	−
2	3	2	1	2	−	−	−	−	2	−	−	1	–	−	−
3	3	2	2	1	−	−	−	−	2	−	−	1	–	−	−
4	3	2	2	1	−	−	−	−	2	−	−	1	–	−	−
5	3	2	2	1	−	−	−	−	2	−	−	1	–	−	−

UNIT I **6 Hours**

CONSERVATION OF ENERGY

Concept of energy - types of energy - conservation of energy Mechanical energy: - translation - rotation - vibration - Kinetic and potential energies - conservation - work and energy - laws of motion - minimization of potential energy - equilibrium - dissipative systems - friction

UNIT II **5 Hours**

VIBRATIONAL ENERGY

Periodic Motion - Simple Harmonic Motion - Energy of the SHM - Pendulum types - Damped oscillations - forced oscillations - natural frequency - resonance

UNIT III **6 Hours**

PROPAGATION OF ENERGY

Transfer of energy - material medium - Transverse wave - Longitudinal wave - standing wave - interference - Doppler effect. Sound waves and its types - characteristics - human voicere - reflection - refraction - beats

UNIT IV **7 Hours**

EXCHANGE OF ENERGY

Energy in transit - heat - Temperature - measurement - specific heat capacity and water - thermal expansion - Heat transfer processes. Thermodynamics: Thermodynamic systems and processes - Laws of thermodynamics - Entropy - entropy on a microscopic scale - maximization of entropy

UNIT V **6 Hours**

ENERGY IN MATERIALS

Elastic energy - Structure and bonding - Stress - strain - Tension and compression - elastic limit - Elastic Modulus - Stress - strain diagram - ductility - brittleness - rubber elasticity and entropy

EXPERIMENT 1 **5 Hours**

Assess the physical parameters of different materials for engineering applications like radius, thickness and diameter to design the electrical wires, bridges and clothes

EXPERIMENT 2 **5 Hours**

Evaluate the elastic nature of different solid materials for modern industrial applications like shock absorbers of vehicles.

EXPERIMENT 3 **5 Hours**

Analyze the photonic behaviour of thin materials for advanced optoelectronic applications like adjusting a patient's head, chest and neck positions as a medical tool

EXPERIMENT 4 **5 Hours**

Investigate the phonon behaviour of poor conductors for thermionic applications like polymer materials and textile materials.

EXPERIMENT 5 **5 Hours**

Assess the elongation of different solid materials for industrial applications like buildings, bridges and vehicles.

EXPERIMENT 6 **5 Hours**

Measure the compressibility of different liquids for modern industrial applications like navigation, medicine and imaging.

Total: 60 Hours

Reference(s)

1. C J Fischer, The energy of Physics Part I: Classical Mechanics and Thermodynamics, Cognella Academic Publishing, 2019.
2. P G Hewitt, Conceptual Physics, Pearson education, 2017
3. R A Serway and J W Jewitt, Physics for Scientists and Engineers, Thomson Brooks/Cole, 2019
4. J Walker, D Halliday and R Resnick, Principles of Physics, John Wiley and Sons, Inc, 2018
5. H C Verma, Concepts of Physics (Vol I & II), Bharathi Bhawan Publishers & Distributors, New Delhi, 2017

22CH103 ENGINEERING CHEMISTRY I 2 0 2 3

Course Objectives

- Understand the origin of elements from the universe
- Outline the properties of elements in the periodic table
- Analyse the different types of bond formed during chemical reactions and its reaction thermodynamics
- Summarize different states of matter based on atomic arrangement

Programme Outcomes (POs)

PO1. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. 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.

PSO1. Apply knowledge on foundation in Life Science, engineering, mathematics and current biomedical engineering practices with an ability to demonstrate advanced knowledge of a selected area within Biomedical Engineering

Course Outcomes (COs)

1. Apply the principles of nuclear fusion and stellar evolution to explain the processes of hydrogen fusion in stars and the creation of elements
2. Apply the concept of atomic structure of elements in the periodic table to interpret the periodic trends in properties of elements with its anomaly
3. Apply the conditions for the formation of different types of chemical bonds and predict the minimum energy required for a reaction to occur
4. Analyze endothermic and exothermic processes and exchange of energy during chemical reactions
5. Analyze whether the given matter is a solid, liquid, gas, or plasma and interpret the arrangement of atoms

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
2	1	−	−	−	−	−	−	−	−	−	−	1	−	−	2
2	1	−	−	−	−	−	−	−	−	−	−	1	−	−	2
2	1	−	−	−	−	−	−	−	−	−	−	1	−	−	2
2	1	−	−	−	−	−	−	−	−	−	−	1	−	−	2
2	1	−	−	−	−	−	−	−	−	−	−	1	−	−	2

UNIT I **6 Hours**

ORIGIN OF ELEMENTS

Hydrogen - Elements and Sun - fusion - hypernova - supernova - dying stars - man-made elements

UNIT II **6 Hours**

ATOMIC STRUCTURE AND PERIODICITY

Atomic Structure - Electronic configuration - Periodic Table - Periodic trends in properties of elements - Anomalous behaviour in periodicity

UNIT III **6 Hours**

CHEMICAL BONDING

Octet rule & its limitations - types of chemical bonds - bond energy - bond cleavage - activation energy of reactions

UNIT IV **6 Hours**

REACTION THERMODYNAMICS

Conservation of energy - Endothermic reactions & exothermic reactions - Exchange of energy involved in chemical reactions

UNIT V **6 Hours**

STATES OF MATTER

Solid - liquid - gas - plasma - quantum dots - arrangement of atoms/ions/molecules in different phases

EXPERIMENT 1 **5 Hours**

Evaluate the dissolved oxygen (DO) levels in effluent samples collected from sewage treatment plants in BIT. Ensure the suitability of outlet water for the growth of aquatic animals (fishes).

EXPERIMENT 2 **5 Hours**

Investigate the amount of Iron (Fe2+) in a mild steel alloy sample using a spectrophotometer.

EXPERIMENT 3 **4 Hours**

Estimate the amount of chromium present in industry effluent samples and bottled beverages.

EXPERIMENT 4 **5 Hours**

Ensure the suitability of drinking water in the RO water supply in BIT based on the presence of chloride ions.

EXPERIMENT 5 **3 Hours**

Assess the acidic nature of effluent water from industries using the conductometric titration method.

EXPERIMENT 6 **4 Hours**

Measure the stain removal efficiency of the prepared soaps from stained clothes.

EXPERIMENT 7 **4 Hours**

Assess the purity of commercially available active pharmaceutical ingredients (aspirin) as per the government-prescribed standards.

Total: 60 Hours

Reference(s)

1. Rose Marie Gallagher and Author Paul Ingram, Complete Chemistry Cambridge IGCSE, 2nd Edition, Oxford university press, 2020.
2. Peter Atkins, Julio D Paula and James Keeler, Atkins' Physical Chemistry, 12th Edition, Oxford university press, 2019.
3. Gareth Price, Thermodynamics of chemical processes, 2nd Edition, Oxford university press, 2019.
4. D Tabor, Gases, liquids and solids and other states of matter, 3rd Edition, Oxford University press, 2018.
5. P L Soni, Text book of inorganic chemistry, Chand publishers, New Delhi, 2017.
6. J.D. Lee, Concise inorganic chemistry, 5th edition (Reprint), Blackman Science Ltd, France, Wiley-India, 2016.

22GE001 FUNDAMENTALS OF COMPUTING 3 0 0 3

Course Objectives

- Understand the fundamental digital logics behind computations of computer systems.
- Develop simple assembly language programs with respect to arithmetic operations.
- Understand the program execution process and basics of software development methodologies.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences
PO3. 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.
PO4. 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. Infer the hidden languages and inner structures of computer hardware and software through codes and combinations.
2. Interpret the organizational and architectural issues of a digital computer with concepts of various data transfer techniques in digital computers and the I/O interfaces.
3. Analyze programming problems and apply assembly instructions to solve simple problems.
4. Infer the fundamentals of operating system and System programs basics.
5. Apply the software development methodologies to various real life scenarios.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	1	1	1	-	-	-	-	-	-	-	-	-	-	-
2	3	3	3	1	-	-	-	-	-	-	-	-	-	-	-
3	2	2	2	1	-	-	-	-	-	-	-	-	-	-	-
4	2	2	2	1	-	-	-	-	-	-	-	-	-	-	-
5	2	2	2	1	-	-	-	-	-	-	-	-	-	-	-

UNIT I **8 Hours**

CODES AND COMBINATIONS

Communication using Mores and Braille binary codes - Digitizing letters, numbers and objects using binary codes - Performing simple operations: addition through binary codes.

UNIT II **9 Hours**

COMPUTATION USING COMPUTER

Communication to computing devices through various input sources - Computational operation - flow, functions and controls - communication to output devices - Basic communication protocol.

UNIT III **11 Hours**

ASSEMBLY LANGUAGE PROGRAMMING

Little Man Computing (LMC) Model - Instruction Set - Labels - Calculation -Branching - Input - Output - Loops - Simple programs.

UNIT IV **9 Hours**

OPERATING SYSTEM AND APPLICATION GENERATION

BIOS - Device Drivers - Resources - Scheduler - Applications Generation and Creation - Stages of Compilation - Linkers, Loaders and Libraries.

UNIT V **8 Hours**

SOFTWARE DEVELOPMENT

Phases of application life cycle management - Software Development Methodologies - Web Page development.

Total: 45 Hours

Reference(s)

1. Charles Petzold, "Code: The Hidden Language of Computer Hardware and Software", Microsoft Press books, 2009.
2. David D. Riley, Kennya. Hunt, "Computational thinking for the modern problem Solver", CRC Press Taylor & Francis Group, 2014.
3. Andrew Eliaz, "Little Man Computer Programming: For The Perplexed From The Ground Up", The Internet Technical Bookshop; 1st edition, 2016.
4. Abraham Silberschatz, "Peter Baer Galvin and Greg Gagne, Operating System Concepts", 9th Edition, John Wiley & Sons Pvt. Ltd, 2015.
5. Roger S. Pressman, "Software Engineering: A Practitioner"s Approach", McGraw Hill International edition, Seventh edition, 2010

22HS001 FOUNDATIONAL ENGLISH 1 0 2 2

Course Objectives

- Heighten awareness of grammar in oral and written expression
- Improve speaking potential in formal and informal contexts
- Improve reading fluency and increased vocabulary
- Prowess in interpreting complex texts
- Fluency and comprehensibility in self-expression
- Develop abilities as critical readers and writers
- Improve ability to summarize information from longer text, and distinguish between primary and supporting ideas

Programme Outcomes (POs)

PO9. Individual and Team Work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO10. 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.
PO12. 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. Express themselves in a professional manner using error-free language
2. Express in both descriptive and narrative formats
3. Interpret and make effective use of the English Language in Business contexts
4. Actively read and comprehend authentic text
5. Express opinions and communicate experiences.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	-	-	-	-	-	-	-	-	2	3	-	2	-	-	1
2	-	-	-	-	-	-	-	-	2	3	-	2	-	-	2
3	-	-	-	-	-	-	-	-	2	3	-	2	-	-	3
4	-	-	-	-	-	-	-	-	2	3	-	2	-	-	4
5	-	-	-	-	-	-	-	-	2	3	-	2	-	-	5

UNIT I 15 Hours

SELF-EXPRESSION

Self-Introduction - Recreating Interview Scenarios (with a focus on verbal communication) - Subject Verb Concord - Tenses - Common Errors in verbal communication Be-verbs - Self-Introduction - Recreating interview scenarios - Haptics - Gestures - Proxemics - Facial expressions - Paralinguistics/ Vocalics - Body Language - Appearance - Eye Contact - Artefacts Self-Introduction - Powerful openings and closings at the interview - Effective stock phrases - Modified for spontaneity and individuality-Question tags, framing questions including WH Questions - Prepositions - Listening to Ted talks-Listening for specific information

UNIT II **15 Hours**

CREATIVE EXPRESSION

Descriptive Expression - Picture Description and Blog Writing- Vocabulary - One-word substitution - Adjectives - Similes, Metaphors, Imagery & Idioms – Link words - Inclusive language Narrative Expression - Travelogue and Minutes of Meeting -Verbal analogy -Sequence & Time order words - Jumbled paragraph, sentences, Sequencing - Text & Paragraph completion - Past tense - Using quotation marks

UNIT III **15 Hours**

FORMAL EXPRESSION

Formal Letters and Emails - Writing: E-mails and Letters of apology, Requisition and Explanation, and Letters to Newspapers - Speaking: Tendering verbal apologies, and explanations, persuading a listener/ audience-Hierarchy in Business correspondence- Subject of a mail, Header, Body (Salutation) and Footer of a mail. Conjunctional clause Punctuation - Formal Idioms - Phrases - Articles - Definite & Indefinite - Types of sentences - Modal verbs Precision in comprehension, Summary writing, Selective summary - Reading: Active reading - short paragraphs, excerpts, articles and editorials - Skimming and Scanning Reading comprehension & analysis - Tenses, QP/ PQ approach. Identifying the central themes/ crux-Interpreting tone - formal/informal/semi-formal - Note - taking - Listening: Listening for data, for specific information, for opinion -Active and passive Listening - Transcription - Paraphrasing and summarising information-Agreeing & disagreeing - Note - taking - Writing: Summary writing, selective summary, paraphrasing, note - making, opinion pieces - Finding synonyms in the context Paraphrasing - Sentence Transformation - simple, compound, complex. Sentence substitution - Sentence completion - Interpreting paragraphs

Total: 45 Hours

Reference(s)

1. Sasikumar, V, et.al. A Course in Listening & Speaking Foundation Books, 2005.
2. Murphy, Raymond. English Grammar in Use: A Self-Study Reference and Practice Book for Intermediate Students: with Answers. Cambridge: Cambridge University Press, 1985.
3. Prasad, Hari Mohan. A Handbook of Spotting Errors. Mcgraw Hill Education, 2010
4. Reynolds, John. Cambridge IGCSEÃ‚Â® First Language English. 2018th ed., Hodder Education, 2018.
5. Wiggins, Grant P., and Jay McTighe. Understanding by Design. Association for Supervision and Curriculum Development, 2008.

22GE003 BASICS OF ELECTRICAL ENGINEERING 2 0 2 3

Course Objectives

- To understand the basic concepts of electrical charge and its properties
- To interpret the formation of electric field due to electric charges
- To illustrate the concept of magnetic fields due to revolving electron
- To illustrate the force on moving charges in electric and magnetic field
- To understand the energy transfer in electro mechanical conversion

Program Outcomes (POs)

PO1. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. 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.
PO3. 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.
PO4. 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.
PSO2. Critically analyse the current healthcare systems and develop innovative solutions effectively through problem specific design and development using modern hardware and software tools.
PSO3. Hands-on knowledge on cutting edge hardware and software tools to acquire real time data, model and simulate physiological processes and analyse limitations on real time implementations.

Course Outcomes (COs)

1. Outline the behavior of electric charges in different medium using coulombs law.
2. Analyse the electric field due to different charge distributions.
3. Analyse the magnetic field intensity due to long conductor, solenoid, toroid and magnetic dipoles.
4. Analyze the force on conductors due to the moving charges.
5. Apply the energy conversion concepts in electromagnetic fields.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	2	2	–	–	–	–	–	–	–	–	–	–	2	2
2	2	2	2	3	–	–	–	–	–	–	–	–	–	2	2
3	2	2	1	3	–	–	–	–	–	–	–	–	–	2	2
4	3	2	1	2	–	–	–	–	–	–	–	–	–	2	2
5	2	2		–	–	–	–	–	–	–	–	–	–	2	2

UNIT I 5 Hours

ELECTRIC CHARGE

Properties of charge, additivity of charges, quantization of charge, conservation of charge, Forces between multiple charges, Electric charge in conductors, Drift of Electrons, Charges in Clouds.

UNIT II **7 Hours**

ELECTRIC FIELD

Electric field due to system of charges, Significance of Electric field line. Electric Dipole and its significance, Continuous charge distribution, Field in infinite long uniform straight conductors, field in uniform charged uniform infinite plane sheet, field due to uniform thin spherical sheet.

UNIT III **7 Hours**

MAGNETIC FIELDS

Concept of magnetic field, magnetic fields in infinitely long straight wire, straight and toroidal solenoids, Magnetic dipole moment of a revolving electron, Magnetic field intensity due to a magnetic dipole (bar magnet) along its axis and perpendicular to axis, Induced Electric field due to changing Magnetic Field.

UNIT IV **6 Hours**

FORCE ON CHARGES

Force on a moving charge in uniform magnetic and electric fields, Force on a current carrying conductor in a uniform magnetic field, Force between two parallel current carrying conductors.

UNIT V **5 Hours**

ELECTRO MECHANICAL ENERGY CONVERSION

Energy transfer in electromagnetic fields, Energy storage in magnetic field, Electromagnetic induction, induced emf, Eddy currents. Self and mutual inductance Linear Momentum and Angular Momentum carried by Electromagnetic Fields.

EXPERIMENT 1 **7 Hours**

Analysis the behaviour of a Fixed Resistor in an Electric Heater

EXPERIMENT 2 **8 Hours**

Construct an Electrical Wiring Layout for a Basic Household Applications

EXPERIMENT 3 **7 Hours**

Analysis the Self and Mutual Induction in a Domestic Fan

EXPERIMENT 4 **8 Hours**

Design a Transistor-Based Electronic Switch

Total: 60 Hours

Reference(s)

1. Mathew N. O. Sadiku, Principles of Electromagnetics, 6th Edition, Oxford University 2020
2. William H. Hayt and John A. Buck, Engineering Electromagnetics, McGraw Hill 2020
3. Kraus and Fleisch, Electromagnetics with Applications, McGraw Hill International Editions, 2017
4. S.P.Ghosh, Lipika Datta, Electromagnetic Field Theory, First Edition, McGraw Hill Education(India) Private Limited 2017

22HS002 STARTUP MANAGEMENT **1 0 2 2**

Course Objectives

- Promote entrepreneurial spirit and motivate to build startups
- Provide insights on markets and the dynamics of buyer behaviour
- Train to develop prototypes and refine them to a viable market offering
- Support in developing marketing strategies and financial outlay
- Enable to scale up the porotypes to commercial market offering

Program Outcomes (POs)

PO7. 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.
PO8. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO9. Individual and Team Work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO10. 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.
PO11. Project Management and Finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

Course Outcomes (COs)

1. Generate valid and feasible business ideas
2. Create Business Model Canvas and formulate positioning statement
3. Invent prototypes that fulfills an unmet market need
4. Formulate business strategies and create pitch decks
5. Choose appropriate strategies for commercialization

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	−	−	−	−	−	−	1	2	1	−	1	−	−	−	−
2	−	−	−	−	−	−	2	2	1	1	2	−	−	−	−
3	−	−	−	−	−	−	3	3	1	2	2	−	−	−	−
4	−	−	−	−	−	−	1	3	1	2	2	−	−	−	−
5	−	−	−	−	−	−	2	3	2	2	2	−	−	−	−

UNIT I **3 Hours**

BUSINESS MODELS AND IDEATION

Startups: Introduction, Types of Business Modes for Startups. Ideation: Sources of Ideas, Assessing Ideas, Validating Ideas, Tools for validating ideas, Role of Innovation and Design Thinking

UNIT II **3 Hours**

UNDERSTANDING CUSTOMERS

Buyer Decision Process, Buyer Behaviour, Building Buyer Personas, Segmenting, Targeting and Positioning, Value Proposition (Business Model Canvas), Information Sourcing on Markets, Customer Validation

UNIT III **3 Hours**

DEVELOPING PROTOTYPES

Prototyping: Methods - Paper and Digital, Customer Involvement in Prototyping, Product Design Sprints, Refining Prototypes

UNIT IV **3 Hours**

BUSINESS STRATEGIES AND PITCHING

Design of Marketing Strategies and Campaigns, Go-To-Market Strategy, Financial KPIs Financial Planning and Budgeting, Assessing Funding Alternatives, Pitching, Preparing Pitch Decks

UNIT V **3 Hours**

COMMERCIALIZATION

Implementation: Prototype to Commercialization, Test Markets, Institutional Support, Registration Process, IP Laws and Protection, Legal Requirements, Type of Ownership, Building and Managing Teams, Defining role of investors

EXPERIMENT 1 **1 Hours**

Analysis of various business sectors

EXPERIMENT 2 **2 Hours**

Developing a Design Thinking Output Chart

EXPERIMENT 3 **1 Hours**

Creating Buyer Personas

EXPERIMENT 4 **3 Hours**

Undertake Market Study to understand market needs and assess market potential

EXPERIMENT 5 **2 Hours**

Preparation of Business Model Canvas

EXPERIMENT 6 **15 Hours**

Developing Prototypes

EXPERIMENT 7 **2 Hours**

Organizing Product Design Sprints

EXPERIMENT 8 **2 Hours**

Preparation of Business Plans

EXPERIMENT 9 **2 Hours**

Preparation of Pitch Decks

Total: 45 Hours

Reference(s)

1. Rashmi Bansal, Connect the Dots, Westland and Tranquebar Press, 2012
2. Pavan Soni, Design Your Thinking: The Mindsets, Toolsets and Skill Sets for Creative Problem-solving, Penguin Random House India, 2020
3. Ronnie Screwvala, Dream with Your Eyes Open: An Entrepreneurial Journey, Rupa Publications, 2015
4. Stephen Carter, The Seed Tree: Money Management and Wealth Building Lessons for Teens, Seed Tree Group, 2021
5. Kotler Philip, Marketing Management, Pearson Education India, 15th Edition
6. Elizabeth Verkey and Jithin Saji Isaac, Intellectual Property, Eastern Book Company, 2nd Edition, 2021

22HS003 HERITAGE OF TAMILS **1 0 0 1**

Course Objectives

- Describe the linguistic diversity in India, highlighting Dravidian languages and their features
- Summarize the evolution of art, highlighting key transitions from rock art to modern sculptures
- Examine the role of sports and games in promoting cultural values and community bonding
- Discuss the education and literacy systems during the Sangam Age and their impact.
- Outline the importance of inscriptions, manuscripts, and the print history of Tamil books in preserving knowledge and culture

Programme Outcomes (POs)

PO9. Individual and Team Work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO10. 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. Integrate the concept of language families in India, with a focus on Dravidian languages.
2. Trace the evolution of art from ancient rock art to modern sculptures in Tamil heritage.
3. Evaluate and differentiate various forms of folk and martial arts in Tamil heritage.
4. Outline the concepts of Flora and Fauna in Tamil culture and literature.
5. Evaluate the contributions of Tamils to the Indian Freedom Struggle.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	−	−	−	−	−	−	−	−	2	3	−	−	−	−	−
2	−	−	−	−	−	−	−	−	2	3	−	−	−	−	−
3	−	−	−	−	−	−	−	−	2	3	−	−	−	−	−
4	−	−	−	−	−	−	−	−	2	3	−	−	−	−	−
5	−	−	−	−	−	−	−	−	2	3	−	−	−	−	−

UNIT I **3 Hours**

LANGUAGE AND LITERATURE

Language Families in India - Dravidian Languages - Tamil as a Classical Language- Classical Literature in Tamil- Secular Nature of Sangam Literature- Distributive Justice in Sangam Literature - Management Principles in Thirukural - Tamil Epics and Impact of Buddhism & Jainism in Tamil Land - Bakthi Literature Azhwars and Nayanmars - Forms of minor Poetry - Development of Modern literature in Tamil - Contribution of Bharathiyar and Bharathidhasan.

UNIT II **3 Hours**

HERITAGE - ROCK ART PAINTINGS TO MODERN ART- SCULPTURE

Hero stone to modern sculpture - Bronze icons - Tribes and their handicrafts - Art of temple car making - Massive Terracotta sculptures, Village deities, Thiruvalluvar Statue at Kanyakumari, Making of musical instruments - Mridhangam, Parai, Veenai, Yazh and Nadhaswaram - Role of Temples in Social and Economic Life of Tamils.

UNIT III **3 Hours**

FOLK AND MARTIAL ARTS

Therukoothu, Karagattam, Villu Pattu, Kaniyan Koothu, Oyillattam, Leatherpuppetry, Silambattam, Valari, Tiger dance - Sports and Games of Tamils.

UNIT IV **3 Hours**

THINAI CONCEPT OF TAMILS

Flora and Fauna of Tamils & Aham and Puram Concept from Tholkappiyam and Sangam Literature - Aram Concept of Tamils - Education and Literacy during Sangam Age - Ancient Cities and Ports of Sangam Age - Export and Import during Sangam Age - Overseas Conquest of Cholas.

UNIT V **3 Hours**

CONTRIBUTION OF TAMILS TO INDIAN NATIONAL MOVEMENT AND INDIAN CULTURE

Contribution of Tamils to Indian Freedom Struggle - The Cultural Influence of Tamils over the other parts of India - Self-Respect Movement - Role of Siddha Medicine in Indigenous Systems of Medicine - Inscriptions & Manuscripts - Print History of Tamil Books.

Total: 15 Hours

Reference(s)

1. Dr. K. K. Pillay, Social Life of Tamils, A joint publication of TNTB & ESC and RMRL.
2. Dr. S. Singaravelu, Social Life of the Tamils - The Classical Period, International Institute of Tamil Studies.
3. Dr. S. V. Subatamanian, Dr. K. D. Thirunavukkarasu, Historical Heritage of the Tamils, International Institute of Tamil Studies.
4. Dr. M. Valarmathi, The Contributions of the Tamils to Indian Culture, International Institute of Tamil Studies.
5. Keeladi, Sangam City Civilization on the banks of river Vaigai, Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu
6. Dr. K. K. Pillay, Studies in the History of India with Special Reference to Tamil Nadu.
7. Porunai Civilization, Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu
8. R.Balakrishnan, Journey of Civilization Indus to Vaigai, RMRL.

22HS003 - தமிழர் மரபு **1 0 0 1**

பாடத்திட்டத்தின் நோக்கம்

1. இந்திய மொழிக்குடும்பத்துள் திராவிட மொழிகள் தனித்து இயங்கும் தன்மையை அதன் சிறப்புகள் வழி அறிதல்.
2. தொன்றுதொட்டு தமிழர், கலையில் அடைந்த வளர்ச்சியை இயம்புதல்.
3. சங்ககால தமிழரின் கற்றல் திறத்தை இலக்கியங்கள் வழி ஆராய்தல்.

கற்றலின் விளைவு

1. இந்திய மொழிக்குடும்பத்துள் திராவிட மொழிகள் தனித்து இயங்கும் தன்மையை அதன் சிறப்புகள் வழி அறிதல்.
2. தொன்றுதொட்டு தமிழர், கலையில் அடைந்த வளர்ச்சியை இயம்புதல்.
3. சங்ககால தமிழரின் கற்றல் திறத்தை இலக்கியங்கள் வழி ஆராய்தல்.
4. தமிழ் மொழியின் சிறப்புகளை அதன் படைப்பிலக்கியங்கள் மூலம் அறிந்து கொள்ளுதல்.
5. கற்காலம் தொடங்கி, இக்காலம் வரை சிற்பக்கலை அடைந்த வளர்ச்சியை கண்டுகொள்ளல் .
6. தமிழர் தம் வாழ்வில் எங்கனம் இயற்கையை வணங்கி போற்றினர் என்பதை திணை கோட்பாட்டின் வழி தெளிதல்.
7. இந்திய விடுதலை போரில் தமிழர் ஆற்றிய பங்கினை தெரிந்து கொள்ளுதல்.

அலகு I மொழி மற்றும் இலக்கியம்: **3**

இந்திய மொழிக் குடும்பங்கள் – திராவிட மொழிகள் – தமிழ் ஒரு செம்மொழி – தமிழ் செவ்விலக்கியங்கள் - சங்க இலக்கியத்தின் சமயச் சார்பற்ற தன்மை – சங்க இலக்கியத்தில் பகிர்தல் அறம் – திருக்குறளில் மேலாண்மைக் கருத்துக்கள் – தமிழ்க் காப்பியங்கள், தமிழகத்தில் சமண பெளத்த சமயங்களின் தாக்கம் - பக்தி இலக்கியம், ஆழ்வார்கள் மற்றும் நாயன்மார்கள் – சிற்றிலக்கியங்கள் – தமிழில் நவீன இலக்கியத்தின் வளர்ச்சி – தமிழ் இலக்கிய வளர்ச்சியில் பாரதியார் மற்றும் பாரதிதாசன் ஆகியோரின் பங்களிப்பு.

அலகு II மரபு – பாறை ஓவியங்கள் முதல் நவீன ஓவியங்கள் வரை – சிற்பக் கலை: **3**

நடுகல் முதல் நவீன சிற்பங்கள் வரை – ஐம்பொன் சிலைகள்– பழங்குடியினர் மற்றும் அவர்கள் தயாரிக்கும் கைவினைப் பொருட்கள், பொம்மைகள் – தேர் செய்யும் கலை – சுடுமண் சிற்பங்கள் – நாட்டுப்புறத் தெய்வங்கள் – குமரிமுனையில் திருவள்ளுவர் சிலை – இசைக் கருவிகள் – மிருதங்கம், பறை, வீணை, யாழ், நாதஸ்வரம் – தமிழர்களின் சமூக பொருளாதார வாழ்வில் கோவில்களின் பங்கு.

அலகு III நாட்டுப்புறக் கலைகள் மற்றும் வீர விளையாட்டுகள்: 3

தெருக்கூத்து, கரகாட்டம், வில்லுப்பாட்டு, கணியான் கூத்து, ஒயிலாட்டம், தோல்பாவைக் கூத்து, சிலம்பாட்டம், வளரி, புலியாட்டம், தமிழர்களின் விளையாட்டுகள்.

அலகு IV தமிழர்களின் திணைக் கோட்பாடுகள்: 3

தமிழகத்தின் தாவரங்களும், விலங்குகளும் – தொல்காப்பியம் மற்றும் சங்க இலக்கியத்தில் அகம் மற்றும் புறக் கோட்பாடுகள் – தமிழர்கள் போற்றிய அறக்கோட்பாடு – சங்ககாலத்தில் தமிழகத்தில் எழுத்தறிவும், கல்வியும் – சங்ககால நகரங்களும் துறை முகங்களும் – சங்ககாலத்தில் ஏற்றுமதி மற்றும் இறக்குமதி – கடல்கடந்த நாடுகளில் சோழர்களின் வெற்றி.

அலகு V இந்திய தேசிய இயக்கம் மற்றும் இந்திய பண்பாட்டிற்குத் தமிழர்களின் பங்களிப்பு: 3

இந்திய விடுதலைப்போரில் தமிழர்களின் பங்கு – இந்தியாவின் பிறப்பகுதிகளில் தமிழ்ப் பண்பாட்டின் தாக்கம் – சுயமரியாதை இயக்கம் – இந்திய மருத்துவத்தில், சித்த மருத்துவத்தின் பங்கு – கல்வெட்டுகள், கையெழுத்துப்படிகள் - தமிழ்ப் புத்தகங்களின் அச்சு வரலாறு.

TOTAL : 15 PERIODS

TEXT-CUM-REFERENCE BOOKS

1. தமிழக வரலாறு – மக்களும் பண்பாடும் – கே.கே. பிள்ளை (வெளியீடு: தமிழ்நாடு பாடநூல் மற்றும் கல்வியியல் பணிகள் கழகம்).
2. கணினித் தமிழ் – முனைவர் இல. சுந்தரம். (விகடன் பிரசுரம்).
3. கீழடி – வைகை நதிக்கரையில் சங்ககால நகர நாகரிகம் (தொல்லியல் துறை வெளியீடு)
4. பொருநை – ஆற்றங்கரை நாகரிகம். (தொல்லியல் துறை வெளியீடு)
5. Social Life of Tamils (Dr.K.K.Pillay) A joint publication of TNTB & ESC and RMRL – (in print)
6. Social Life of the Tamils - The Classical Period (Dr.S.Singaravelu) (Published by: International Institute of Tamil Studies.
7. Historical Heritage of the Tamils (Dr.S.V.Subatamanian, Dr.K.D. Thirunavukkarasu) (Published by: International Institute of Tamil Studies).
8. The Contributions of the Tamils to Indian Culture (Dr.M.Valarmathi) (Published by: International Institute of Tamil Studies.)
9. Keeladi - 'Sangam City C ivilization on the banks of river Vaigai' (Jointly Published by: Department ofArchaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
10. Studies in the History of India with Special Reference to Tamil Nadu (Dr.K.K.Pillay) (Publishedby: The Author)
11. Porunai Civilization (Jointly Published by: Department of Archaeology & Tamil Nadu Text Bookand Educational Services Corporation, Tamil Nadu)
12. Journey of Civilization Indus to Vaigai (R.Balakrishnan) (Published by: RMRL) – Reference Book.

22MA201 ENGINEERING MATHEMATICS II 3 1 0 4

Course Objectives

- To impart and analyze the concepts of differential equations to describe in real-world phenomena
- To provide basic understanding on differential equation models and vector field models
- Summarize and apply the methodologies involved in framing the real world problems related to fundamental principles of complex functions

Program Outcomes (POs)

PO1. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. 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.
PSO1. Apply knowledge on foundation in Life Science, engineering, mathematics and current biomedical engineering practices with an ability to demonstrate advanced knowledge of a selected area within Biomedical Engineering.

Course Outcomes (COs)

1. Interpret the concept of differential equations through mathematical modeling and analyze its applications in engineering
2. Formulate the real world problems as second order linear differential equations and give solutions for the same
3. Demonstrate the real-world phenomena with magnitude and direction in the form of vector functions
4. Apply the concept of vector fields and line integrals through mathematical modeling in engineering
5. Determine complex functions and apply them to formulate problems arising in engineering

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	1	2	-	-	-	-	-	-	-	-	-	-	2	-	-
2	2	2	-	-	-	-	-	-	-	-	-	-	2	-	-
3	2	2	-	-	-	-	-	-	-	-	-	-	2	-	-
4	2	1	-	-	-	-	-	-	-	-	-	-	2	-	-
5	1	2	-	-	-	-	-	-	-	-	-	-	2	-	-

UNIT I 9 Hours

FIRST ORDER LINEAR DIFFERENTIAL EQUATIONS

Formation of differential equations- Solutions of first order linear ODE: Leibnitzs and method of separation of variables - Cooling/Heating of an object - A falling object - Modeling of electric circuits: RL and RC circuits - Modeling of population dynamics: Exponential growth and decay - Logistic growth model

UNIT II **9 Hours**

SECOND ORDER LINEAR DIFFERENTIAL EQUATIONS

Methods of solving second order linear ordinary differential equations - Models for linear oscillators: Simple harmonic motion - Mechanical vibrations with and without damping - Electric circuit system: RLC circuits

UNIT III **9 Hours**

VECTOR DIFFERENTIAL CALCULUS

Vector and scalar functions - Fields - Derivative of a vector function and geometrical interpretation - Velocity and acceleration - Gradient and its properties - Tangent and normal vectors - Directional derivative - Divergence of a vector field - Curl of a vector field - Projectile motion

UNIT IV **9 Hours**

VECTOR INTEGRAL CALCULUS

Line integrals of vector point functions - Surface integral of vector point functions - Applications of line and surface integrals - Greens theorem in a plane - Stokes theorem - Gauss divergence theorem

UNIT V **9 Hours**

COMPLEX FUNCTIONS

Basic concepts of Complex numbers Geometrical representation of complex number - Analytic functions and its properties - Construction of Analytic functions: Fluid flow Electric flow - Mapping of complex functions

Tutorial: 15 Hours
Total: 60 Hours

Reference(s)

1. Richard E. Williamson, Introduction to Differential Equations and Dynamical Systems, McGraw Hill Companies. Inc, 1997
2. Michael Greenberg, Advanced Engineering Mathematics, 2/e, Pearson, 2018
3. George B. Thomas, Maurice D. Weir and Joel Hass Thomas Calculus, 13/e, Pearson Publishers, 2013
4. Erwin Kreyszig, Advanced Engineering Mathematics Wiley, 10th editi5. J. Stewart, Essential Calculus, Cengage, 2nd edition, 2017on ,2015
5. J. Stewart, Essential Calculus, Cengage, 2nd edition, 2017

22PH202 ELECTROMAGNETISM AND MODERN PHYSICS

2 0 2 3

Course Objectives

- Understand the principles and mechanisms of electricity and magnetism
- Infer the classification of electromagnetic waves
- Analyze the theory of relativity and energy bands

Program Outcomes (POs)

PO1. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. 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.
PO3 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.
PO4 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.
PO9. Individual and Team Work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO12 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.
PSO1. Apply knowledge on foundation in Life Science, engineering, mathematics and current biomedical engineering practices with an ability to demonstrate advanced knowledge of a selected area within Biomedical Engineering.

Course Outcomes (COs)

1. Analyze the mechanisms of Coulomb's law and electric potential in various charge system
2. Analyze the magnetic properties of materials and their effects on external magnetic fields
3. Analyze the classification of electromagnetic waves based on frequency and wavelength
4. Outline the importance of theory of relativity and analyze the wave nature of particles
5. Apply the principles of electron and hole transport to study p-type and n-type semiconductors

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	2	1	1	-	-	-	-	2	-	-	1	1	-	-
2	3	2	1	2	-	-	-	-	2	-	-	1	1	-	-
3	3	2	2	1	-	-	-	-	2	-	-	1	1	-	-
4	3	2	2	1	-	-	-	-	2	-	-	1	1	-	-
5	3	2	2	1	-	-	-	-	2	-	-	1	1	-	-

UNIT I **6 Hours**

ELECTRICITY

Electric monopoles - Electric field - Electric flux - Electric potential - Electrical energy- Capacitor- Conductors and Insulators - Electric dipole and polarization - Electric current - Voltage sources - Resistance

UNIT II **6 Hours**

MAGNETISM

Sources of magnetism - Monopoles - Magnetic field and force - magnetic field and current distribution - Magnetic dipole - Magnetic potential energy - Inductor - Electric and magnetic field comparison

UNIT III **6 Hours**

ELECTROMAGNETIC WAVES AND LIGHT

Electromagnetism: Basic laws - Electromagnetic energy - radiation. Electromagnetic waves: Origin, nature and spectrum - Visible light. Principle of least time - Geometrical optics-Human eye - Diffraction - Interference - Polarization - LASER

UNIT IV **6 Hours**

MODERN PHYSICS

Special theory of relativity - Simultaneity and time dilation - Length contraction - Relativistic mass variation. Matter waves - De-Broglie hypothesis - Wave nature of particles

UNIT V **6 Hours**

ENERGY BANDS IN SOLIDS

Band theory of solids - Classification of materials - Semiconductors - Direct and indirect semiconductor - Fermi energy - Intrinsic and extrinsic semiconductor - Carrier concentration - Electrical conductivity

EXPERIMENT 1 **5 Hours**

Analysis of I-V characteristics of a solar cell for domestic applications

EXPERIMENT 2 **5 Hours**

Investigate the photonic behavior of laser source for photo copier device

EXPERIMENT 3 **5 Hours**

Implement the principle of stimulated emission of laser for grain size distribution in sediment samples

EXPERIMENT 4 **5 Hours**

Assess the variation of refractive index of glass and water for optical communication

EXPERIMENT 5 **5 Hours**

Evaluate the band gap energy of semiconducting materials for display device applications

EXPERIMENT 6 **5 Hours**

Determine the carrier concentration of charge carriers in semiconductors for automotive applications

Total: 60 Hours

Reference(s)

1. C J Fischer, The energy of Physics Part II: Electricity and Magnetism, Cognella Academic Publishing, 2019
2. P G Hewitt, Conceptual Physics, Pearson education, 2017
3. R A Serway and J W Jewitt, Physics for Scientists and Engineers, Thomson Brooks/Cole, 2019
4. J Walker, D Halliday and R Resnick, Principles of Physics, John Wiley and Sons, Inc, 2018
5. H C Verma, Concepts of Physics (Vol I & II), Bharathi Bhawan Publishers & Distributors, New Delhi, 2017

22CH203 ENGINEERING CHEMISTRY II 2 0 2 3

Course Objectives

- Understand the concept of electrochemistry for determination of electrode potential, pH and applications as energy storage devices
- Outline the chemistry of metal corrosion and analyze the methods of corrosion control
- Understand the role of catalyst in the rate of reaction
- Summarize the variation in properties and reactivity of isotopes.

Program Outcomes (POs)

PO1. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. 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.
PO7. 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. Apply the electrochemical concepts to determine the electrode potential of a metal
2. Analyze the working of batteries for the energy storage devices
3. Analyze the specific operating conditions under which corrosion occurs and suggest a method to control corrosion.
4. Analyze the reaction mechanisms and assess the role of catalyst in a chemical reaction
5. Analyze various types of nuclear transmutation including decay reactions

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	1	-	-	-	-	-	-	-	-	-	-	-	-	-
2	2	1	-	-	-	-	-	-	-	-	-	-	-	-	-
3	2	1	-	-	-	-	1	-	-	-	-	-	-	-	-
4	2	1	-	-	-	-	-	-	-	-	-	-	-	-	-
5	2	1	-	-	-	-	-	-	-	-	-	-	-	-	-

UNIT I **6 Hours**

ELECTROCHEMISTRY

Origin of potential - Electromotive force - Electrical double layer - Transport of charge within the cell - Cell description - Prediction of cell potentials

UNIT II **6 Hours**

ENERGY STORING DEVICES

Relation between electrical energy and energy content of a cell - Reversible and irreversible cell - Charging and discharging reactions in a reversible cell - Current challenges in energy storage technologies

UNIT III **6 Hours**

METAL CORROSION AND ITS PREVENTION

Oxidation of metals: Electrochemical origin of corrosion - Electromigration - Electron transfer in the presence and absence of moisture - Galvanic series. Strategies for corrosion control: Galvanic anode and impressed current.

UNIT IV **6 Hours**

CATALYSIS

Energy profile diagram for a chemical reaction - activation energy - role of catalyst - homogeneous and heterogeneous catalysis - types

UNIT V **6 Hours**

NUCLEAR REACTIONS

Radioactive and stable isotopes - Variation in properties between isotopes - Radioactive decay (alpha, beta and gamma) - Half-life period - Nuclear reactions - Radiocarbon dating

EXPERIMENT 1 **4 Hours**

Measure industrial effluent water pH and assess water quality against allowed standards

EXPERIMENT 2 **4 Hours**

Iron (Fe^{2+}) in Bhavani River water: Potentiometric Analysis & Pollution Assessment (CPCB Standards)

EXPERIMENT 3 **4 Hours**

Construct a Zn-Cu electrochemical cell and validate the output by connecting the LED light

EXPERIMENT 4 **5 Hours**

Evaluate the corrosion percentage in concrete TMT bars

EXPERIMENT 5 **4 Hours**

Determination of the percentage of corrosion inhibition in plain-carbon steel using natural inhibitors

EXPERIMENT 6 **4 Hours**

Electroplating of copper metal on iron vessels for domestic application

EXPERIMENT 7 **5 Hours**

Determination of acid-catalyzed hydrolysis kinetics in locally sourced fruit extracts

Total: 60 Hours

Reference(s)

1. U. Hanefeld, L. Lefferts, Catalysis: An Integrated Textbook for Students, 2nd Edition, Wiley-VCH, 2017.
2. S. Vairam, Engineering Chemistry, 1st Edition, John Wiley & Sons, 2014.
3. Jain and Jain, Engineering Chemistry, 16th Edition, Dhanpat Rai Publishing Company, New Delhi, 2013.
4. P.H. Rieger, Electrochemistry, Second Edition (Reprint), Springer, Netherland, 2012.
5. H.J. Arnikar, Essentials of Nuclear Chemistry, 4th Edition (revised), New Age International Publishers, 2011.
6. E. McCafferty, Introduction to Corrosion Science, 1st Edition, Springer, 2010.

22GE002 COMPUTATIONAL PROBLEM SOLVING 3 0 0 3

Course Objectives

- Analyze the algorithm design techniques and development principles in solving the real life problems.
- Illustrate the different ways of organizing and storing the data in computing systems.
- Understand the basic network configuration and setup connections among different device systems.

Program Outcomes (POs)

PO1. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. 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.
PO3. 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.
PO4. Conduct Investigations of Complex Problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

Course Outcomes (COs)

1. Analyze a problem and formulate algorithms, pseudocodes and flowcharts.
2. Develop algorithmic solutions to simple computational problems and explore algorithmic approaches to problem solving.
3. Design and apply appropriate data structures for solving computing problems.
4. Compare the various storage devices used in a computer system.
5. Analyze the requirements for a given organizational structure and establish the connection between two or more computers to form a network.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	1	1	2	-	-	-	-	-	-	-	-	-	-	-
2	3	3	3	3	-	-	-	-	-	-	-	-	-	-	-
3	2	2	2	3	-	-	-	-	-	-	-	-	-	-	-
4	2	2	2	2	-	-	-	-	-	-	-	-	-	-	-
5	2	2	2	2	-	-	-	-	-	-	-	-	-	-	-

UNIT I **6 Hours**

VISUAL PROCESS MODELING

Scenario decomposition - Logical sequencing - Drawing flowchart - Preparation of visual process model.

UNIT II **12 Hours**

ALGORITHMIC DESIGN THINKING

Analysis - Verification - Brute force - Divide and conquer - Greedy - Backtracking.

UNIT III **12 Hours**

DATA ORGANIZATION

Elementary Data Organization - Abstract Data Types - Fundamentals of Linear and Non Linear Data Structures.

UNIT IV **7 Hours**

DATA STORAGE

Flat File and Relational database - Data Read & Write in Local Storage, Server Storage and Cloud storage - Database Query Methods.

UNIT V **8 Hours**

NETWORKING ESSENTIALS

Networking Components and Services - IP Addressing - Configuring and Managing the Campus Network - Network Security - Firewalls.

Total: 45 Hours

Reference(s)

1. David D. Riley, Kennya. Hunt, "Computational thinking for the modern problem Solver", CRC Press Taylor & Francis Group, 2014.
2. Anany Levitin, "Introduction to the Design and Analysis of Algorithms", Third Edition, Pearson Education Asia, 2011.
3. Mark Allen Weiss, "Data Structures and Algorithm Analysis in C", 2nd Edition, Pearson Education,2016.
4. Abraham Silberschatz, Henry F. Korth and S. Sudarshan, "Database System Concepts", McGraw Hill, 2015.
5. Behrouz A.Forouzan, "Data Communication and Networking", 5th Edition, Tata McGraw-Hill, 2014.

22GE004 BASICS OF ELECTRONICS ENGINEERING 2 0 2 3

Course Objectives

- To Understand the concept of energy transmission through mechanical, electrical and electromagnetic form.
- To Analyze the use of PN Junction Diode and BJT for signal conditioning.
- To apply the working principle of PN Junction Diode and BJT for the design of basic Digital Logic.
- To analyze the working and characteristics of Special Purpose Semiconductor Electronic Devices.

Program Outcomes (POs)

PO1. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. 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.
PO3. 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.
PO4. 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.
PSO1. Apply knowledge on foundation in Life Science, engineering, mathematics and current biomedical engineering practices with an ability to demonstrate advanced knowledge of a selected area within Biomedical Engineering.
PSO2. Critically analyse the current healthcare systems and develop innovative solutions effectively through problem specific design and development using modern hardware and software tools.
PSO3. Hands-on knowledge on cutting edge hardware and software tools to acquire real time data, model and simulate physiological processes and analyse limitations on real time implementations.

Course Outcomes (COs)

1. Interpret the need for electrical and electromagnetic signal transmission.
2. Analyze the working principle and characteristics of PN junction diode.
3. Analyze the working principle and characteristics of Bipolar Junction Transistor.
4. Apply the working principle of PN Junction diode and BJT for designing basic Digital Logic functions.
5. Analyze the energy conversion needs and working principle of Special purpose electronic devices.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	3	3	1	-	-	-	-	-	-	-	-	1	-	-
2	3	3	3	2	-	-	-	-	-	-	-	-	1	-	-
3	3	3	3	2	-	-	-	-	-	-	-	-	1	-	-
4	3	3	3	2	-	-	-	-	-	-	-	-	1	2	2
5	3	3	3	1	-	-	-	-	-	-	-	-	1	2	2

UNIT I **6 Hours**

ENERGY TRANSFER AND SIGNALS

Energy Transmission through Mechanical, Electrical and Electromagnetic means, Signal as Energy Transmission, Complexity in signal transmission (Volume of Information, Distance and Time taken), Limitations of Mechanical Energy Transmission, Electrical and Electromagnetic Signal Transmission, Need for Conversion between Electrical and Mechanical Signals.

UNIT II **8 Hours**

SIGNAL CONDITIONING USING DIODE

Need for Vacuum Tubes in the Evolution of Electronics, Overview of Vacuum Tubes, Diode and Triode, Limitations of Vacuum Tubes. Semiconductor Group in Periodic Table, Overview of Semiconductor Materials, Flow of electrical energy through PN Junction Diode, Signal Clipping, Signal Clamping and Signal Multiplication using PN Junction Diode, Limitations of PN Junction Diode.

UNIT III **6 Hours**

SIGNAL CONDITIONING USING TRANSISTOR

Need for controlling electrical signals, Principle of Bipolar Junction Transistor operation, Signal Switching and Amplification using BJT, Limitations of BJT, Principle of Field Effect Transistor operation.

UNIT IV **6 Hours**

LOGIC SYNTHESIS USING DIODE AND TRANSISTORS

Overview of Logic Gates, PN Junction and BJT as electronic switches, Digital Logic Synthesis using Diode and Transistor: Diode Logic, Resistor Transistor Logic, Diode Transistor Logic, Transistor Logic.

UNIT V **4 Hours**

DEVICES FOR SPECIAL REQUIREMENTS

Voltage Regulation using Zener Diode, Variable Capacitance using Varactor Diode, Electrical Energy to Light Energy conversion using Light Emitting Diode, Light to Energy to Electrical Energy conversion using Solar Cell.

EXPERIMENT 1 **6 Hours**

Design a voltage multiplier to convert the low voltage from the mains power supply to the high voltage to operate the microwave oven.

EXPERIMENT 2 **6 Hours**

Design and construct regulated DC power supply for Mobile phone charger

EXPERIMENT 3 **6 Hours**

Design and construct an audio amplifier circuit to play the mobile music in a huge speaker.

EXPERIMENT 4 **6 Hours**

Design and construct Switching circuit for the Pump to control over flow and drain condition for overhead tank using PN junction diode.

EXPERIMENT 5 **6 Hours**

Design and construct BJT based circuit to implement two way connection for stair case light application.

Total: 60 Hours

Reference(s)

1. Thomas L. Floyd, Electronic Devices: Electron Flow Version, Ninth Edition, Prentice Hall, 2012.
2. J Millman, C. Halkias & Satyabrata JIT, Electronic Devices and Circuits, Tata McGraw-Hill, 2007.
3. L Robert Boylestead, Louis Nashelsky, Electronic Devices and Circuit Theory, Pearson Education 2006.
4. David A. Bell, Electronic Devices and Circuits, Prentice Hall of India, 2003.
5. Adel S. Sedra & Kenneth C. Smith, Micro Electronic Circuits Theory and Applications, Sixth Edition, Oxford University Press, 2013.
6. Behzad Razavi, Microelectronics, Wiley India Pvt. Ltd.; 2nd edition (2018)

22GE005 ENGINEERING DRAWING 1 0 2 2

Course Objectives

- To provide knowledge on fundamentals of engineering drawings and conic sections.
- To impart skill on orthographic projections of points and lines.
- To familiarize on projection of planes and simple solids.
- To provide knowledge on section of solids and development of surfaces of simple solids.
- To impart skill on conversion of isometric view to orthographic projection and vice versa.

Program Outcomes (POs)

PO1. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO8. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO10. 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.
PO12. 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. Outline the engineering drawing concepts as per industrial standards.
2. Construct orthographic projections of points and lines.
3. Draw the projection of planes and simple solids.
4. Draw the section of solids and development of surfaces.
5. Draw the orthographic projection from isometric view and vice versa.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	-	-	-	-	-	-	2	-	2	-	-	-	-	-
2	2	-	-	-	-	-	-	2	-	2	-	-	-	-	-
3	1	-	-	-	-	-	-	2	-	2	-	-	-	-	-
4	1	-	-	-	-	-	-	2	-	2	-	-	-	-	-
5	1	-	-	-	-	-	-	2	-	2	-	-	-	-	-

UNIT I **7 Hours**

FUNDAMENTALS OF ENGINEERING DRAWING

Definition - standards - drawing tools - drawing sheets - scales - line and its types. Practices on lettering - numbering - dimension of drawings. Construction of conic sections - ellipse - parabola and hyperbola using eccentricity method.

UNIT II **9 Hours**

PROJECTION OF POINTS AND LINES

Principles of projection - projection of points in four quadrants - first angle projection of straight lines - perpendicular to one plane - parallel and inclined to both planes.

UNIT III **9 Hours**

PROJECTION OF PLANES AND SOLIDS

Projection of simple planes and projection of simple solids - parallel - perpendicular and inclined to one plane using change of position method - inclined to both the planes

UNIT IV **9 Hours**

SECTION OF SOLIDS AND DEVELOPMENT OF SURFACES

Section of Solids - simple position with cutting plane parallel - perpendicular and inclined to one plane with true shape of section. Development of surfaces - simple and truncated solids.

UNIT V **11 Hours**

ORTHOGRAPHIC PROJECTIONS AND ISOMETRIC VIEW

Orthographic projections and isometric view of components used in engineering applications.

Total: 45 Hours

Reference(s)

1. N. D. Bhatt and V. M. Panchal, Engineering Drawing, Charotar Publishing House Pvt. Limited, 2019.
2. K.V. Natarajan, A Text Book of Engineering Graphics, Dhanalakshmi Publishers, 2013.
3. K Venugopal, Engineering Drawing and Graphics, Sixth edition, New Age International, 2013.
4. Basant Agarwal, Mechanical drawing, Tata McGraw-Hill Education, 2013.
5. Engineering Drawing Practice for Schools & Colleges, Bureau of Indian Standards - Sp46, 2013.

22HS006 TAMILS AND TECHNOLOGY 1 0 0 1

Course Objectives

- Analyse graffiti on potteries as a form of historical and cultural documentation during the Sangam Age.
- Investigate the building materials and the historical context of Hero stones during the Sangam Age by Analysing the details of stage constructions in Silappathikaram and their cultural significance.
- Examine ancient knowledge of oceans and its impact on Tamil society.

Programme Outcomes (POs)

PO9. Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO10.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. Outline the significance of the weaving industry during the Sangam Age and its cultural importance.
2. Outline the significance of dams, tanks, ponds, and sluices in the agricultural and irrigation practices of the Chola Period.
3. Explore the architectural designs and structural construction methods used in household materials during the Sangam Age.
4. Explore the art of shipbuilding in ancient Tamil culture and its role in maritime trade and transportation.
5. Trace the development of scientific terminology and vocabulary in Tamil language.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	-	-	-	-	-	-	-	-	2	3	-	-	-	-	-
2	-	-	-	-	-	-	-	-	2	3	-	-	-	-	-
3	-	-	-	-	-	-	-	-	2	3	-	-	-	-	-
4	-	-	-	-	-	-	-	-	2	3	-	-	-	-	-
5	-	-	-	-	-	-	-	-	2	3	-	-	-	-	-

UNIT I **3 Hours**

WEAVING AND CERAMIC TECHNOLOGY

Weaving Industry during Sangam Age - Ceramic technology - Black and Red Ware Potteries (BRW) - Graffiti on Potteries.

UNIT II **3 Hours**

DESIGN AND CONSTRUCTION TECHNOLOGY

Designing and Structural construction House and designs in household materials during Sangam Age - Building materials and Hero stones of Sangam age - Details of Stage Constructions in Silappathikaram - Sculptures and Temples of Mamallapuram - Great Temples of Cholas and other worship places - Temples of Nayaka Period - Type study (Madurai Meenakshi Temple) - Thirumalai Nayakar Mahal - Chetti Nadu Houses, Indo - Saracenic architecture at Madras during British Period

UNIT III **3 Hours**

MANUFACTURING TECHNOLOGY

Art of Ship Building-Metallurgical studies-Iron industry-Iron smelting,steel-Copper and gold-Coins as source of history-Minting of Coins-Beads making-industries Stone beads -Glass beads-Terracotta beads-Shell beads-bone beats-Archeological evidences-Gem stone types described in Silappathikaram.

UNIT IV **3 Hours**

AGRICULTURE AND IRRIGATION TECHNOLOGY

Dam, Tank, ponds, Sluice, Significance of Kumizhi Thoompu of Chola Period, Animal Husbandry-Wells designed for cattle use- Agriculture and Agro Processing-Knowledge of Sea-Fisheries-Pearl-Conche diving-Ancient Knowledge of Ocean-Knowledge Specific Society.

UNIT V **3 Hours**

SCIENTIFIC TAMIL

Development of Scientific Tamil-Tamil computing-Digitalization of Tamil Books-Development of Tamil Software-Tamil Virtual Academy-Tamil Digital Library-Online Tamil Dictionaries-Sorkuvai Project.

Total: 15 Hours

Reference(s)

1. Dr. K. K. Pillay , Social Life of Tamils, A joint publication of TNTB & ESC and RMRL
2. Dr. S. Singaravelu, Social Life of the Tamils - The Classical Period, International Institute of Tamil Studies.
3. Dr. S. V. Subatamanian , Dr.K.D. Thirunavukkarasu, Historical Heritage of the Tamils, International Institute of Tamil Studies.
4. Dr. M. Valarmathi, The Contributions of the Tamils to Indian Culture, International Institute of Tamil Studies
5. Keeladi - Sangam City Civilization on the banks of river Vaigai, Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu
6. Dr. K. K. Pillay, Studies in the History of India with Special Reference to Tamil Nadu.
7. Porunai Civilization, Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu
8. R.Balakrishnan , Journey of Civilization Indus to Vaigai, RMRL

22HS006 - தமிழரும் தொழில்நுட்பமும் 1 0 0 1

பாடத்திட்டத்தின் நோக்கம்

1. சங்க காலத்தில் வரலாறு மற்றும் கலாச்சார ஆவணங்களின் ஒரு வடிவமாக, மட்பாண்டங்கள் மீதான கிராஃபிட்டியை பகுப்பாய்வு செய்தல்.
2. சிலப்பதிகாரத்தில் கட்டப்பட்ட மேடை கட்டுமானங்களின் விவரங்களையும் அவற்றின் கலாச்சார முக்கியத்துவத்தையும் பகுப்பாய்வு செய்வதன் மூலம், சங்க காலத்தில் மாவீரர் கற்களின் கட்டுமானப் பொருட்கள் மற்றும் வரலாற்று சூழலை ஆராய்தல்.
3. சமுத்திரங்கள் பற்றிய பண்டைய அறிவையும், தமிழ் சமூகத்தில் அதன் தாக்கத்தையும் ஆராய்வது ஆகியவை இப்பாடத்திட்டத்தின் நோக்கம் ஆகும்.

கற்றலின் விளைவு

1. சங்க காலத்தில் நெசவுத் தொழிலின் முக்கியத்துவத்தையும் அதன் கலாச்சார முக்கியத்துவத்தையும் புரிந்து கொள்ளல்.
2. சோழர் கால விவசாய மற்றும் நீர்ப்பாசன நடைமுறைகளில் அணைகள், குளங்கள் மற்றும் மதகுகளின் முக்கியத்துவத்தைப் புரிந்து கொள்ளல்.
3. சங்க காலத்தில் வீட்டுப் பொருட்களில் பயன்படுத்தப்பட்ட கட்டடக்கலை வடிவமைப்புகள் மற்றும் கட்டமைப்பு கட்டுமான முறைகளை ஆராய்தல்.
4. பண்டைய தமிழ் கலாச்சாரத்தில், கப்பல் கட்டும் கலை, கடல் வர்த்தகம் மற்றும் போக்குவரத்தில் அதன் பங்கை ஆராய்தல்.
5. தமிழ் மொழியில் அறிவியல் சொற்களஞ்சியம் மற்றும் சொல்லகராதியின் வளர்ச்சியைக் கண்டறிதல்.

அலகு I நெசவு மற்றும் பானைத் தொழில்நுட்பம்: 3

சங்க காலத்தில் நெசவுத் தொழில் – பானைத் தொழில்நுட்பம் - கருப்பு சிவப்பு பாண்டங்கள் – பாண்டங்களில் கீறல் குறியீடுகள்.

அலகு II வடிவமைப்பு மற்றும் கட்டிடத் தொழில்நுட்பம்: 3

சங்க காலத்தில் வடிவமைப்பு மற்றும் கட்டுமானங்கள் & சங்க காலத்தில் வீட்டுப் பொருட்களில் வடிவமைப்பு- சங்க காலத்தில் கட்டுமான பொருட்களும் நடுகல்லும் – சிலப்பதிகாரத்தில் மேடை அமைப்பு பற்றிய விவரங்கள் - மாமல்லபுரச் சிற்பங்களும், கோவில்களும் – சோழர் காலத்துப் பெருங்கோயில்கள் மற்றும் பிற வழிபாட்டுத் தலங்கள் – நாயக்கர் காலக் கோயில்கள் - மாதிரி கட்டமைப்புகள் பற்றி அறிதல், மதுரை மீனாட்சி அம்மன் ஆலயம் மற்றும் திருமலை நாயக்கர் மஹால் – செட்டிநாட்டு வீடுகள் – பிரிட்டிஷ் காலத்தில் சென்னையில் இந்தோ-சாரோசெனிக் கட்டிடக் கலை.

அலகு III **உற்பத்தித் தொழில் நுட்பம்**: **3**

கப்பல் கட்டும் கலை – உலோகவியல் – இரும்புத் தொழிற்சாலை – இரும்பை உருக்குதல், எஃகு – வரலாற்றுச் சான்றுகளாக செம்பு மற்றும் தங்க நாணயங்கள் – நாணயங்கள் அச்சடித்தல் – மணி உருவாக்கும் தொழிற்சாலைகள் – கல்மணிகள், கண்ணாடி மணிகள் – சுடுமண் மணிகள் – சங்கு மணிகள் – எலும்புத்துண்டுகள் – தொல்லியல் சான்றுகள் – சிலப்பதிகாரத்தில் மணிகளின் வகைகள்.

அலகு IV **வேளாண்மை மற்றும் நீர்ப்பாசனத் தொழில் நுட்பம்**: **3**

அணை, ஏரி, குளங்கள், மதகு – சோழர்காலக் குமுழித் தூம்பின் முக்கியத்துவம் – கால்நடை பராமரிப்பு – கால்நடைகளுக்காக வடிவமைக்கப்பட்ட கிணறுகள் – வேளாண்மை மற்றும் வேளாண்மைச் சார்ந்த செயல்பாடுகள் – கடல்சார் அறிவு – மீன்வளம் – முத்து மற்றும் முத்துக்குளித்தல் – பெருங்கடல் குறித்த பண்டைய அறிவு – அறிவுசார் சமூகம்.

அலகு V **அறிவியல் தமிழ் மற்றும் கணித்தமிழ்**: **3**

அறிவியல் தமிழின் வளர்ச்சி –கணித்தமிழ் வளர்ச்சி - தமிழ் நூல்களை மின்பதிப்பு செய்தல் – தமிழ் மென்பொருட்கள் உருவாக்கம் – தமிழ் இணையக் கல்விக்கழகம் – தமிழ் மின் நூலகம் – இணையத்தில் தமிழ் அகராதிகள் – சொற்குவைத் திட்டம்.

TOTAL : 15 PERIODS

1. தமிழக வரலாறு – மக்களும் பண்பாடும் – கே.கே. பிள்ளை (வெளியீடு: தமிழ்நாடு பாடநூல் மற்றும் கல்வியியல் பணிகள் கழகம்).
2. கணினித் தமிழ் – முனைவர் இல. சுந்தரம். (விகடன் பிரசுரம்).
3. கீழடி – வைகை நதிக்கரையில் சங்ககால நகர நாகரிகம் (தொல்லியல் துறை வெளியீடு)
4. பொருநை – ஆற்றங்கரை நாகரிகம். (தொல்லியல் துறை வெளியீடு)
5. Social Life of Tamils (Dr.K.K.Pillay) A joint publication of TNTB & ESC and RMRL – (in print)
6. Social Life of the Tamils - The Classical Period (Dr.S.Singaravelu) (Published by: International Institute of Tamil Studies.
7. Historical Heritage of the Tamils (Dr.S.V.Subatamanian, Dr.K.D. Thirunavukkarasu) (Published by: International Institute of Tamil Studies).
8. The Contributions of the Tamils to Indian Culture (Dr.M.Valarmathi) (Published by: International Institute of Tamil Studies.)
9. Keeladi - 'Sangam City C ivilization on the banks of river Vaigai' (Jointly Published by: Department ofArchaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
10. Studies in the History of India with Special Reference to Tamil Nadu (Dr.K.K.Pillay) (Published by: The Author)
11. Porunai Civilization (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
12. Journey of Civilization Indus to Vaigai (R.Balakrishnan) (Published by: RMRL) – Reference Book.

22BM301 TRANSFORMS AND PARTIAL DIFFERENTIAL EQUATIONS

3 1 0 4

Course Objectives

- Understand the concepts of Fourier series, Transforms and formation of partial differential equations, 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
- 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

Program Outcomes (POs)

PO1 Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems
PO2 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
PSO1 Apply knowledge on foundation in Life Science, engineering, mathematics and current biomedical engineering practices with an ability to demonstrate advanced knowledge of a selected area within Biomedical Engineering.

Course Outcomes (COs)

1. Analyze the periodicity of a function and formulate the same as a combination of sine and cosine using Fourier series.
2. Apply Fourier transform to convert the function in time domain into a sum of sine waves of different frequencies, each of which represents a frequency component.
3. Demonstrate the function in frequency domain whenever the function is defined in time domain through Laplace transforms.
4. Apply the Z-transform to convert a discrete-time signal, which is a sequence of real or complex numbers, into a complex frequency domain representation.
5. Exemplify the concepts of partial differential equations and able to apply them to solve real scenarios.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	2	-	-	-	-	-	-	-	-	-	-	1	-	-
2	2	2	-	-	-	-	-	-	-	-	-	-	1	-	-
3	2	2	-	-	-	-	-	-	-	-	-	-	1	-	-
4	2	2	-	-	-	-	-	-	-	-	-	-	1	-	-
5	2	2	-	-	-	-	-	-	-	-	-	-	1	-	-

UNIT I **9 Hours**

FOURIER SERIES

Introduction-Periodic functions - Dirichlets conditions - General Fourier series - Odd and even functions - Parsevals Identity-Root mean square value- Harmonic analysis

UNIT II **9 Hours**

FOURIER TRANSFORM

Fourier integral theorem- Fourier transform and inverse Fourier transform- Sine and cosine transforms- Properties - Transforms of simple functions = Convolution theorem - Parsevals identity

UNIT III **9 Hours**

LAPLACE TRANSFORM

Laplace transform: Existence of Laplace transform- Properties of Laplace Transform-Laplace transform of periodic function- Inverse Laplace transform: Properties of inverse Laplace Transform-Partial fraction method - Convolution- Application of Laplace transform to solve ordinary differential equations with constant coefficients.

UNIT IV **9 Hours**

Z TRANSFORM

Z-Transform - Properties - Inverse Z-transform - Convolution method- Partial fraction method - Solution of difference equations using Z-transform.

UNIT V **9 Hours**

APPLICATIONS OF PARTIAL DIFFERENTIAL EQUATIONS

Formation of partial differential equations by elimination of arbitrary constants and arbitrary functions- Solution of standard types of first order partial differential equations (clairauts form, Lagrange linear equation) - Linear partial differential equations of second order with constant coefficients.

Total: 45+15=60 Hours

Reference(s)

1. Erwin Kreyszig, Advanced Engineering Mathematics, Tenth Edition, Wiley India Private Limited, New Delhi, 2016.
2. Peter V O Neil., Advanced Engineering Mathematics, 7th Edition, TBH Publishers, 2013.
3. James Glyn, Advanced Modern Engineering Mathematics, Pearson, 3rd edition 2014.
4. Michael D Greenberg., Advanced Engineering Mathematics, Pearson Education, 2nd Edition 2002.
5. B. S. Grewal, Higher Engineering Mathematics, Forty third Edition, Khanna Publications, New Delhi 2015.

22BM302 CIRCUIT ANALYSIS **3 1 0 4**

Course Objectives

- To apply basic laws in Circuits and to calculate the voltages and current in a circuit using basic theorems.
- To apply the concept of transients and resonance in series and parallel circuit
- To develop two port networks and analysis different types of two port networks

Program Outcomes (POs)

PO1 Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems
PO2 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
PO5 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.
PSO1 Apply knowledge on foundation in Life Science, engineering, mathematics and current biomedical engineering practices with an ability to demonstrate advanced knowledge of a selected area within Biomedical Engineering.

Course Outcomes (COs)

1. Apply Voltage-Current laws and transformation techniques to solve linear electric circuits and analyse the phase relationships of circuits with RLC components
2. Determine the electrical parameters of the circuits by using network theorems
3. Analyse the steady state and transient response of RLC circuit using Laplace transform
4. Analyse the frequency response of an electric circuit
5. Determine driving point and transfer function of two port network and classify different two port network

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	2	-	-	1	-	-	-	-	-	-	-	1	-	-
2	3	2	-	-	-	-	-	-	-	-	-	-	1	-	-
3	3	2	-	-	-	-	-	-	-	-	-	-	1	-	-
4	2	3	-	-	-	-	-	-	-	-	-	-	1	-	-
5	2	3	-	-	-	-	-	-	-	-	-	-	1	-	-

UNIT I **10 Hours**

CIRCUIT LAWS AND ANALYSIS TECHNIQUES

Basic electrical components, Voltage - current laws, Divider theorem, Short and Open Circuits, Phase relationship for R, L and C, Impedance and Admittance for R, L and C, Mesh and Nodal Analysis for AC and DC circuits, Source transformation techniques, Star delta transformation techniques.

UNIT II **9 Hours**

NETWORK THEOREMS FOR DC AND AC CIRCUITS

Superposition theorem - Thevenin"s theorem - Norton"s theorem - Maximum power transfer theorem - Reciprocity theorem.

UNIT III **8 Hours**

STEADY STATE AND TRANSIENT ANALYSIS OF AC AND DC CIRCUITS

Steady state and Transient analysis of RL, RC, and RLC circuits using Laplace Transform for both AC and DC input.

UNIT IV **9 Hours**

RESONANCE AND MAGNETICALLY COUPLED CIRCUITS

Resonance: Natural frequency and Damping Ratio - Series Resonance - Parallel Resonance - Quality Factor. Coupled Circuits: Self-inductance- Mutual inductance - Dot conversion - Ideal Transformer.

UNIT V **9 Hours**

LINEAR TWO PORT NETWORK PARAMETERS

Driving point and transfer function of two port network, Z, Y, T, inverse T, Hybrid, Inverse Hybrid Parameters and its conversion.

Tutorial: 15 Hours
Total: 60 Hours

Reference(s)

1. William Hayt, J V Jack, E Kemmerly and Steven M Durbin, Engineering Circuits Analysis, Tata McGraw-Hill, 2013.
2. Joseph Edminister and Mahmood Nahri, Theory and Problems of Electric Circuits Tata McGraw Hill, 2008.
3. A Sudhakar, S Shyammohan and Palli, Circuits and Network (Analysis and synthesis) Tata McGraw-Hill, 2010.
4. L Robert Boylested, Experiments in Circuit Analysis to Accompany Introductory Circuit Analysis, PHI, 2002.
5. M. Russell, Mersereau and Joel R. Jackson, Circuit Analysis- A System Approach, Pearson Education, 2009.
6. Steven T. Karris, Circuit Analysis I with MATLAB Applications, Orchard Publications, 2004

22BM303 HUMAN ANATOMY AND PHYSIOLOGY 3 0 2 4

Course Objectives

- To identify all the organelles of an animal cell and their function
- To understand structure and functions of the various types of systems of human body
- To demonstrate their knowledge of importance of anatomical features and physiology of human systems

Program Outcomes (POs)

PO1 Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems
PO2 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
PO4 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.
PO5 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. Represent the structure and function of cells and tissues.
2. Outline Skeletal, Muscular and Respiratory systems and their importance.
3. Interpret the working of Cardiovascular and Lymphatic systems.
4. Analyze the functions of Nervous, Endocrine and Special sensory systems.
5. Analyze the functions of various components of the digestive system and evaluate the role of the urinary system in maintaining homeostasis.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	-	-	-	2	-	-	-	-	-	-	-	-	-	-
2	2	-	-	-	2	-	-	-	-	-	-	-	-	-	-
3	3	-	-	1	2	-	-	-	-	-	-	-	-	-	-
4	3	2	-	1	2	-	-	-	-	-	-	-	-	-	-
5	3	2	-	1	2	-	-	-	-	-	-	-	-	-	-

UNIT I **9 Hours**

BASIC ELEMENTS OF HUMAN BODY

Cell: Structure and organelles - Functions of each component in the cell. Cell membrane - transport across cell membrane - origin of cell membrane potential - Action potential - Cell to cell signalling- Cell Division. Tissue Types - Specialized tissues - functions.

UNIT II **9 Hours**

SKELETAL, MUSCULAR AND RESPIRATORY SYSTEMS

Skeletal: Bone types and functions - Joint-Types of Cartilage and functions. Muscular: Parts of Muscle-Movements. Respiratory: Components of respiratory system-Respiratory Mechanism. Types of respiration - Oxygen and carbon dioxide transport and acid base regulation.

UNIT III **9 Hours**

CARDIOVASCULAR AND LYMPHATIC SYSTEM

Cardiovascular: Blood composition - functions of blood - functions of RBC. WBC types and their functions. Blood groups - Importance of blood groups - Identification of blood groups. Structure of heart - Conducting system of heart - Properties of Cardiac muscle - Cardiac cycle - Types of Blood Vessel - ECG - Heart sound - Volume and pressure changes and regulation of heart rate - Coronary Circulation. Factors regulating Blood flow. Lymphatic: Parts and Functions of Lymphatic systems - Types of Lymphatic organs and vessels.

UNIT IV **9 Hours**

NERVOUS, ENDOCRINE AND SPECIAL SENSORY SYSTEMS

Nervous: Structure of Neuron - Types of Neurons. Synapses and types. Condition of action potential in neuron. Brain - Divisions of brain lobes - Cortical localizations and functions - EEG. Spinal cord - Tracts of spinal cord - Reflex mechanism - Types of reflex. Autonomic nervous system and its functions. Endocrine - Pituitary and thyroid gland. Special sensory: Optics of Eye - Retina - Photochemistry of Vision - Neurophysiology of Vision - EOG. Structure and functions of Internal Ear - Mechanism of Hearing - Auditory pathway, Hearing Tests.

UNIT V **9 Hours**

DIGESTIVE AND URINARY SYSTEMS

Digestive: Organs of Digestive system - Digestion and Absorption. Urinary: Structure of Kidney and Nephron. Mechanism of Urine formation and acid base regulation - Urinary reflex - Homoeostasis and blood pressure regulation by urinary system.

3 Hours

EXPERIMENT 1

Diagnosis of platelet related disorder and hemophilia by analyzing bleeding and clotting time.

3 Hours

EXPERIMENT 2

Diagnosis of anemia by measuring the amount of hemoglobin in the blood.

4 Hours

EXPERIMENT 3

Determine whether the donor's blood group is compatible with the recipient's blood group for a safe blood transfusion.

4 Hours

EXPERIMENT 4

Diagnosis of Leukocytosis and Leukopenia by counting the WBC present in the blood

4 Hours

EXPERIMENT 5

Diagnosis of Myocardial Infarction from Abnormal PQRST Waveform.

4 Hours

EXPERIMENT 6
Diagnosis of myopathies and neuropathies using EMG.

4 Hours

EXPERIMENT 7
Diagnose the conductive and sensorineural type of hearing loss.

4 Hours

EXPERIMENT 8
Identification of refractive errors like myopia, hyperopia, and presbyopia.

Total: 75 Hours

Reference(s)

1. Elaine.N. Marieb, "Essential of Human Anatomy and Physiology",12th Edition, Pearson Education, New Delhi,2018
2. Gillian Pocock, Christopher D. Richards, "The Human Body - An Introduction for Biomedical and Health Sciences",Oxford University Press, USA,2009
3. William F.Ganong, "Review of Medical Physiology", 26nd Edition, McGraw Hill, New Delhi, 2019
4. Eldra Pearl Solomon, "Introduction to Human Anatomy and Physiology", W.B. Saunders Company, Harcourt Brace Jovanovich, 2003
5. Guyton & Hall, "Medical Physiology", 14th Edition, Elsevier Saunders,2020

22BM304 ANALOG AND DIGITAL ELECTRONICS 3 0 2 4

Course Objectives

- To study various number systems and to simplify the mathematical expressions using Boolean functions
- To design combinational and sequential circuits
- To design analog circuits for various application using operational amplifier

Program Outcomes (POs)

PO1 Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems
PO2 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
PO3 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.
PSO1 Apply knowledge on foundation in Life Science, engineering, mathematics and current biomedical engineering practices with an ability to demonstrate advanced knowledge of a selected area within Biomedical Engineering.
PSO2 Critically analyse the current healthcare systems and develop innovative solutions effectively through problem specific design and development using modern hardware and software tools.

Course Outcomes (COs)

1. Interpret number systems, encoding techniques and simplifications of logic expressions using K-maps and design the combinational logic circuits
2. Design Sequential logic circuits for given real time problems
3. Apply the basic op-amp circuits for basic operation on signals
4. Design filter circuits and waveform generators using Op-Amp
5. Design and analyze the timer circuit and signal converters using Op-amp

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	1	2	-	-	-	-	-	-	-	-	-	-	-	-
2	2	1	3	-	-	-	-	-	-	-	-	-	2	-	-
3	2	2	-	-	-	-	-	-	-	-	-	-	1	1	-
4	2	1	3	-	-	-	-	-	-	-	-	-	2	-	-
5	2	2	3	-	-	-	-	-	-	-	-	-	1	1	-

UNIT I **10 Hours**

NUMBER SYSTEM AND LOGIC GATES

Introduction to Digital Systems, Number Systems- Binary, Octal, Decimal and Hexadecimal, Methods of base conversions, Representation of signed numbers, Binary Arithmetic- Addition, Subtraction, Complementary numbering systems; Binary Codes- BCD codes, Gray codes; Basic Theorems and properties of Boolean Algebra, logic gates - Basic and Universal gates, Simplification of logic expressions using Karnaugh Map method - Combinational logic circuit design; half adder- full adder, Multiplexers and Demultiplexers - Decoders and encoders

UNIT II **8 Hours**

SYNCHRONOUS AND ASYNCHRONOUS SEQUENTIAL CIRCUITS

Gated Latches & Flip Flops- Level triggered and Edge triggered Flip-Flops, Flip Flop Conversion. Shift Registers; Design of synchronous sequential circuits - Moore and Mealy models - State Assignment State table; state diagram; state reduction; Design of Counters- Binary Counter, Ring counters.

UNIT III **9 Hours**

OPERATIONAL AMPLIFIERS

The characteristics of Ideal Operational Amplifier- equivalent circuit of an Op-Amp - virtual ground concept - Linear applications of op-amp - inverting and non-inverting amplifier, summing amplifier - differentiator and integrator. Nonlinear applications - comparator - Schmitt Triggers - Half wave and full wave rectifiers - Average detectors - peak Detector

UNIT IV **9 Hours**

ACTIVE FILTERS AND SIGNAL GENERATOR

Active filters (first and second order) - Low pass, high pass, band pass filters, band reject filters. Oscillators - RC Phase shift and Wein-bridge. Waveform generators - Square, triangular and saw tooth

UNIT V **9 Hours**

TIMER, PLL, A/D AND D/A CONVERTERS

555 Timer (internal diagram) and its applications - monostable and astable multivibrator. Phase locked Loop (565 - block diagram approach) and its applications. DAC - Binary weighted DAC and R-2R DAC. ADC - single slope and dual slope ADCs, successive approximation ADC.

6 Hours

EXPERIMENT 1

Design an automatic health monitoring system to indicate the condition of a patient in an ICU using the concept of (4:2) encoder and (2:4) decoder.

4 Hours

EXPERIMENT 2

Design a combinational logic circuit for a patient monitoring device to transmit any four vital parameters through the input channels and view the required parameter using appropriate selection lines.

4 Hours

EXPERIMENT 3

In a hospital, patients' data will be recorded and stored in their database. Design a sequential logic circuit, to transmit/receive different types of patient data through a single channel and also transmit the signal with predetermined delay period.

4 Hours

EXPERIMENT 4

Design a bioamplifier circuit with specified gain value to increase the strength of the biosignals. (ECG/EMG)

4 Hours

EXPERIMENT 5

Design a Biosignal (ECG/EMG/EEG) processing unit to identify its zero crossings, and convert it into a digital signal using schmitt trigger circuit, which can be used as a feature for classification problems.

4 Hours

EXPERIMENT 6

Design a ECG/EMG signal enhancement unit with appropriate filters (ECG/EMG/EEG)

4 Hours

EXPERIMENT 7

Generate a sinusoidal signal using RC phase shift oscillator circuit, which can be used as a reference for bio signal processing unit.

Total: 75 Hours

Reference(s)

1. M.Morris Mano, Digital Logic and Computer design, Prentice Hall,2010
2. Ramakant A. Gayakwad, Op-AMP and Linear ICs, Prince Hall,2015
3. Robert B. Northrop, Analysis and Application of Analog Electronic Circuits to Biomedical Instrumentation, CRC Press, second edition,2012
4. Sergio Franco, Design with Operational Amplifiers and analog Integrated circuits, McGraw-Hills, Fourth edition, 2014
5. Millman J, Halkias. C., Integrated Electronics, TMH, Second edition, 2017
6. John. F. Wakerly, Digital Design Principles and Practices, Fourth Edition, Pearson Education, 2008

22BM305 SENSORS AND MEASUREMENTS 3 0 2 4

Course Objectives

- To introduce the relevance of this course to the existing technology through demonstrations, case studies, simulations, contributions of scientist, national/international policies with a futuristic vision along with socio-economic impact and issues
- To understand the purpose of measurement, the methods of measurements, errors associated with measurements.
- To know the principle of transduction, classifications and the characteristics of different transducers and study its biomedical applications.
- To know the different display and recording devices.

Program Outcomes (POs)

PO1 Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems
PO2 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
PO3 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.
PSO1 Apply knowledge on foundation in Life Science, engineering, mathematics and current biomedical engineering practices with an ability to demonstrate advanced knowledge of a selected area within Biomedical Engineering.

Course Outcomes (COs)

1. Outline the basic concept of measurements
2. Apply the suitable displacement, pressure and temperature sensors for biomedical applications
3. Analyze the characteristics of photoelectric and piezoelectric sensors
4. Apply AC and DC bridge circuits for various signal conditioning applications.
5. Apply different display and recording devices for various applications.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	1	-	-	-	-	-	-	-	-	-	-	1	-	-
2	2	2	2	-	-	-	-	-	-	-	-	-	1	-	-
3	3	1	2	-	-	-	-	-	-	-	-	-	1	-	-
4	2	1	2	-	-	-	-	-	-	-	-	-	1	-	-
5	2	2	2	-	-	-	-	-	-	-	-	-	1	-	-

UNIT I **9 Hours**

SCIENCE OF MEASUREMENT

Measurement System - Instrumentation - Classification of Transducers - Static and Dynamic - Errors in Measurements - Calibration - Primary and Secondary standards.

UNIT II **9 Hours**

DISPLACEMENT, PRESSURE, TEMPERATURE SENSORS

Resistive Transducers: Strain Gauge: Gauge factor, sensing elements, configuration, biomedical applications; strain gauge as displacement & pressure transducers, RTD materials & range, Characteristics, thermistor characteristics, biomedical applications of Temperature sensors Capacitive transducer, Inductive transducer, LVDT, Active type: Thermocouple - characteristics

UNIT III **9 Hours**

PHOTOELECTRIC AND PIEZOELECTRIC SENSORS

Phototube, scintillation counter, Photo Multiplier Tube (PMT), photovoltaic, Photo conductive cells, photo diodes, phototransistor, comparison of photoelectric transducers, spectrophotometric applications of photo electric transducers. Piezoelectric active transducer and biomedical applications as pressure and ultrasound transducer.

UNIT IV **9 Hours**

BRIDGES

AC and DC Bridges - Wheat stone bridge, Kelvin, Maxwell, Hay, Schering - Concepts of filters, Pre-amplifier, impedance matching circuits- isolation amplifier, spectrum analyzer.

UNIT V **9 Hours**

DISPLAY AND RECORDING DEVICES

Digital voltmeter - Multimeter - CRO - Block diagram, CRT - Vertical & Horizontal deflection system, DSO, LCD monitor, PMMC writing systems, Servo recorders, photographic recorder, magnetic tape recorder, inkjet recorder, thermal recorder. Demonstration of the display and recording devices.

3 Hours

EXPERIMENT 1

Design an electronic controller using LVDT transducers for the pressure measurement of a liquid flow in drug delivery systems

3 Hours

EXPERIMENT 2

Design of signal conditioning circuit to detect the body temperature using thermistor.

4 Hours

EXPERIMENT 3

Measurement of magnetic field using Hall Effect transducer for monitoring and controlling the magnetic field strength of MRI scan

4 Hours

EXPERIMENT 4

Design a circuit to measure the liquid level of the water storage tank using a capacitive transducer

4 Hours

EXPERIMENT 5

Measurement of SpO2 in the blood using the optical transducers.

4 Hours

EXPERIMENT 6

Design an electronic controller to control the position of gantry of the CT scanner using digital shaft encoder

4 Hours

EXPERIMENT 7

Measurement of vibration in the ultrasonic blood flowmeter using piezoelectric transducers.

4 Hours

EXPERIMENT 8

Measurement of the muscle contraction and force applied during exercises to track a patient's progress using strain gauge and load cell.

Total: 75 Hours

Reference(s)

1. Doebelin E.O. and Manik D.N., "Measurement Systems", Tata McGraw-Hill Education Pvt.Ltd., 6th Edition, 2011.
2. L.A Geddes and L.E.Baker , "Principles of Applied Biomedical Instrumentation", - John Wiley and sons, 3rd Edition, Reprint 2008.
3. Albert D.Helfrick and William D.Cooper, "Modern Electronic Instrumentation and Measurement Techniques", Prentice Hall of India, 2007.
4. A.K.Sawhney, "Electrical and Electronics Measurement and Instrumentation", DhanpatRai & Co, New Delhi, 17th Edition, 2004.
5. Khandpur R.S, "Handbook of Biomedical Instrumentation", Tata McGraw Hill, New Delhi, 3rd Edition, 2014.
6. Leslie Cromwell, Fred J. Weibell, Erich A. Pfeiffer, "Biomedical Instrumentation and Measurement", Prentice Hall India Pvt. Ltd, New Delhi, 2nd Edition, Reprint, 2013.

22HS004 HUMAN VALUES AND ETHICS 2 0 0 2

Course Objectives

- Understand the concept of good values and comprehend the importance of value-based living.
- Recognize the culture of peace through education.
- Identify and apply the practices for value development and clarification.

Program Outcomes (POs)

PO8 Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO9 Individual and Team Work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO10 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.
PSO1 Apply knowledge on foundation in Life Science, engineering, mathematics and current biomedical engineering practices with an ability to demonstrate advanced knowledge of a selected area within Biomedical Engineering.
PSO2 Critically analyse the current healthcare systems and develop innovative solutions effectively through problem specific design and development using modern hardware and software tools.

Course Outcomes (COs)

1. Interpret the importance of human values and ethics in life.
2. Execute the importance of harmonious living in a diverse society.
3. Analyze the sensitivity to the crying needs of society such as ungodliness, corruption, poverty, and suffering, and play a vital role in eradicating them.
4. Plan intellectually mature, morally upright, ethically correct, and spiritually inspired decisions.
5. Execute a correct balance between professional excellence and social commitment.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	-	-	-	-	-	-	-	3	2	2	-	-	1	1	-
2	-	-	-	-	-	-	-	3	2	2	-	-	-	-	-
3	-	-	-	-	-	-	-	3	2	2	-	-	-	-	-
4	-	-	-	-	-	-	-	3	2	2	-	-	-	-	-
5	-	-	-	-	-	-	-	3	2	2	-	-	1	1	-

UNIT I 6 Hours

COURSE INTRODUCTION - NEED, BASIC GUIDELINES AND ANALYSIS

Importance of Human Values & Ethics in 21st Century - Understanding the theory of basic human values and ethics. Openness to change -Self enhancement -Conservation -Self transcendence - Schwartz Value Survey: Self-Assessment

UNIT II **6 Hours**

EMBRACING THE COMMON ETIQUETTE

Altruism- Integrity-Freedom-Justice-Honesty-Truthfulness-Responsibility-Compassion

UNIT III **6 Hours**

CONTINUOUS HAPPINESS AND PROSPERITY

An overview on basic Human Aspirations- Understanding and living in harmony at various levels of life-Embracing self-love and wellness-Understanding harmony in the family and society

UNIT IV **6 Hours**

UNIVERSAL HUMAN VALUES AND PROFESSIONAL ETHICS

Reflection on growing global multifold problems: poverty, pollution, hunger, disease, unemployment, caste system, child labour, gender equality, politics and violence. Understanding the challenges in cultural, personal, social, political, and economic environment

UNIT V **6 Hours**

UNDERSTANDING HARMONY IN THE NATURE AND EXISTENCE - WHOLE EXISTENCE AS CO-EXISTENCE

Understanding the harmony in the Nature- Holistic perception of harmony at all levels of existence-Practice Exercises and Case Studies will be taken up in Practice Sessions

Total: 30 Hours

Reference(s)

1. Martin, G. The Little Book of Ethics: A Human Values Approach. Australia: G.P. Martin. 2011.
2. Gupta, N. L. Human Values For The 21St Century. India: Anmol Publications Pvt. Limited. 2002.
3. Mishra, A. Happiness Is All We Want. India: Bloomsbury Publishing.2017.
4. Universal Human Values. (n.p.): Booksclinic Publishing. 2023.
5. A Textbook on Professional Ethics And Human Values. India: New Age International (P) Limited.2007.

22HS005 SOFT SKILLS AND EFFECTIVE COMMUNICATION

0 0 2 1

Course Objectives

- Communicate proficiently in formal discussions at the workplace.
- Describe experiences and events, and briefly give reasons and explanations for opinions and plans.
- Interact with a degree of fluency and spontaneity that results in efficacious communication
- Convey agreement and disagreement in a polite but firm manner
- Communicate with coherence and imagination in both written and spoken formats

Program Outcomes (POs)

PO9 Individual and Team Work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO10 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. Enhance confidence in expressing thoughts in grammatically proper language and etiquette in waiting for the opportunity to provide input.
2. Effectively communicate in English on formal occasions and proficiency in the use of link words and other discourse markers
3. Provide constructive feedback and file logical complaints.
4. Analyse the understanding of oral and written communication in real-world situations.
5. Apply the improved spelling and punctuation in writing and heightened understanding of tone, pitch and stress in oral formats.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	-	-	-	-	-	-	-	-	2	3	-	-	-	-	1
2	-	-	-	-	-	-	-	-	2	3	-	-	-	-	2
3	-	-	-	-	-	-	-	-	2	3	-	-	-	-	3
4	-	-	-	-	-	-	-	-	2	3	-	-	-	-	4
5	-	-	-	-	-	-	-	-	2	3	-	-	-	-	5

UNIT I **10 Hours**

SELF-EXPRESSION

Group discussion/ Peer discussion - Communicating decisions and opinions - Tone, Pitch, Stress - Agreeing, Disagreeing, Suggesting, Speculating - Comparing and Contrasting - Comparatives and Superlatives - Discourse markers – Interjections - Decision making - Synthesis - Higher order thinking. Group discussion/Peer discussion - Effective Communication Types of communication - Written vs Spoken – Contractions Intonation Stress Active voice - Question tags - Confidence and body language

Guided writing- Outlining Main Points - Group discussion/Peer discussion - Avoiding common errors Reduction of MTI - Common errors - Barriers to communication Accent

UNIT II **10 Hours**

CREATIVE EXPRESSION

JAM, Debate, Review writing, Social media posts Synonyms – Antonyms Cloze test Phrasal verbs Spotting errors Collocation - Commonly mispronounced

UNIT III **10 Hours**

FORMAL EXPRESSION

Writing: Giving written feedback, Review writing, and Letter of complaint. Speaking: Giving constructive feedback and offering suggestions, asking for inputs, commenting politely on appropriate phrases - Giving written feedback, Review writing, and Letter of complaint. Critical reasoning - Modal verbs - Polite ways to express negatives

Total: 30 Hours

Reference(s)

1. Word Power Made Easy by Norman Lewis, W. R. Goyal Pub. & Distributors, 2009.
2. Sasikumar, V, et al., A Course in Listening & Speaking Foundation Books, 2005.
3. Murphy, Raymond. English Grammar in Use: A Self-Study Reference and Practice Book for Intermediate Students: with Answers. Cambridge: Cambridge University Press, 1985.
4. Prasad, Hari Mohan. A Handbook of Spotting Errors, Mcgraw Hill Education, 2010.
5. Personality Development & Soft Skills, BarunK.Mira, Oxford University Press, 2012

22BM401 PROBABLITY, STATISTICS AND RANDOM PROCESS

3 1 0 4

Course Objectives

- Understand the basic concepts of probability and the distributions with characteristics and also random variables
- Summarize and apply the design of experimental methodologies of probability for the data analysis using statistical notions
- The random process represents the mathematical model of the random signals

Programme Outcomes (POs)

PO1. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. 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.

PSO1. Apply knowledge on foundation in Life Science, engineering, mathematics and current biomedical engineering practices with an ability to demonstrate advanced knowledge of a selected area within Biomedical Engineering.

Course Outcomes (COs)

1. Demonstrate and apply the basic probability axioms and concepts in their core areas of random phenomena.
2. Apply the concepts of probability distributions in an appropriate place of science and Engineering.
3. Apply the basic statistical inference techniques, including confidence intervals, hypothesis testing to science/engineering problems.
4. Design an experiment for an appropriate situation using ANOVA technique.
5. Apply Random Process techniques to the problem of random input signals.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	2	-	-	-	-	-	-	-	-	-	-	1	-	-
2	2	2	-	-	-	-	-	-	-	-	-	-	1	-	-
3	2	2	-	-	-	-	-	-	-	-	-	-	1	-	-
4	2	2	-	-	-	-	-	-	-	-	-	-	1	-	-
5	2	2	-	-	-	-	-	-	-	-	-	-	1	-	-

UNIT I **9 Hours**

PROBABILITY AND RANDOM VARIABLES

Axioms of probability - Conditional probability - Total probability - Bayes theorem - Random variables - Probability mass function - Probability density functions - Properties.

UNIT II **9 Hours**

STANDARD DISTRIBUTIONS

Binomial distribution - Poisson distribution - Negative binomial distribution - Exponential distribution - Gamma distribution - Normal distribution and their properties.

UNIT III **9 Hours**

TESTING OF HYPOTHESIS

Sampling distributions - Estimation of parameters - Statistical hypothesis - Large sample test based on Normal distribution for single mean and difference of means -Small sample tests: t-test for mean-F- test - Chi-square test for Goodness of fit and Independence of attributes.

UNIT IV **9 Hours**

DESIGN OF EXPERIMENTS AND CONTROL CHART

One way and two way classifications - Completely Randomized Design - Randomized Block Design - Latin Square Design. Control charts for measurements (X and R charts) - Control charts for attributes (p, c and np charts).

UNIT V **9 Hours**

RANDOM PROCESSES

Definition and examples - first order, second order, strictly stationary, wide sense stationary and Ergodic processes - Markov process - Poisson and Normal processes.

Tutorial: 15 Hours
Total: 60 Hours

Reference(s)

1. Peyton Z Peebles, Probability, Random Variables and Random Signal Principles, Tata McGraw Hill Publications, New Delhi, 4th Edition, 2010.
2. Richard A Johnson and John Freund, Miller and Freunds Probability Statistics for Engineers, 8th Edition, Pearson Education, 2015.
3. Henry Stark and John W. Woods, Probability and Random Processes with Applications to Signal Processing, Pearson Education, Delhi, 3rd Edition, 2002.
4. Athanasios Papoulis, S. UnniKrishna Pillai, Probability, Random Variables and Stochastic Processes, Tata McGraw Hill Publications, New Delhi, 4th Edition, 2010.

22BM402 BIOSCIENCES IN MEDICAL ENGINEERING **3 0 2 4**

Course Objectives

- To study structural and functional properties of carbohydrates, proteins, lipids and nucleic acids
- To emphasize structural and functional aspects of living organisms
- To discuss the concepts of microbial culture and immunopathology

Programme Outcomes (POs)

PO1. Engineering Knowledge: the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. 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.
PO4. 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.
PO5. 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.
PO7. 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.
PO8. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO12. 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.
PSO1. Apply knowledge on foundation in Life Science, engineering, mathematics and current biomedical engineering practices with an ability to demonstrate advanced knowledge of a selected area within Biomedical Engineering.

Course Outcomes (COs)

1. Outline the fundamental concepts of biochemistry correlated to biomedical engineering
2. Outline the concept of cell degeneration, cell repair and Neoplasia.
3. Analyze the effect of derangement in haematology
4. Analyze the growth of bacterial cultures
5. Analyze the pathological conditions related to immunity

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	-	-	1	2	-	-	1	-	-	-	1	2	-	-
2	2	2	-	1	-	-	-	-	-	-	-	1	2	-	-
3	3	2	-	3	2	-	-	1	-	-	-	1	2	-	-
4	2	2	-	2	-	-	-	-	-	-	-	1	2	-	-
5	2	2	-	3	2	-	1	1	-	-	-	1	2	-	-

UNIT I **9 Hours**
INTRODUCTION TO BIOCHEMISTRY
Introduction to Biochemistry, water as a biological solvent, weak acid and bases, pH, buffers, Handerson-Hasselbalch equation, physiological buffers, fitness of the aqueous environment for living organism. Principle of viscosity, surface tension, adsorption, diffusion, osmosis and their applications in biological systems. Introduction to Biomolecules, Biological membrane, Clinical application of Electrolytes and radioisotopes

UNIT II **9 Hours**
CELL DEGENERATION, REPAIR AND NEOPLASIA
Cell injury - Reversible cell injury and irreversible cell injury and Necrosis, Apoptosis, Intracellular accumulations, Pathological Calcification-Dystrophic and Metastatic. cellular adaptations of growth and differentiation, Inflammation and Repair including fracture healing, Neoplasia, Classification, Benign and malignant tumors, carcinogenesis, spread of tumours, autopsy and biopsy

UNIT III **9 Hours**
FLUID AND HEMODYNAMIC DERANGEMENTS
Edema, Hyperemia/Ischemia, normal haemostasis, thrombosis, disseminated intravascular coagulation, embolism, infarction, shock, chronic venous congestion. Haematological disorders- Bleeding disorders, Leukaemia, Lymphomas Haemorrhage.

UNIT IV **9 Hours**
MICROBIAL CULTURES
Morphological features and structural organization of bacteria, growth curve, identification of bacteria, culture media and its types, culture techniques and observation of culture.

UNIT V **9 Hours**
IMMUNOPATHOLOGY
Natural and artificial immunity, types of Hypersensitivity, antibody and cell mediated tissue injury: opsonisation, phagocytosis, inflammation, Secondary immunodeficiency including HIV infection. Auto-immune disorders: Basic concepts and classification, SLE. Antibodies and its types, antigen and antibody reactions, immunological techniques: immune diffusion, immune-electrophoresis, RIA and ELISA, monoclonal antibodies.

EXPERIMENT 1 **5 Hours**
Identify and assess the presence of Biomolecules in a given food sample to make a specific diet chart for a patient.

EXPERIMENT 2 **5 Hours**
Identification of Blood groups and Analysis of Blood Cell for a given Blood sample to detect the presence of any Blood disorders.

EXPERIMENT 3 **4 Hours**
Prediction of Biomarkers for a given blood sample to detect the presence of any foreign agents in the human body.

EXPERIMENT 4 **4 Hours**
Perform diagnosis of diabetic mellitus from a given blood sample of a patient.

EXPERIMENT 5 **4 Hours**
Perform a Kidney Function Test to assess the normal functioning of the Kidney, for a patient who is diabetic.

EXPERIMENT 6 **4 Hours**

Identification of protein-associated disorders and multiple myeloma from a given blood sample.

EXPERIMENT 7 **4 Hours**

Identification of Unknown components in a drug to be given to the patient.

Total: 75 Hours

Reference(s)

1. Rafi MD, "Textbook of Biochemistry for Medical Student", Second Edition, University Press, 2014
2. Donold Voet, Judith, G.Voet and Charlotte W. Pratt, "Principles of Biochemistry", 4th Edition, John Wiley and Sons, New Delhi, 2012.
3. David.W.Martin, Peter.A.Mayes, Victor. W.Rodwell, Harper"s Illustrated Biochemistry, LANGE Medical Publications, 2018
4. Keith Wilson, John Walker, Practical Biochemistry- Principles & Techniques, Oxford University Press,2009
5. Harsh Mohan, Text book of Pathology, Jaypee Brothers Medical publishers private Limited, 8th Edition,2019

22BM403 SIGNAL PROCESSING 3 1 0 4

Course Objectives

- To analyze the frequency domain behaviour of a given Discrete Time signal using Discrete Fourier Transform
- To design IIR filters for given specifications by following the suitable design procedures
- To design FIR filters for given specifications by following the suitable design procedures
- To analyze the finite word length effect in the design of digital signal processing systems
- To understand the architectural overview and addressing modes in DSP processors

Programme Outcomes (POs)

PO1. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. 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.

PO3. 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.

PO4. 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.

PSO1. Apply knowledge on foundation in Life Science, engineering, mathematics and current biomedical engineering practices with an ability to demonstrate advanced knowledge of a selected area within Biomedical Engineering.

Course Outcomes (COs)

1. Analyze the frequency domain behaviour of a given Discrete Time signal using Discrete Fourier Transform
2. Design digital IIR filters and construct its realization structures
3. Design digital FIR filters and construct its realization structures
4. Analyze the effect of finite word length for fixed &floating point number representation.
5. Analyze multirate signal processing concepts for real time applications

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	2	-	-	-	-	-	-	-	-	-	-	2	-	-
2	1	-	3	-	-	-	-	-	-	-	-	-	2	-	-
3	1	-	3	-	-	-	-	-	-	-	-	-	2	-	-
4	2	3	-	-	-	-	-	-	-	-	-	-	2	-	-
5		3	-	2	-	-	-	-	-	-	-	-	2	-	-

UNIT I 9 Hours

DISCRETE FOURIER TRANSFORM: PROPERTIES, APPLICATIONS AND COMPUTATION

Discrete Time Fourier Transform- Spectrum limitations, The Discrete Fourier Transform- Properties of DFT- Periodicity, Linearity, Symmetry, Multiplication-Circular Convolution. Efficient Computation of DFT-FFT Algorithm-Implementation of Radix 2 FFT algorithm (DIT and DIF)

UNIT II **9 Hours**

DESIGN OF IIR FILTERS

Introduction to Digital filters - General consideration in the design of digital filters. Design of analogue Butterworth and Chebyshev Filters. Design of IIR digital filters using impulse invariant technique, bilinear transformation technique. Realization of IIR filters using direct, cascade and parallel forms.

UNIT III **9 Hours**

DESIGN OF FIR FILTERS

Linear phase FIR filters – Design of FIR filters using Fourier series method, Frequency sampling techniques, Windowing techniques- Hamming, Hanning windows. Realization of FIR filters- Direct, Linear phase realization structures.

UNIT IV **9 Hours**

FINITE WORD LENGTH EFFECT IN DIGITAL FILTERS

Number Representation-Fixed and Floating Point Quantization Noise-Finite Word Length Effects in Digital filters- Input Quantization, Product Quantization, Coefficient quantization error, Limit cycle oscillations.

UNIT V **9 Hours**

MULTIRATE SIGNAL PROCESSING

Introduction to multirate signal processing – Interpolation by the factor I, Decimation by the factor D, Sampling rate conversion by the factor I/D, Application of multirate signal processing concepts in real time.

Tutorial: 15 Hours
Total: 60 Hours

Reference(s)

1. Digital Signal Processing by John G. Proakis and Dimitris K. Manolakis, 4th edition, Pearson Education India, 2013
2. Discrete-Time Signal Processing by Alan V. Oppenheim and Ronald W. Schafer, 3rd edition, 2010, Prentice Hall
3. Digital Signal Processing by Sanjit Mitra, 4th edition, 2011, McGraw-Hill, New York.
4. Understanding Digital Signal Processing, Lyons, Richard G., 3/e, Pearson Education India, 2004
5. Digital Signal Processing: A Practical Approach, Barrie W. Jervis and Emmanuel C. Ifeachor2/e, Pearson Education India, 2009.

22BM404 COMMUNICATION SYSTEMS 3 0 0 3

Course Objectives

- To understand the fundamental concepts of communication systems.
- To analyze different analog, digital modulation schemes and coding techniques
- To familiarize the basic concept of Optical Fiber in biomedical field.

Programme Outcomes (POs)

PO1. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. 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.
PO3. 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.
PO4. 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.
PO8. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PSO2. Critically analyse the current healthcare systems and develop innovative solutions effectively through problem specific design and development using modern hardware and software tools.

Course Outcomes (COs)

1. Outline the concept of amplitude modulation techniques and in time and frequency domain
2. Apply angle and phase modulation technique to design FM transmitter and receiver
3. Analyze different types of digital modulation techniques in digital communication system
4. Apply various coding techniques to convert real time data into data suitable for transmission
5. Analyze fiber optic systems used in the domain of biomedical applications.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	2		-	-	-	-	1	-	-	-	-	-	-	-
2	2	1	3	-	-	-	-	1	-	-	-	-	-	1	-
3	2	3		-	-	-	-	1	-	-	-	-	-	-	-
4	1		3	2	-	-	-	-	-	-	-	-	-	1	-
5	2	3		2	-	-	-	1	-	-	-	-	-	2	-

UNIT I **9 Hours**

AMPLITUDE MODULATION

Elements of communication systems - Modulation - Types - Need for modulation, Amplitude modulation - carrier waves- AM in time domain and frequency domain, Evolution and Description of SSB, DSBSC Techniques, AM Demodulator.

UNIT II **9 Hours**

ANGLE MODULATION

Angle modulation - Phase modulation - Angle modulation spectrum - FM and Noise - FM stereo - FM measurements - FM Transmitters- FM Receivers - Receiver topologies - FM Demodulators

UNIT III **9 Hours**

DIGITAL MODULATION

Amplitude Shift Keying (ASK) - Frequency Shift Keying (FSK) - Phase Shift Keying (PSK)- BPSK- QPSK- Quadrature Amplitude Modulation (QAM)- 8 QAM - 16 QAM - Bandwidth Efficiency- Comparison of various Digital Modulation schemes (ASK-FSK-PSK-QAM).

UNIT IV **9 Hours**

INFORMATION CODING TECHNIQUES

Entropy, Source encoding theorem, Shannon Fano coding, Huffman coding, mutual information, channel capacity, Error Control Coding, Linear Block Codes, cyclic codes.

UNIT V **9 Hours**

FIBER OPTIC SYSTEMS

Basic Fiber Optic Systems - repeaters and optical amplifiers - wavelength division multiplexing - Fiber in local area networks - Biomedical Optical Fiber Sensors - Application of optical fiber in biomedical diagnosis.

Total: 45 Hours

Reference(s)

1. Simon Haykins, Communication Systems, Wiley, 5th Edition, 2009.
2. B.P.Lathi, Modern Digital and Analog Communication Systems, 4th Edition, Oxford University Press, 2011
3. Wayner Tomasi, Electronic Communication System, Pearson Education,2012.
4. Miller, Modern Electronic Communication, Prentice Hall of India, New Delhi, 2010.
5. William Schweber, Electronic Communication System, Prentice Hall of India Ltd, India, New York, 2010.

22BM405 EMBEDDED SYSTEMS 3 0 2 4

Course Objectives

- To understand the overview of Embedded System Architecture.
- To apply the Embedded C programming concepts in Microcontroller
- To analyse embedded communication protocols

Programme Outcomes (POs)

PO1.Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. 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.
PO3. 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.
PSO1.Apply knowledge on foundation in Life Science, engineering, mathematics and current biomedical engineering practices with an ability to demonstrate advanced knowledge of a selected area within Biomedical Engineering.
PSO2. Critically analyse the current healthcare systems and develop innovative solutions effectively through problem specific design and development using modern hardware and software tools.

Course Outcomes (COs)

1. Analyze the 8086 architecture and write ALP for 8086 processor.
2. Demonstrate the hardware and software architectures of Embedded Systems
3. Outline the special features and architecture of TIVA C series microcontroller.
4. Analyse and program different communication protocols used for Embedded Networking.
5. Design embedded applications by interfacing the OFF-chip peripherals with the microcontroller.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	3	2	-	-	-	-	-	-	-	-	-	1	-	-
2	1	2	3	-	-	-	-	-	-	-	-	-	2	-	-
3	2	3	2	-	-	-	-	-	-	-	-	-	3	2	-
4	3	2	2	-	-	-	-	-	-	-	-	-	-	1	-
5	1	3	2	-	-	-	-	-	-	-	-	-	-	2	-

UNIT I **9 Hours**

8086 MICROPROCESSOR

8086 Architecture-8086 Instruction set-8086 Addressing modes- 8086 ALP-Interrupts

UNIT II **9 Hours**

INTRODUCTION TO EMBEDDED SYSTEM

Categories of embedded systems, Specialties of embedded systems, Recent trends in embedded systems, Hardware architecture, Software architecture, Communication software, Process of generation of executable image, Development/testing tools.

UNIT III **9 Hours**

TIVA-C MICROCONTROLLER

TIVA-C Microcontroller Architecture and Its memory map, GPIO Programming, WDT Programming, Interrupt Programming, LPM Programming

UNIT IV **9 Hours**

COMMUNICATION PROTOCOLS

UART, ADC, PWM, Timer, I2C, SPI

UNIT V **9 Hours**

OFF-CHIP PERIPHERAL INTERFACING AND PROGRAMMING

RTC Interfacing, Bluetooth module interfacing, Analog Sensor interfacing, Motor Interfacing.

EXPERIMENT 1 **4 Hours**

Design a car parking system using 16-bit, 32-bit 8086 microprocessor

EXPERIMENT 2 **4 Hours**

Design a display system for hotel using 8086 microprocessor

EXPERIMENT 3 **5 Hours**

Design a ranking system for students using 8086 microprocessor

EXPERIMENT 4 **5 Hours**

Design a traffic light controller using TIVA-C microcontroller

EXPERIMENT 5 **6 Hours**

Design a printing machine with dc and stepper motor using TIVA-C microcontroller

EXPERIMENT 6 **6 Hours**

Design server room temperature monitoring system using TIVA-C microcontroller

Total: 75 Hours

Reference(s)

1. Ray K & Bhurchandi K.M, "Advanced Microprocessors and Peripherals: Architecture, Programming and Interface", 3rd Edition, McGraw Hill, New Delhi, 2012.
2. Prasad K V K K Embedded Real Time Systems Concepts, Design and Programming Dreamtech press 2013
3. Muhammad Ali Mazidi, Sarmad Naimi and Sepehr Naimi TI ARM Peripherals Programming and Interfacing Using C Language Pearson Education 2014
4. Jonathan W. Valvano Embedded Systems Introduction to Arm Cortex M Microcontrollers 5th edition ISBN 978-1477508992 2014
5. Embedded System Design Using TIVA, TI University Program, Learning Material.

22HS007 ENVIRONMENTAL SCIENCE 2 0 0 0

Course Objectives

- Understand the interdisciplinary and holistic nature of the environment
- Identify the significance of natural resources and environment on the quality of life and stimulate the quest for sustainable development
- Assess the socio-economic, political and ethical issues in environmental science

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. 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.

PO7. 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.

PSO1.Apply knowledge on foundation in Life Science, engineering, mathematics and current biomedical engineering practices with an ability to demonstrate advanced knowledge of a selected area within Biomedical Engineering.

Course Outcomes (COs)

1. Apply principles of natural resource management to analyze exploitation cases in forestry, water, minerals, and agricultural sectors, assessing their environmental impacts.
2. Analyze the different types of ecosystems and biodiversity, its values and also role of professionals in protecting the environment from degradation
3. Analyze the existing environmental challenges related to pollution and its management
4. Analyze the impacts of unsustainable practices, waste management, climate change, and water conservation on environmental sustainability
5. Analyze the impact 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	PSO3
1	1	2	-	-	-	-	-	-	-	-	-	-	1	-	-
2	1	1	-	-	-	-	-	-	-	-	-	-	1	-	-
3	2	2	-	-	-	-	1	-	-	-	-	-	-	-	-
4	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5	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, bio magnification). Energy resources: renewable (solar, wind, and hydro).

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: desert ecosystem. Biodiversity - value of biodiversity - threats to biodiversity - endangered and endemic species - Conservation of biodiversity: In-situ and ex-situ conservation of biodiversity.

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) - noise pollution- thermal pollution. Disaster management: causes - effects - control measures of floods – earthquake.

UNIT IV **7 Hours**

SOCIAL ISSUES AND ENVIRONMENT

Sustainable development: Definition - Unsustainable to sustainable development - solid waste management - causes - effects - 5R Principles (landfills, incineration, composting). Water conservation - rain water harvesting - watershed management. Climate change - global warming - acid rain - ozone layer depletion. E-waste

UNIT V **5 Hours**

HUMAN POPULATION AND ENVIRONMENT

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

Total: 30 Hours

Reference(s)

1. Anubha Kaushik and C.P. Kaushik, Environmental Science and Engineering, 4th Edition, New Age International Publishers, New Delhi, 2014.
2. T.G.Jr. Miller and S. Spoolman, New Environmental Science, 14th Edition, Wadsworth Publishing Co, New Delhi, 2014.
3. A. K. De, Environmental Chemistry, 7th Edition, New age international publishers, New Delhi, 2014.
4. Raven, P.H , Hassenzahl, D.M. and Berg, L.R., Environment, 8th edition. John Wiley & Sons, 2012.
5. Pepper I.L, Gerba C.P. and Brusseau M.L, Environmental and Pollution Science. Academic Press, 2011.

22HS008 ADVANCED ENGLISH AND TECHNICAL EXPRESSION

0 0 2 1

Course Objectives

- To enable students to achieve proficiency in academic writing
- effectively use the language to persuade others
- appreciate the nuances of the language and engage an audience
- use advanced tools of language to improve communicative competence
- prepare for professional demands at the workplace
- give concrete expression to the plans and goals

Programme Outcomes (POs)

PO9. Individual and Team Work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10. 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. Infer the clarity in articulating the objectives and aims and improved proficiency in using the English language
2. Communicate effectively and with good interpersonal skills; speak in public, engage the audience, and lead a group discussion
3. Critically evaluate the ethics of persuasive appeals and confidence to influence opinion
4. Analyse a specific piece of information; take in what is read, and use good writing techniques with proper grammar and syntax in all formal situations
5. Create awareness and empathy to emotional signals in communication

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	-	-	-	-	-	-	-	-	2	3	-	-	-	-	-
2	-	-	-	-	-	-	-	-	2	3	-	-	-	-	-
3	-	-	-	-	-	-	-	-	2	3	-	-	-	-	-
4	-	-	-	-	-	-	-	-	2	3	-	-	-	-	-
5	-	-	-	-	-	-	-	-	2	3	-	-	-	-	-

UNIT I **15 Hours**

CREATIVE EXPRESSION

Proposals & Grant applications, Argumentative essays & editorials, Sales Pitches, Campaigning, Commercials/advertisements, effectively answering the famous interview question: 'Why should we hire you?' Sentence and paragraph formation - Rhetorical questions - Emphasis & effective repetition - Empathetic expression, knowing the audience, capturing attention - Creating Memes, Comic Strips, Stand-up comedy, Caption writing, and Limericks, Vocabulary and slang words for comedy - Similes & Metaphors - Homophones, homonyms, alliteration, wordplay

UNIT II **15 Hours**

FORMAL EXPRESSION

Writing: Action plans, Cover letters, Mind-Mapping, Paragraph writing Logical reasoning - SVA - Advanced level - Style: Clarity, Concision, Coherence, Evocativeness, Efficacious Vocabulary - Conditional Clause - Be verbs- Tenses- advanced - Opening and closing sentences - Action plans, Anecdotal references, order of communication/ narration, complete communication- Wh-questions - Effective beginning and closing - Rhetorical questions - Appraising target audience - Pronunciation, Enunciation, Tone, Pace and Volume. - Writing: SOPs, Research Objectives, Thesis Statement, Indexing, Scholarly Articles, Academic Writing, Executive Summary, Survey Questionnaires, Citations and Bibliography - Reading: Quantitative & qualitative analysis, Analysis and paraphrasing of reference materials Speaking: Commentate live events, give instructions to operate machines/ conduct TASKs Listening: Informational listening, Reflective listening, - Discriminative listening - Connective words - Prefixes and Suffixes - Quoting and paraphrasing Proofreading - Directed writing and writing formats- Note taking - Active verbs

Total: 30 Hours

Reference(s)

1. Sangeeta Sharma et.al. Communication Skills for Engineers and Scientists, PHI Learning Pvt. Ltd, 2011
2. Murphy, Raymond. English Grammar in Use: A Self-Study Reference and Practice Book for Intermediate Students: with Answers. Cambridge: Cambridge University Press, 1985.
3. Business Correspondence and Report Writing by Prof. R.C. Sharma & Krishna Mohan, Tata McGraw Hill & Co. Ltd., 2001
4. Personality Development, Harold R. Wallace &L. Ann Masters, Cengage Learning, New Delhi
5. Developing Communication Skills by Krishna Mohan, Meera Bannerji - Macmillan India Ltd. 1990, Delhi
6. English Grammar, Composition and Usage by N. K. Agrawal & F. T. Wood, Macmillan India Ltd., New Delhi

22BM501 BIOMEDICAL INSTRUMENTATION 3 0 2 4

Course Objectives

- To illustrate origin of bio potentials and its propagations to understand the different types of electrodes and its placement for various recordings.
- To design bio amplifier for various physiological recordings and analyze different measurement techniques for non-physiological parameters
- To Summarize different biochemical measurements

Program Outcomes (POs)

PO1. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. 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.
PO4. 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.
PO5. 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.
PSO1. Apply knowledge on foundation in Life Science, engineering, mathematics and current biomedical engineering practices with an ability to demonstrate advanced knowledge of a selected area within Biomedical Engineering.
PSO3. Hands-on knowledge on cutting edge hardware and software tools to acquire real time data, model and simulate physiological processes and analyse limitations on real time implementations.

Course Outcomes (COs)

1. Categorize different bio potential electrodes based on its origin, propagations and characteristics.
2. Apply different bio-potential measurements techniques and analyze the characteristics of bio signals
3. Apply various Biosignal conditioning techniques as a pre-processing method in Biosignal processing.
4. Apply various technique for non-electrical physiological measurements
5. Analyze the performance of biochemical sensors and biochemical measurement techniques

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	3	-	1	1	-	-	-	-	-	-	-	1	-	-
2	2	3	-	2	1	-	-	-	-	-	-	-	1	-	-
3	2	2	-	3	1	-	-	-	-	-	-	-	1	-	2
4	2	2	-	2	1	-	-	-	-	-	-	-	1	-	2
5	2	3	-	2	1	-	-	-	-	-	-	-	1	-	2

UNIT I **9 Hours**

BIOPOTENTIAL ELECTRODES

Origin of biopotential and its propagation, Electrode-electrolyte interface, electrode-skin interface, half-cell potential, Contact impedance, polarization effects of electrode-non polarizable electrodes. Types of electrodes surface, needle, and microelectrodes and their equivalent circuits. Recording problems-motion artifacts, measurement with two electrodes.

UNIT II **9 Hours**

BIOPOTENTIAL MEASUREMENTS

Bio signals characteristics-frequency and amplitude ranges. ECG-Einthoven's triangle, standard 12 lead system, Principles of vector cardiography. EEG-10-20 electrode system, unipolar, bipolar and average mode. EMG-unipolar and bipolar mode. Recording of ERG, EOG and ECG.

UNIT III **9 Hours**

BIOSIGNAL CONDITIONING

Need for bio-amplifier-single ended bio-amplifier, differential bio-amplifier, impedance matching circuit, isolation amplifiers- transformer and optical isolation- isolated DC amplifier and AC carrier amplifier, power line interference, Right leg driven ECG amplifier, Band pass filtering, artefacts and removal.

UNIT IV **9 Hours**

MEASUREMENT OF NON- ELECTRICAL PARAMETERS

Temperature, respiratory rate and pulse rate measurements. Blood Pressure: indirect methods-Auscultatory method, oscillometric method, direct methods: electric manometer, pressure amplifiers, systolic, diastolic, mean detector circuit. Blood flow and cardiac output measurement: Indicator dilution, thermal dilution and dye dilution method, Electromagnetic and ultrasound blood flow measurement.

UNIT V **9 Hours**

BIOCHEMICAL MEASUREMENT AND BIOSENSORS

Biochemical sensors- pH, pO2 and pCO2, Ion selective Field Effect Transistor (ISFET), Immunologically sensitive FET(IMFET), Blood glucose sensors, Blood gas analyzers- colorimeter, Sodium Potassium Analyser, spectrophotometer, blood cell counter, auto analyzer (simplified schematic description)-Biosensors-Principles-amperometric and voltometric techniques, Electrophoretic techniques.

EXPERIMENT 1 **6 Hours**

Acquire an ECG signal and analyze its QRS complex, P & T wave, Heart rate variability to detect cardiac arrhythmias

EXPERIMENT 2 **6 Hours**

Analyze EEG signals to identify and classify different stages of brain activity, understanding the characteristics of each stage and their physiological significance

EXPERIMENT 3 **6 Hours**

Detect and assess ergonomic factors and muscle strain in workplace settings using EMG signal analysis.

EXPERIMENT 4 **6 Hours**

Acquire and analyze the vital physiological parameters like heart rate, blood pressure, respiratory rate, oxygen saturation, temperature using Patient monitoring systems to detect potential complications.

EXPERIMENT 5 **6 Hours**

Analyze the skin contact impedance using GSR setup for pain management and emotion detection.

Total: 75 Hours

Reference(s)

1. John G. Webster, Medical Instrumentation Application and Design, 5th edition, Wiley India Pvt Ltd, New Delhi,2020
2. Leslie Cromwell, Biomedical Instrumentation and measurement, 2nd edition, Prentice Hall of India, New Delhi,2015
3. Khandpur R.S, Handbook of Biomedical Instrumentation, 3rd edition, Tata McGraw-Hill New Delhi,2014.
4. Joseph J. Carr and John M. Brown, Introduction to Biomedical Equipment Technology, Pearson Education, 2004.
5. Myer Kutz, Standard Handbook of Biomedical Engineering and Design, McGraw Hill Publisher, 2003.

22BM502 MEDICAL IMAGE PROCESSING 3 0 2 4

Course Objectives

- To understand the fundamentals and of biomedical image processing.
- To understand image processing principles of CT, MRI, diagnostic and therapeutic devices.
- To develop the algorithms for image analysis and diagnosis in medical imaging.

Program Outcomes (POs)

PO1. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. 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.

PO3. 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.

PO4. 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.

PO5. 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.

PO12. 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.

PSO1. Apply knowledge on foundation in Life Science, engineering, mathematics and current biomedical engineering practices with an ability to demonstrate advanced knowledge of a selected area within Biomedical Engineering.

PSO2. Critically analyse the current healthcare systems and develop innovative solutions effectively through problem specific design and development using modern hardware and software tools.

PSO3. Hands-on knowledge on cutting edge hardware and software tools to acquire real time data, model and simulate physiological processes and analyse limitations on real time implementations.

Course Outcomes (COs)

1. Assess the fundamental concepts of images and its acquisition techniques.
2. Apply suitable image enhancement techniques to reduce the noise and interference level.
3. Apply various image segmentation techniques for feature extraction and classification applications.
4. Apply image compression techniques to reduce the size of the image
5. Analyze the features of medical images for disease diagnosis.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	2	-	2	1	-	-	-	-	-	-	2	2	-	-
2	1	2	3	2	1	-	-	-	-	-	-	2	-	1	2
3	1	3	2	3	1	-	-	-	-	-	-	1	-	1	2
4	1	1	3	2	1	-	-	-	-	-	-	1	-	1	2
5	1	2	2	3	1	-	-	-	-	-	-	1	-	1	2

UNIT I **9 Hours**

INTRODUCTION

Objectives of biomedical image analysis - Computer aided diagnosis - Nature of medical images: X-ray imaging - Tomography - Nuclear medicine imaging - SPECT imaging - Positron imaging tomography - Ultrasonography - Magnetic resonance imaging. Removal of artefacts - Space domain filters - Frequency domain filters - Optimal filtering - Adaptive filters

UNIT II **9 Hours**

IMAGE ENHANCEMENT

Image enhancement - Gray level transforms - Histogram transformation - Convolution mask operators - Contrast enhancement. Detection of regions of interest - Thresholding and binarization - Detection of isolated lines and points - Edge detection - Region growing.

UNIT III **9 Hours**

IMAGE SEGMENTATION

Detection of discontinuous, Point-line- edge detection, Linear and Circular Hough Transform, Basic Global and Adaptive Thresholding, Region-based segmentation, and K-Means Clustering.

UNIT IV **9 Hours**

IMAGE COMPRESSION

Fundamentals of Image compression models, Lossless compression: variable length coding, LZW coding, Arithmetic coding, Lossy compression: Wavelet and DCT coding, Predictive coding.

UNIT V **9 Hours**

IMAGE ANALYSIS

Analysis of shape and texture - Representation of shapes and contours - Shape factors - Models for generation of texture - statistical analysis of texture - Fractal analysis - Fourier domain analysis of texture - Segmentation and structure analysis of texture. Pattern classification and diagnostic decision - Measures of diagnostic accuracy - Applications: Contrast enhancement of mammograms - Detection of calcification by region growing- Shape and texture analysis of tumours.

EXPERIMENT 1 **3 Hours**

Develop an algorithm to remove noise present in the colon cancer images

EXPERIMENT 2 **3 Hours**

Apply various filters in medical images, highlighting regions of interest in skin cancer

EXPERIMENT 3 **3 Hours**

Non-Melanoma Skin Cancer detection using various edge detection techniques.

EXPERIMENT 4 **3 Hours**

To detect and segment lung nodules in CT scan images using neighbourhood operations for texture analysis and morphological operations for refinement.

EXPERIMENT 5 **6 Hours**

Performance analysis of brain tumors detection algorithm using nonlinear operators to process similarity and consistency in images.

EXPERIMENT 6 **6 Hours**

Apply pseudo-color generation to highlight the detected brain tumor regions.

EXPERIMENT 7 **6 Hours**

Integrate Parallel Beam and Fan Beam CT Geometries for Enhancing Clarity of Cancer-Type Images Through Blur Reduction.

Total: 75 Hours

Reference(s)

1. Rafael C. Gonzalez, Richard E. Woods, Digital Image Processing, Pearson, Education, Inc., 4th Edition, 2018
2. S.Sridhar, Digital Image processing, Oxford University press, 2ndEdition, 2016.
3. Anil K. Jain, Fundamentals of Digital Image Processing, Pearson Education, Inc., 1st Edition, 2015.
4. Milan Sonka, Vaclav Hlavac and Roger Boyle, Image Processing, Analysis and Machine vision, Cengage, 4th Edition, 2017.
5. Alan C. Bovik, Handbook of image and video processing, Elsevier Academic press, 2005.

22BM503 HEALTHCARE ANALYTICS 3 0 0 3

Course Objectives

- To understand the fundamentals of data mining techniques in healthcare.
- To understand the healthcare data analytics approaches used.
- To analyze the effective information retrieval from healthcare data using data analytics approaches.

Program Outcomes (POs)

PO2. 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.
PO3. 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.
PO4. 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.
PO6. 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.
PO8. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO12. 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.
PSO1. Apply knowledge on foundation in Life Science, engineering, mathematics and current biomedical engineering practices with an ability to demonstrate advanced knowledge of a selected area within Biomedical Engineering.
PSO2. Critically analyse the current healthcare systems and develop innovative solutions effectively through problem specific design and development using modern hardware and software tools.

Course Outcomes (COs)

1. Assess the fundamental concepts of healthcare data analytics
2. Analyze the effectiveness of data mining in clinical and non-clinical applications
3. Categorize the approaches to retrieve data from social media.
4. Analyze the process of advanced healthcare data analytics
5. Analyze the information present based on visual characteristics of an expert system.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	-	2	-	2	-	-	-	1	-	-	-	1	1	-	-
2	-	3	-	2	-	1	-	1	-	-	-	2	-	2	-
3	-	2	2	3	-	1	-	1	-	-	-	-	-	-	-
4	-	3	-	2	-	-	-	-	-	-	-	-	-	-	-
5	-	3	-	2	-	-	-	-	-	-	-	-	-	-	-

UNIT I **9 Hours**

INTRODUCTION TO HEALTHCARE DATA ANALYTICS

Introduction, Healthcare data sources and basic analytics, Advanced data analytics for healthcare, Applications and practical systems for healthcare, resources for healthcare data analytics- Healthcare data sources and Basic analytics: Electronic Health Records (EHR), Components of EHR, Coding systems, Benefits of EHR, Barriers to Adopting EHR, Challenges using EHR data.

UNIT II **9 Hours**

MINING OF SENSOR DATA AND DATA MINING

Introduction, Scopes and Challenges in mining sensor data, Challenges in Healthcare data analytics, sensor data mining applications, Nonclinical Health care applications, Introduction to data mining, Natural language processing, Mining information from clinical text and current methodologies, Informatics for integrating Biology, Challenges of processing clinical reports, Clinical applications.

UNIT III **9 Hours**

SOCIAL MEDIA ANALYTICS

Introduction, Social media analysis for detection and tracking of infectious disease outbreaks: Outbreak detection, Analyzing and tracking outbreaks, syndromic surveillance systems based on social media, Social medical analysis for public health reserach: Topic models for analyzing health-related contents, detecting reports of adverse medical events and drug reactions, characterising life style and well-being, analysis of social media use in healthcare.

UNIT IV **9 Hours**

ADVANCED DATA ANALYTICS FOR HEALTHCARE

Introduction- Basic statistical prediction models: Linear regression, generalized additive model, Logistic regression: Multi class, polytomous and ordered Logistic regression, Bayesian models, Markov Random Fields, Alternative clinical prediction models: Decision trees, ANN, cost sensitive learning, Advanced prediction models, survival models, Evaluation and validation.

UNIT V **9 Hours**

VISUAL ANALYTICS AND INFORMATION RETRIEVAL FOR HEALTHCARE

Introduction, Medical data visualization, Visual analytics in Healthcare, Introduction to information retrieval, Knowledge based information in healthcare and biomedicine, content of knowledge- based information resources, indexing, retrieval: Exact match and partial match retrieval, Evaluation: system-oriented evaluation, user oriented evaluation, Introduction to clinical decision support system

Total: 45 Hours

Reference(s)

1. Tinglong Dai, Sridhar Tayur, Handbook of Healthcare Analytics, Wiley, 2018
2. Hui Yang, Eva K, Lee, Healthcare Analytics: From Data to Knowledge to Healthcare Improvement, Wiley, 2016.
3. Vikas Kumar, Healthcare Analytics Made simple, Pack Publishing, 2018.
4. Chandan K Reddy and Charu C. Aggarwal, Healthcare Data Analytics, CRC Press,2015
5. Raymond A Gensinger, Analytics in Healthcare : An Introduction, HIMSS, 2014

22BM504 BIOCONTROL SYSTEMS 3 1 0 4

Course Objectives

- To Study the principles of system modelling, system analysis and feedback control, and use them to design and evaluate feedback control systems with desired performance.
- Control system modelling: modelling of electric and mechanical systems, using differential equations, transfer functions, block diagrams, and state variables.
- Control system analysis: analysis of properties of control systems, such as stability, controllability, tracking, in time and frequency domains.
- Analyze the frequency domain specifications of the different systems.
- To study the concept of a physiological control system.

Program Outcomes (POs)

PO1. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. 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.
PO3. 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.
PO4. 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.
PO12. 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.
PSO1. Apply knowledge on foundation in Life Science, engineering, mathematics and current biomedical engineering practices with an ability to demonstrate advanced knowledge of a selected area within Biomedical Engineering.

Course Outcomes (COs)

1. Formulate the transfer function model of electrical and mechanical systems.
2. Analyse the time response and steady error for the different order systems to various inputs.
3. Implement the stability condition for the given biocontrol systems
4. Analyse performance of the system using frequency response methods.
5. Categorize the model of physiological control systems.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	3	1	-	-	-	-	-	-	-	-	1	1	-	-
2	2	3	-	2	-	-	-	-	-	-	-	-	1	-	-
3	-	3	-	2	-	-	-	-	-	-	-	1	1	-	-
4	-	3	-	2	-	-	-	-	-	-	-	-	1	-	-
5	-	2	2	3	-	-	-	-	-	-	-	1	1	-	-

UNIT I **9 Hours**

CONTROL SYSTEM MODELING

Terminology and the basic structure of control system, the example of a closed loop system, transfer function, modeling of electrical systems, translational and rotational mechanical systems, and electromechanical systems, block diagram and signal flow graph representation of systems, reduction of the block diagram, and signal flow graph, conversion of the block diagram to signal flow graph, Need for modeling physiological system.

UNIT II **9 Hours**

TIME RESPONSE ANALYSIS

Step and impulse responses of the first-order and second-order systems, determination of time-domain specifications of first and second- order systems from its output responses, the definition of steady-state error constants, and its computations. Introduction to PI, PD and PID controllers.

UNIT III **9 Hours**

STABILITY ANALYSIS

Definition of stability, Routh-Hurwitz criteria of stability, root locus technique, construction of root locus and study of stability, the definition of dominant poles, and relative stability.

UNIT IV **9 Hours**

FREQUENCY RESPONSE ANALYSIS

Frequency response, Nyquist stability criterion, Nyquist plot, and determination of closed-loop stability, the definition of gain margin and phase margin, Bode plot, determination of gain margin and phase margin using Bode plot, use of Nicholas chart to compute frequency and bandwidth.

UNIT V **9 Hours**

PHYSIOLOGICAL CONTROL SYSTEM

Example of the physiological control system, the difference between engineering and physiological control systems, generalized system properties, models with the combination of system elements, linear models of physiological systems-Examples, Introduction to simulation, Illustration with real-time applications.

Tutorial: 15 Hours
Total: 60 Hours

Reference(s)

1. I..J. Nagrath and M. Gopal, "Control System Engineering", New Age International Publisher, 2011.
2. Benjamin C. Kuo, "Automatic Control Systems", Prentice-Hall of India Pvt. Ltd, 2012
3. M. Gopal, "Control Systems Principles and Design", Tata McGraw-Hill, 2012
4. M.N. Bandyopadhyay, "Control Engineering Theory and Practice", Prentice Hall of India, 2009.
5. Norman S. Nise, "Control Systems Engineering", 4th edition, New York, John Wiley, 2003.
6. K. Ogatta, "Modern Control Engineering", Pearson Education, New Delhi, 2010.

22BM507 MINI PROJECT **0 0 2 1**

Course Objectives

- Identify the problem statement and apply the engineering concepts to find the solution.
- Improve the analysing capability of the students.
- Increase the exuberance in finding the solution to various problems.

Program Outcomes (POs)

PO1. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. 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.
PO3. 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.
PO4. 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.
PO5. 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.
PO8. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO9. Individual and Team Work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO10. 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.
PO11. Project Management and Finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PSO1. Apply knowledge on foundation in Life Science, engineering, mathematics and current biomedical engineering practices with an ability to demonstrate advanced knowledge of a selected area within Biomedical Engineering.
PSO2. Critically analyse the current healthcare systems and develop innovative solutions effectively through problem specific design and development using modern hardware and software tools.
PSO3. Hands-on knowledge on cutting edge hardware and software tools to acquire real time data, model and simulate physiological processes and analyse limitations on real time implementations.

Course Outcomes (COs)

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

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	1	2	1	1	2	-	-	2	2	2	-	-	1	1	1
2	1	2	1	1	2	-	-	2	2	2		-	1	1	1
3	1	2	1	1	2	-	-	2	2	2	2	-	1	1	1
4	1	2	1	1	2	-	-	2	2	2	2	-	1	1	1
5	1	2	-	-	2	-	-	2	2	2	-	-	1	1	1

22BM601 DIAGNOSTIC AND THERAPEUTIC EQUIPMENT

3 0 2 4

Course Objectives

- To understand the ECG, EEG and EMG devices for measurement of physiological parameters.
- To explain diagnostic and therapeutic devices related to respiratory parameters.
- To understand the various sensory measurements that hold clinical importance.

Program Outcomes (POs)

PO1. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. 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.
PO4. 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.
PO8. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO12. 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.
PSO1. Apply knowledge on foundation in Life Science, engineering, mathematics and current biomedical engineering practices with an ability to demonstrate advanced knowledge of a selected area within Biomedical Engineering.
PSO2. Critically analyse the current healthcare systems and develop innovative solutions effectively through problem specific design and development using modern hardware and software tools.
PSO3. Hands-on knowledge on cutting edge hardware and software tools to acquire real time data, model and simulate physiological processes and analyse limitations on real time implementations.

Course Outcomes (COs)

1. Analyze the working and recording setup of all basic cardiac equipment.
2. Evaluate the working and recording of all basic neurological equipment.
3. Categorize and analyze various diagnostic and therapeutic equipment related to EMG.
4. Apply the appropriate measurement and assistive techniques related to the respiratory system.
5. Analyze the performance of sensory diagnostic equipment.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	2	-	1	-	-	-	1	-	-	-	1	2	1	1
2	3	2	-	1	-	-	-	1	-	-	-	1	2	1	1
3	3	2	-	2	-	-	-	1	-	-	-	1	2	1	1
4	3	2	-	1	-	-	-	1	-	-	-	1	2	1	1
5	3	3	-	2	-	-	-	1	-	-	-	1	2	1	1

UNIT I **9 Hours**

CARDIAC EQUIPMENT

Electrocardiograph, Normal and Abnormal Waves, Heart rate monitor, Holter Monitor, Phonocardiography, ECG machine maintenance and troubleshooting, Cardiac Pacemaker- Internal and External Pacemaker- Batteries, AC and DC Defibrillator- Internal and External, Defibrillator Protection Circuit, Cardiac ablation catheter.

UNIT II **9 Hours**

NEUROLOGICAL EQUIPMENT

Clinical significance of EEG, Multi-channel EEG recording system, Epilepsy, Evoked Potential-Visual, Auditory and S0matosensory, MEG (Magneto Encephalograph). EEG Bio Feedback Instrumentation. EEG system maintenance and troubleshooting.

UNIT III **9 Hours**

MUSCULAR AND BIOMECHANICAL EQUIPMENT

Recording and analysis of EMG waveforms, fatigue characteristics, Muscle stimulators, nerve stimulators, Nerve conduction velocity measurement, EMG Bio Feedback Instrumentation. Static Measurement - Load Cell, Pedobarograph. Dynamic Measurement - Velocity, Acceleration, GAIT, Limb position.

UNIT IV **9 Hours**

RESPIRATORY MEASUREMENT AND ASSIST SYSTEM

Instrumentation for measuring the mechanics of breathing - Spirometer- Lung Volume and vital capacity, measurements of residual volume, Pneumotachomter - Airway resistance measurement, Whole body Plethysmograph, Intra-Alveolar and Thoracic pressure measurements, Apnoea Monitor. Types of Ventilators - Pressure, Volume, and Time Controlled. Flow, Patient Cycle Ventilators, Humidifiers, Nebulizers, Inhalators.

UNIT V **9 Hours**

SENSORY DIAGNOSTIC EQUIPMENT

Psychophysiological Measurements - polygraph, basal skin resistance (BSR), galvanic skin resistance (GSR), Sensory responses - Audiometer-Pure tone, Speech, Eye Tonometer, Applanation Tonometer, slit lamp, auto refractometer.

3 Hours

EXPERIMENT 1

Auditory system check-up using Audiometer

3 Hours

EXPERIMENT 2

Pacemaker Simulator analysis

3 Hours

EXPERIMENT 3

Examine Bio telemetry.

3 Hours

EXPERIMENT 4

Working operation of CPAP ventilator

3 Hours

EXPERIMENT 5

Demonstration of Heart Lung machine model

3 Hours

EXPERIMENT 6
Demonstration of Hemodialysis model

3 Hours

EXPERIMENT 7
Electrical safety measurements

3 Hours

EXPERIMENT 8
Inspection ESU - cutting and coagulation modes.

3 Hours

EXPERIMENT 9
Visual evoked potential analysis using EEG

3 Hours

EXPERIMENT 10
Study of Ultrasound imaging modality

Total: 75 Hours

Reference(s)

1. John G. Webster, "Medical Instrumentation Application and Design", 4th edition, Wiley India Pvt. Ltd, New Delhi, 2012
2. Joseph J. Carr and John M. Brown, "Introduction to Biomedical Equipment Technology", Pearson education, 2012.
3. L.A Geddes and L.E. Baker, "Principles of Applied Biomedical Instrumentation", 3rd edition, 2008.
4. Khandpur. R.S., "Handbook of Biomedical Instrumentation", Second edition, Tata McGrawHill Pub.Co.,Ltd. 2003.
5. Antony Y.K.Chan, "Biomedical Device Technology, Principles and Design", Charles Thomas Publisher Ltd, Illinois, USA, 2008.
6. Lesile Cromwell, "Biomedical Instrumentation and Measurement", Pearson Education, New Delhi, 2007.

3 0 2 4

22BM602 BIOMECHANICS

Course Objectives

- To study the mechanics involved with various physiological systems.
- To gain knowledge in deriving the mathematical models related to blood vessels.

Program Outcomes (POs)

PO1. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. 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.
PO3. 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.
PO4. 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.
PO5. 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.
PO6. 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.
PO8. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO12. 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.
PSO1. Apply knowledge on foundation in Life Science, engineering, mathematics and current biomedical engineering practices with an ability to demonstrate advanced knowledge of a selected area within Biomedical Engineering.
PSO2. Critically analyse the current healthcare systems and develop innovative solutions effectively through problem specific design and development using modern hardware and software tools.
PSO3. Hands-on knowledge on cutting edge hardware and software tools to acquire real time data, model and simulate physiological processes and analyse limitations on real time implementations.

Course Outcomes (COs)

1. Analyze the fundamental concepts of biomechanics in engineering its properties.
2. Apply the solid and fluid dynamics in biomechanics.
3. Analyze the mechanical properties of hard and soft tissues.
4. Analyze the biomechanical properties of joints.
5. Design and develop the models specific to orthopaedic applications.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	2	-	1	2	1	-	-	-	-	-	1	2	-	2
2	3	2	-	2		1	-	-	-	-	-	1	2	-	2
3	3	2	-	2	2	1	-	-	-	-	-	1	2	-	2
4	3	2	-	2	2	1	-	-	-	-	-	1	2	-	2
5	2	2	3	2	2	1	-	2	-	-	-	1	2	2	2

UNIT I **9 Hours**

INTRODUCTION

Definition and perspective of biomechanics, Kinematic concept for analysing human motion, Kinetic concepts for analyzing human motion, Linear kinetics of human movement, Equilibrium, Angular kinetics of human movement, Anthropometry.

UNIT II **9 Hours**

BIOMECHANICS OF SOLIDS AND FLUIDS

Constitutive Equation, Stress, strain, viscoelasticity, models of viscoelasticity, Flow properties of blood, dynamics of fluid flow in cardiovascular system, Rheology of blood in micro vessels, Bio viscoelastic solids, Lubrication of joints.

UNIT III **9 Hours**

BIOMECHANICS OF HARD AND SOFT TISSUES

Bone: structure, composition, mechanical properties, anisotropy, fracture mechanisms - pseudo elasticity, Structure, function, mechanical properties of: skin, ligaments, skeletal muscles and tendons, Constitutive equations for soft tissues.

UNIT IV **9 Hours**

BIOMECHANICS OF JOINTS

Kinetics and kinematics of joints, Skeletal joints, mechanics of the elbow, mechanics of shoulder, mechanics of spinal column, mechanics of hip, mechanics of knee, mechanics of ankle.

UNIT V **9 Hours**

ORTHOPAEDIC APPLICATIONS

Gait analysis, Qualitative biomechanical analysis to: improve technique, understand injury development, Amputations and prosthetics, prosthetic components, Introduction to 3D printing, Introduction to accelerometer.

3 Hours

EXPERIMENT 1

Introduction to Motion Analysis: Linear Kinematics and Total Body Centre of Mass (TBCM).

3 Hours

EXPERIMENT 2

Angular Kinematics.

3 Hours

EXPERIMENT 3

Linear impulse and momentum.

3 Hours

EXPERIMENT 4
Angular impulse and momentum.

3 Hours

EXPERIMENT 5
Total Body Kinetics.

3 Hours

EXPERIMENT 6
A Joint Kinetics.

3 Hours

EXPERIMENT 7
Force measurement using Foot sensors.

3 Hours

EXPERIMENT 8
Musculoskeletal modelling.

3 Hours

EXPERIMENT 9
Simulation of Musculoskeletal models.

3 Hours

EXPERIMENT 10
A Gait Analysis

Total: 75 Hours

Reference(s)

1. Susan J Hall, Basics of Biomechanics, McGraw Hill Publishing.co. New York, 8th Edition, 2019.
2. Joseph D.Bronzino, Biomedical Engineering Fundamentals, Taylor& Francis, Fourth edition,2015.
3. John Enderle, Susanblanchard, Joseph Bronzino, Introduction to Biomedical Engineering, Elsevier, Third edition, 2011.
4. C. Ross Ether and Craig A. Simmons, Introductory Biomechanics from cells to organisms, Cambridge University Press, New Delhi, 2007.
5. Y.C.Fung, Bio-Mechanics, Mechanical Properties of Tissues, Springer-Verilog,1993.
6. Dhanjoo N. Ghista, Orthopaedic Mechanics, Academic Press, 1990.

22BM603 ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING

3 0 2 4

Course Objectives

- To understand the problem solving intelligent agents and searching techniques.
- To Impart domain knowledge in different machine learning method.
- To realize the different applications in AI

Program Outcomes (POs)

PO1. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. 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.
PO3. 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.
PO4. 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.
PO5. 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.
PO6. 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.
PO7. 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.
PO12. 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.
PSO1. Apply knowledge on foundation in Life Science, engineering, mathematics and current biomedical engineering practices with an ability to demonstrate advanced knowledge of a selected area within Biomedical Engineering.
PSO2. Critically analyse the current healthcare systems and develop innovative solutions effectively through problem specific design and development using modern hardware and software tools.
PSO3. Hands-on knowledge on cutting edge hardware and software tools to acquire real time data, model and simulate physiological processes and analyse limitations on real time implementations.

Course Outcomes (COs)

1. Analyze the concepts of intelligent agents and its structure
2. Apply the appropriate search algorithms for solving given AI problems.
3. Differentiate learning strategies, regression and classification in Artificial Intelligence Systems.
4. Analyze the basic concepts of reinforcement learning and find solutions
5. Implement the machine learning techniques in AI applications.

Articulation Matrix

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

UNIT I **9 Hours**

INTELLIGENT AGENTS

Introduction to AI, Agents and Environments, Concept of rationality, Nature of environments, Structure of agents, problem solving agents, search algorithms, uninformed search strategies

UNIT II **9 Hours**

PROBLEM SOLVING

Heuristic search strategies, Heuristic functions, Local search and optimization problems, Local search in continuous space Online search agents and unknown environments, optimal Decisions in games, Constraint satisfaction problems (CSP).

UNIT III **9 Hours**

MACHINE LEARNING METHODS

Forms of learning, Supervised learning, Learning decision trees, Evaluation and choosing the best hypothesis, Theory of Learning, Regression and classification with linear models, Artificial Neural network, Non parametric model, Support vector machine, Ensemble learning.

UNIT IV **9 Hours**

REINFORCEMENT LEARNING

Introduction to Reinforcement Learning, Active and Passive Reinforcement Learning, Generalization in reinforcement learning, Policy Search, Applications of Reinforcement Learning.

UNIT V **9 Hours**

AI APPLICATIONS

Natural Language Processing Language Models, Text Classification, Information Retrieval, Information Extraction, Machine Translation, Speech Recognition, Robotics, Robotic Hardware and Robotic perception.

4 Hours

EXPERIMENT 1

Develop PEAS descriptions for given AI task

4 Hours

EXPERIMENT 2

Implement basic search strategies for selected AI applications

5 Hours

EXPERIMENT 3

Implement a classifier for the sales data

5 Hours

EXPERIMENT 4

Develop a predictive model for predicting house prices

6 Hours

EXPERIMENT 5

Apply reinforcement learning and develop a game of your own

6 Hours

EXPERIMENT 6

Apply Natural language processing to develop filters for spam and non-spam mails

Total: 75 Hours

Reference(s)

1. Stuart Jonathan Russell, Peter Norvig, John Canny, Artificial Intelligence: A Modern Approach, Prentice Hall,Fourth edition, 2020
2. Ameet V Joshi, Machine Learning and Artificial Intelligence, Springer Publications, 2020
3. T.M. Mitchell, Machine Learning, McGraw-Hill 2017
4. Ethem Alpaydin,Introduction to Machine Learning, MIT Press, Third edition 2014
5. Stephen Marsland, Machine Learning An Algorithmic Perspective, Second Edition, Chapman and Hall/CRC Machine Learning and Pattern Recognition Series, 2014

22BM607 MINI PROJECT II **0 0 2 1**

Course Objectives

- Identify the problem statement and apply the engineering concepts to find the solution.
- Improve the analysing capability of the students.
- Increase the exuberance in finding the solution to various problems.

Program Outcomes (POs)

PO1. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. 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.

PO3. 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.

PO4. 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.

PO5. 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.

PO8. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO9. Individual and Team Work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10. 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.

PO11. Project Management and Finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PSO1. Apply knowledge on foundation in Life Science, engineering, mathematics and current biomedical engineering practices with an ability to demonstrate advanced knowledge of a selected area within Biomedical Engineering.

PSO2. Critically analyse the current healthcare systems and develop innovative solutions effectively through problem specific design and development using modern hardware and software tools.

PSO3. Hands-on knowledge on cutting edge hardware and software tools to acquire real time data, model and simulate physiological processes and analyse limitations on real time implementations.

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, and techniques that contribute to obtaining the solution of the project.
4. Test and validate through conformance of the developed prototype and analysis of the cost-effectiveness.
5. Prepare the report and present oral demonstrations.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	1	2	1	1	2	-	-	2	2	2	-	-	1	1	1
2	1	2	1	1	2	-	-	2	2	2	-	-	1	1	1
3	1	2	1	1	2	-	-	2	2	2	-	-	1	1	1
4	1	2	1	1	2	-	-	2	2	2	2	-	1	1	1
5	1	2	-	-	2	-	-	2	2	2	-	-	1	1	1

3 0 0 3

22BM701 RADIOLOGICAL EQUIPMENT

Course Objectives

- To understand the principle of X-ray, Computed Tomography, MRI and its uses in imaging
- To study the principles of different radio diagnostic equipment in Imaging
- To understand radiation therapy techniques and radiation safety.

Program Outcomes (POs)

PO1. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. 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.
PO4. 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.
PO8. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO12. 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.
PSO1. Apply knowledge on foundation in Life Science, engineering, mathematics and current biomedical engineering practices with an ability to demonstrate advanced knowledge of a selected area within Biomedical Engineering.
PSO2. Critically analyse the current healthcare systems and develop innovative solutions effectively through problem specific design and development using modern hardware and software tools.

Course Outcomes (COs)

1. Analyze the working principle of the X-ray machine and its application.
2. Apply the concept of computer tomography for imaging applications.
3. Analyze the technique used for visualizing various sections of the body using magnetic resonance imaging
4. Apply the suitable nuclear medicine techniques for disease diagnosis
5. Evaluate the features of radiation measuring instruments and radiation safety.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	1	2	-	-	-	-	-	1	-	-	-	1	2	-	-
2	1	2	-	3	-	-	-	1	-	-	-	1	2	2	-
3	1	2	-	3	-	-	-	1	-	-	-	1	2	2	-
4	1	2	-	3	-	-	-	1	-	-	-	1	2	2	-
5	1	2	-	3	-	-	-	1	-	-	-	1	2	2	-

UNIT I **9 Hours**

MEDICAL X-RAY EQUIPMENT

Nature of X-rays- X-Ray absorption - Tissue contrast. X- Ray Equipment (Block Diagram)- X-Ray tube, collimator, Bucky Grid, power supply, Cathode and filament currents, focusing cup, Thermionic emission, Electromagnet induction, Line focus principle and the heel effect, causes of x-ray tube failure: Electron arcing/ filament burn out, Failure to warm up tube, High temperature due to over exposure, x-ray tube rating charts. X- ray image intensifier tubes - Fluoroscopy - Digital Fluoroscopy - Digital Fluoroscopy. Angiography, Cine Angiography, Digital subtraction Angiography. Mammography and Dental X-ray unit.

UNIT II **9 Hours**

COMPUTED TOMOGRAPHY

Principles of tomography, CT Generations, X- Ray sources- collimation - X- ray detectors- Viewing systems- spiral CT Scanning - Ultra fast CT Scanners. Advantages of computed radiography over film screen radiography: Time, Image quality, Lower patient dose, Differences between conventional imaging equipment and digital imaging equipment: Image plate, Plate readers, Image characteristics, Image reconstruction techniques- back propagation and iterative method. Spiral CT, 3D Imaging and its application.

UNIT III **9 Hours**

MAGNETIC RESONANCE IMAGING

Fundamentals of magnetic resonance- Interaction of Nuclei with static magnetic field and Radio frequency wave - rotation and precession - Introduction of magnetic resonance signals - bulk magnetization- Relaxation processes T1 and T2. Block Diagram approach of MRI system- system magnet (Permanent, Electromagnet and super conductors), generations of gradient magnetic fields, Radio Frequency coils (sending and receiving), and shim coils, Electronic components, fMRI.

UNIT IV **9 Hours**

NUCLEAR MEDICINE TECHNIQUES

Nuclear imaging- Anger scintillation camera- Nuclear tomography- single photon emission computer tomography, positron emission tomography - Recent advances- Radionuclide imaging- Bone imaging, dynamic renal function, myocardial perfusion. Non imaging techniques- haematological measurements, Glomerular filtration rate, volume measurements, clearance measurement, whole-body counting, surface counting.

UNIT V **9 Hours**

RADIATION THERAPY AND RADIATION SAFETY

Radiation therapy- linear accelerator, Telegram Machine. SRS-SRT, Recent Techniques in radiation therapy - 3DCRT-IMRT-IGRT and Cyber knife- radiation measuring instruments- Dosimeter, film badges, Thermo Luminescent dosimeters- electronic dosimeter- Radiation protection in medicine- radiation protection principles.

Total: 45 Hours

Reference(s)

1. P. Ragunathan, "Magnetic Resonance Imaging and Spectroscopy in Medicine Concepts and Techniques", Paperback - Import, 2007.
2. Gopal B. Saha, "Physics and Radiobiology of Nuclear Medicine"- Third edition Springer, 2006.
3. Myer Kutz, "Standard handbook of Biomedical Engineering and design", McGraw Hill, 2003.
4. R. Hendee and Russell Ritenour "Medical Imaging Physics", Fourth Edition William, Wiley-Liss, 2002.
5. B.H.Brown, PV Lawford, R H Small wood, D R Hose, D C Barber, "Medical physics and Biomedical Engineering", CRC Press, 1999.
6. Steve Webb, "The Physics of Medical Imaging", Adam Hilger, Philadelpia, 1988.

22BM702 HOSPITAL SYSTEM MANAGEMENT 3 0 2 4

Course Objectives

- To understand the fundamentals of hospital administration and management.
- To explore various information management systems and relative supportive services.
- To learn the quality and safety aspects in hospitals.

Program Outcomes (POs)

PO2. 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.
PO3. 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.
PO4. 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.
PO6. 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.
PO7. 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.
PO8. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO12. 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.
PSO3. Hands-on knowledge on cutting edge hardware and software tools to acquire real time data, model and simulate physiological processes and analyse limitations on real time implementations.

Course Outcomes (COs)

1. Analyze the challenges in hospital administration with appropriate hospital management system.
2. Analyze the functions and characteristics of human resource management in hospitals.
3. Implement the various marketing research techniques and its challenges involved in Hospital system management.
4. Outline the quality and safety aspects to be maintained in the Hospital environment.
5. Structure the Information system to be implemented in the Hospital environment.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	-	3	-	-	-	2	-	1	-	1	-	1	-	-	-
2	-	3	-	1	-	2	-	1	-	1	-	1	-	-	-
3	-	2	2	2	-	2	2	1	-	1	-	1	-	-	2
4	-	2	2	2	-	2	3	1	-	1	-	2	-	-	2
5	-	2	3	1	-	2	-	1	-	1	-	2	-	-	3

UNIT I **9 Hours**

HOSPITAL MANAGEMENT

Nature and Scope of a hospital, History of Indian Hospitals, Distinction between Hospital and Industry, Challenges in Hospital Administration, Hospital Planning- Equipment Planning - Functional Planning- Current issues in Hospital Management- Telemedicine- Biomedical Waste Management.

UNIT II **9 Hours**

HUMAN RESOURCE MANAGEMENT IN HOSPITAL

Human Resource Management- Principles, Characteristics, Functions, Significance and Importance - Profile of HRD Manager, Good HR Practices, Causes for Poor Human Resource Management, Tools of HRD, Human Resources Inventory- Manpower Planning, Recruitment, Selection, Induction, Training Guidelines, Promotion, Termination and Communication.

UNIT III **9 Hours**

HOSPITAL DATA MANAGEMENT

Managing A Service Organization - Hospital Service Delivery - Quality Control- Six Sigma, NABH. Hospital Queuing Systems - Simple Queuing Systems, Interdependent Queuing Systems- Hospital Management Functions - Operation Management, Finance and Cost Management, Materials Management - Case Studies.

UNIT IV **9 Hours**

QUALITY AND SAFETY ASPECTS IN HOSPITAL

Quality system - Elements, implementation of quality system, Documentation, Quality auditing, International Standards ISO 9000-9004- Features of ISO 9001- ISO 14000 - Environment Management Systems, NABA, JCI, NABL. Security - Loss Prevention - Fire Safety- Alarm System- Safety Rules. Health Insurance & Managing Health Care- Medical Audit- Hazard and Safety in a Hospital Setup.

UNIT V **9 Hours**

HOSPITAL INFORMATION SYSTEMS

Management Decisions and Related Information Requirement - Clinical Information Systems- Administrative Information Systems - Support Service Technical Information Systems - Medical Transcription, Medical Records Department- Central Sterilization and Supply Department- Pharmacy- Food Services- Laundry Services.

HOSPITAL TRAINING **30 Hours**

Students need to complete training in any leading Multi-specialty hospital for 30 Hours. They need to prepare an extensive report and submit to their respective course in- charges during the session. Out of the following departments, it is mandatory to complete training in any 10. The students can give a presentation of the remaining departments

Departments for visit

1 Cardiology
2 ENT
3 Ophthalmology
4 Orthopedic and Physiotherapy
5 ICU/CCU
6 Operation Theatre
7 Neurology
8 Nephrology
9 Radiology
10 Nuclear Medicine

11 Pulmonology
12 Urology
13 Obstetrics and Gynaecology
14 Emergency Medicine
15 Biomedical Engineering Department
16 Histo-Pathology
17 Biochemistry
18 Pediatric/Neonatal
19 Dental
20 Oncology
21 PACS
22 Medical Records and Telemetry

Total: 75 Hours

Reference(s)

1. Ramani K V, Hospital Management - Text and Cases, Pearson education, New Delhi, 2012.
2. Malhotra A K, Hospital Management - An Evaluation, Global India Publications, New Delhi, 2009.
3. G.D.Kunders, Hospitals Facilities Planning and Management - TMH, New Delhi - Fifth Reprint 2007.
4. R.C.Goyal, Hospital Administration and Human Resource Management, PHI -Fourth Edition, 2006.
5. Blane, David, Brunner, Health and social organization: Towards a Health Policy for the 21st Century, Eric Calrendon Press 2002.
6. Norman Metzger, Handbook of Health Care Human Resources Management, 2nd edition Aspen Publication Inc. Rockville, Maryland, USA, 1990.

22BM707 PROJECT WORK I **0 0 4 2**

Course Objectives

- Work in teams to propose, formulate, and solve a challenging open-ended design problem of significant scope, depth, and breadth.
- Understand and incorporate engineering standards and multiple realistic constraints, within realistic design time, budget, and performance objectives.
- Develop a prototype of the proposed design and demonstrate the prototype in accordance with the specifications.
- Effectively communicate information relating to all aspects of the design process in written, oral, and graphical form.

Program Outcomes (POs)

PO1. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. 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.

PO3. 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.

PO4. 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.

PO5. 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.

PO6. 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.

PO7. 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.

PO8. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO9. Individual and Team Work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10. 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.

PO11. Project Management and Finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one’s own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO12. 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.

PSO1. Apply knowledge on foundation in Life Science, engineering, mathematics and current biomedical engineering practices with an ability to demonstrate advanced knowledge of a selected area within Biomedical Engineering.

PSO2. Critically analyse the current healthcare systems and develop innovative solutions effectively through problem specific design and development using modern hardware and software tools.

PSO3. Hands-on knowledge on cutting edge hardware and software tools to acquire real time data, model and simulate physiological processes and analyse limitations on real time implementations.

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	PSO1	PSO2	PSO3
1	2	2	3	3	1	3	3	3	3	3	-	2	3	3	3
2	2	2	3	3	1	3	3	3	3	3	-	2	3	3	3
3	2	2	3	3	3	3	3	3	3	3	2	2	3	3	3
4	2	2	3	3	3	3	3	3	3	3	2	2	3	3	3
5	2	2	-	-	2	-	-	3	3	3	-	2	3	3	3

22BM801 PROJECT WORK II 0 0 20 10

Course Objectives

- Work in teams to propose, formulate, and solve a challenging open-ended design problem of significant scope, depth, and breadth.
- Understand and incorporate engineering standards and multiple realistic constraints, within realistic design time, budget, and performance objectives.
- Develop a prototype of the proposed design and demonstrate the prototype in accordance with the specifications.
- Effectively communicate information relating to all aspects of the design process in written, oral, and graphical form.

Program Outcomes (POs)

PO1. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. 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.

PO3. 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.

PO4. 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.

PO5. 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.

PO6. 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.

PO7. 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.

PO8. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO9. Individual and Team Work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10. 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.

PO11. Project Management and Finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO12. 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.

PSO1. Apply knowledge on foundation in Life Science, engineering, mathematics and current biomedical engineering practices with an ability to demonstrate advanced knowledge of a selected area within Biomedical Engineering.

PSO2. Critically analyse the current healthcare systems and develop innovative solutions effectively through problem specific design and development using modern hardware and software tools.

PSO3. Hands-on knowledge on cutting edge hardware and software tools to acquire real time data, model and simulate physiological processes and analyse limitations on real time implementations.

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	PSO1	PSO2
1	2	2	3	3	1	3	3	3	3	3	-	2	3	3
2	2	2	3	3	1	3	3	3	3	3	-	2	3	3
3	2	2	3	3	3	3	3	3	3	3	2	2	3	3
4	2	2	3	3	3	3	3	3	3	3	2	2	3	3
5	2	2	-	-	2	-	-	3	3	3	-	2	3	3

22HS201 COMMUNICATIVE ENGLISH II 1 0 2 2

Course Objectives

- Command over the English language for day-to-day transactions.
- Improve listening and reading skills to comprehend complex content
- Enhance confidence in expressing with clarity and elegance with enthusiastic and reflective use of the language

Programme Outcomes (POs)

PO9. Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10.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.

PO12.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. Engage with the English language in functional contexts
2. Express in both descriptive and narrative formats
3. Interpolate and make effective use of the English Language in Business contexts
4. Actively read and comprehend authentic text
5. Express opinions and communicate experiences.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	-	-	-	-	-	-	-	-	3	3	-	3	-	-	-
2	-	-	-	-	-	-	-	-	3	3	-	3	-	-	-
3	-	-	-	-	-	-	-	-	3	3	-	3	-	-	-
4	-	-	-	-	-	-	-	-	3	3	-	3	-	-	-
5	-	-	-	-	-	-	-	-	3	3	-	3	-	-	-

UNIT I **15 Hours**

SELF-EXPRESSION

Personal Goals and Values - Being a Team Player-Expressing strengths and Weaknesses-Abstract nouns -Adjectives-Active Listening Skills-Note Making-Pronunciation and Accent Personal goals and values - Reading for Gist and Details-Professional Ethics-Reported Speech- Conjunctions Reading skills - phonemics, word/phrase recognition, sight words Personal Goals and Values-Conditional clauses- Hypothetical questions and Answers-Sentence Structure-Simple Present Tense-Perfect tense

UNIT II **15 Hours**

CREATIVE EXPRESSION

Instructive and Expository Expression - Creating brochures, catalogues, and manuals for products/ services, Giving directions, Process writing, Sequencing experiments, Concept Explanation-Reported Speech-Voice Sentence Equivalence-Proofreading

UNIT III **15 Hours**

FORMAL EXPRESSION

Notices and Announcements-Writing: Creating notices and circulars for events, announcing college tours and lost and Found-Varied Vocabulary - Gender Sensitive Vocabulary, Non-discriminatory Vocabulary, Concise Vocabulary-Paragraph writing - Effective titles, topics and supporting sentences, calling in registrations and queries. Effective communication- Understanding purpose, reach and target audience, achieving complete communication Punctuation - Capitalization, Numeration, Use of proper nouns and Articles-Spelling-Reading: Analyzing and interpreting notices and Circulars-Understanding the gist of short real-world notices, and messages. Culling out keywords Information words vs Supporting words-Interpreting Abbreviations, Acronyms and Short-forms-Listening: Analyzing and interpreting announcements Decoding - Screening for salient points-Note making-Raising queries for clarification-Speaking: Announcements-Giving complete information-Pronunciation and Enunciation Pace, Intonation, and Pitch-Conducting Events-Speaking: Master of ceremonies, Short speeches - welcome speech, the vote of thanks/ valedictory speech, award-acceptance speech Writing: Invitations, Preparation of script/draft after interviewing someone. Adjectives-Pronunciation/ Punctuation Precision and Concision-Politeness markers

Total: 45 Hours

Reference(s)

1. Sasikumar, V, et.al. A Course in Listening & Speaking Foundation Books, 2005.
2. Murphy, Raymond. English Grammar in Use: A Self-Study Reference and Practice Book for Intermediate Students: with Answers. Cambridge: Cambridge University Press, 1985.
3. Prasad, Hari Mohan. A Handbook of Spotting Errors. Mcgraw Hill Education, 2010.
4. Reynolds, John. Cambridge First Language English. 2018th ed., Hodder Education, 2018.
5. Wiggins, Grant P., and Jay McTighe. Understanding by Design. Association for Supervision and Curriculum Development, 2008.

22HSH01 HINDI 1 0 2 2

Course Objectives

- To help students acquire the basics of Hindi
- To teach them how to converse in Hindi on simple day- to -day situations
- To help students understand a simple technical text in Hindi

Programme Outcomes (POs)

PO9. Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10.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. Construct simple sentences and use vocabulary required for day- to -day conversation.
2. Distinguish and understand the basic sounds of Hindi language.
3. Apply appropriate grammar to write and speak in Hindi language
4. Comprehend the conversation and give correct meaning
5. Take up Hindi examinations conducted by Dakshin Bharat Hindi Prachar Sabha

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	-	-	-	-	-	-	-	-	3	3	-	-	-	-	-
2	-	-	-	-	-	-	-	-	3	3	-	-	-	-	-
3	-	-	-	-	-	-	-	-	3	3	-	-	-	-	-
4	-	-	-	-	-	-	-	-	3	3	-	-	-	-	-
5	-	-	-	-	-	-	-	-	3	3	-	-	-	-	-

UNIT I **9 Hours**

VOWELS AND CONSONANTS

Hindi Alphabet: Introduction (Self introduction) - Vowels - Consonants - Plosives - Fricatives - Nasal sounds - Vowel Signs - Chandra Bindu & Visarg -Table of Alphabet -Vocabulary.

UNIT II **9 Hours**

NOUNS

Nouns: Genders -Masculine & Feminine -Reading Exercises

UNIT III **9 Hours**

PRONOUNS AND TENSES

Pronouns and Tenses - Categories of Pronouns - Personal Pronouns - Second person (you & honorific) - Definite & Indefinite pronouns - Relative pronouns - Present tense - Past tense - Future tense - Assertive & Negative Sentences - Interrogative Sentences.

UNIT IV **9 Hours**

CLASSIFIED VOCABULARY

Classified Vocabulary: Parts of body -Relatives Spices Eatables -Fruit & Vegetables -Clothes - Directions -Seasons Professions.

UNIT V **9 Hours**

CONVERSATIONS

Speaking -Telling the times -Saying the Numbers from 1 to 50 Speaking practice for various occasions.

Total: 45 Hours

Reference(s)

1. B.R. Kishore, Self Hindi Teacher for Non-Hindi Speaking People, Vee Kumar Publications (P) Ltd., New Delhi, 2009.
2. Hindi Prachar Vahini - 1
3. Videos, Stories, Rhymes and Songs.

22HSG01 GERMAN **1 0 2 2**

Course Objectives

- To help students appear for the A1 level Examination
- To teach them how to converse fluently in German in day-to-day scenarios

Programme Outcomes (POs)

PO9. Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10.Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

Course Outcomes (COs)

1. Listen and identify individual sounds of German
2. Use basic phonemes and words while speaking
3. Read and understand short passages on familiar topics
4. Use basic sentence structures while writing
5. Illustrate basic grammar and appropriate vocabulary in completing language tasks

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	-	-	-	-	-	-	-	-	3	3	-	-	-	-	-
2	-	-	-	-	-	-	-	-	3	3	-	-	-	-	-
3	-	-	-	-	-	-	-	-	3	3	-	-	-	-	-
4	-	-	-	-	-	-	-	-	3	3	-	-	-	-	-
5	-	-	-	-	-	-	-	-	3	3	-	-	-	-	-

UNIT I **9 Hours**

INTRODUCTION

Introduction to the German language-Alphabets-Numbers Greetings -Days and Seasons-Working with Dictionary.

UNIT II **9 Hours**

LANGUAGE AND ITS COMMON USE

Nouns -articles-Speaking about oneself-Listening to CD supplied with books-paying special attention to pronunciation

UNIT III **9 Hours**

TECHNICAL DEUTSCHE

Regular &Irregular verbs -Personal pronouns-family-Introduction to types of sentences

UNIT IV **9 Hours**

INTERROGATION

Question words -Types of Questions -Nominative case-Verb Conjugation -country -nationalities

UNIT V **9 Hours**

IMPLEMENTATION

Verbs to be & to have -conjugation -Hobbies -Framing basic Questions and answers

Total: 45 Hours

Reference(s)

1. Kursbuch and Arbeitsbuch, NETZWERK A1 DEUTSCH ALS FREMDSPRACHE, Goyal Publishers & Distributers Pvt. Ltd., New Delhi, 2015.
2. Langenscheidt Eurodictionary, German English / English German, Goyal Publishers & Distributers Pvt. Ltd., New Delhi, 2009.
3. Grundkurs, DEUTSCH Lehrbuch Hueber Munichen, 2007.

22HSJ01 JAPANESE 1 0 2 2

Course Objectives

- To train students for N5 Level Examination
- To teach them use basic Japanese sentences in day-to-day conversation
- To make students familiar with the Japanese cultural facets and social etiquette

Programme Outcomes (POs)

PO9. Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO10.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. Recognize and write Japanese alphabet
2. Speak using basic sounds of the Japanese language
3. Apply appropriate vocabulary needed for simple conversation in Japanese language
4. Apply appropriate grammar to write and speak in Japanese language
5. Comprehend the conversation and give correct meaning

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	-	-	-	-	-	-	-	-	3	3	-	-	-	-	-
2	-	-	-	-	-	-	-	-	3	3	-	-	-	-	-
3	-	-	-	-	-	-	-	-	3	3	-	-	-	-	-
4	-	-	-	-	-	-	-	-	3	3	-	-	-	-	-
5	-	-	-	-	-	-	-	-	3	3	-	-	-	-	-

UNIT I **9 Hours**

SELF INTRODUCTION / DEMONSTRATIVES / NOUN MODIFIERS
Introduction to Japanese Japanese script - Pronunciation of Japanese(Hiragana (Katakana) Long vowels - Pronunciation of in,tsu,ga -Letters combined with ya,yu,yo - Daily Greetings and Expressions - Numerals. Speaking: Self Introduction - Listening: Listening to Greetings, Listening to specific information: Numbers, Time

UNIT II **9 Hours**
TIME EXPRESSION / VERBS - PAST
Introduction to time -Introduction of verbs -Listening to specific information

UNIT III **9 Hours**

ADJECTIVES

Word Sentence -Introduction to Adjectives -Technical Japanese Vocabulary -Pair Activity Day to day situational conversation Listening to Japanese Alphabet Pronunciation -Simple Conversation

UNIT IV **9 Hours**

CONJUGATION OF II ADJECTIVE

Past tense of Noun sentences and Na adjective sentences -Past tense of ii adjective sentences -houga adjective desu -Technical Japanese Vocabulary -Individual Activity - Listening to conversation with related particles

UNIT V **9 Hours**

CONJUGATION OF VERBS - TE FORM / TA FORM / NAI FORM / PLAIN FORM

N gahoshidesu - V masu form tai desu - Verb te form - Technical Japanese Vocabulary -Listening to different Counters, simple conversations with verbs and adjectives

Total: 45 Hours

Reference(s)

1. Minna no Nihongo Japanese for Everyone Elementary Main Textbook1-1, Goyal Publishers and Distributors Pvt. Ltd., Delhi, 2007.
2. Minna no Nihongo Japanese for Everyone Elementary Main Textbook 1-2 Goyal Publishers and Distributors Pvt. Ltd., Delhi, 2007.

22HSF01 FRENCH **1 0 2 2**

Course Objectives

- To prepare the students for DELF A1 Examination
- To teach them to converse fluently in French in day-to-day scenarios

Programme Outcomes (POs)

PO9. Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO10.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. Help students acquire familiarity in the French alphabet & basic vocabulary
2. Listen and identify individual sounds of French
3. Use basic sounds and words while speaking
4. Read and infer short passages on familiar topics
5. Interpret and use basic grammar and appropriate vocabulary in completing language tasks

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	-	-	-	-	-	-	-	-	3	3	-	-	-	-	-
2	-	-	-	-	-	-	-	-	3	3	-	-	-	-	-
3	-	-	-	-	-	-	-	-	3	3	-	-	-	-	-
4	-	-	-	-	-	-	-	-	3	3	-	-	-	-	-
5	-	-	-	-	-	-	-	-	3	3	-	-	-	-	-

UNIT I **9 Hours**

ENTRER EN CONTACT

La langue franÃƒÂ§aise, alphabets, les numÃƒÂ©ros, les jours, les mois. Grammaire Les verbes s appeler, etre, avoir, les articles definis, indefinis Communication Saluer, s informer sur quelqu un, demander de se presenter Lexique L alphabet, les nationalites, l age, les pays, les couleurs, les jours de la semaine, les mois de l annee, les professions

UNIT II **9 Hours**

PARTAGER SON LIEU DE VIE

Les francais et leur habitat, des habitations insolites -Grammaire Verbes Conjugaison Present (Avoir / Etre / ER, IR, RE Regulier et Irregulier) Adjectifs les propositions de lieu Communication Chercher un logement, decrire son voisin, s informer sur un logement - Lexique L habitat, les pieces, l equipement, la description physique

UNIT III **9 Hours**

VIVRE AU QUOTIDIEN LES LOISIRS DES FRANCAIS, LES GOUTS DES AUTRES, LES ACTIVITES QUOTIDIENNES

Grammaire Articles contractes, verbes vouloir, pouvoir, devoir, adjectifs interrogatifs, future proche Communication Exprimer ses gouts, parler de ses loisirs, justifier un choix, exprimer une envie - Lexique le temps libre et les loisirs, les saisons, les activites quotidiennes, le temps (le matin, le soir, la nuit)

UNIT IV **9 Hours**

COMPRENDRE SON ENVIRONNEMENT SOUVRIR A LA CULTURE

Grammaire Verbes Finir, Sortir, les adjectifs demonstratifs, le passe compose, l imparfait Communication Propose a quelqu un de faire quelque chose, raconter une sortie au passe, parler d un film Lexique Les sorties, la famille, l art, les vetements et les accessoires

UNIT V **9 Hours**

GOUTER A LA CAMPAGNE

Grammaire La forme negative, les verbes acheter, manger, payer, articles partitifs, le pronom en de quantite Communication Accepter et refuser une invitation, donner des instructions, commander au restaurant Lexique Les services et les commerces, les aliments, les ustensiles, l argent

Total: 45 Hours

Reference(s)

1. Grammaire Progressive du Francais, CLE International, 2010.
2. Saison1, Marie Noelle Cocton et al, Didier, 2014.
3. Preparation a l examen du DELF A1 Hachette.
4. Reussir le DELF A1 Bruno Girardeau.
5. Website: Francais Linguaphone Linguaphone Institute Ltd., London, 2000.
6. Francais Harrisonburg : The Rosetta Stone : Fairfield Language Technologies, 2001.

22BM001 SPEECH AND AUDIO SIGNAL PROCESSING 3 0 0 3

Course Objectives

- To familiarize the basic mechanism of speech production and the basic concepts of speech analysis and parametric representation of speech
- To impart ideas of Perception of Sound, Psycho-acoustic analysis, Spatial Audio Perception and speech analysis
- To disseminate Audio Compression Schemes

Program Outcomes (POs)

PO1. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. 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.

PO3. 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.

PO4. 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.

PO12. 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.

PSO1. Apply knowledge on foundation in Life Science, engineering, mathematics and current biomedical engineering practices with an ability to demonstrate advanced knowledge of a selected area within Biomedical Engineering.

Course Outcomes (COs)

1. Implement the basic concepts of speech production, speech analysis, speech coding and parametric representation of speech in real time applications
2. Analyze the speech signal based on its features
3. Analyze the Signal processing models of sound perception and apply the speech perception models in audio signal processing.
4. Apply suitable audio compression algorithms and standards for real time applications.
5. Analyze the subjective and objective qualities of audio signal.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	3	-	1	-	-	-	-	-	-	-	1	1	-	-
2	2	3	-	2	-	-	-	-	-	-	-	1	1	-	-
3	2	3	-	2	-	-	-	-	-	-	-	1	1	-	-
4	1	2	1	3	-	-	-	-	-	-	-	1	1	-	-
5	1	3	-	2	-	-	-	-	-	-	-	1	1	-	-

UNIT I **9 Hours**

SPEECH PRODUCTION AND MODELLING

Speech Production: Acoustic theory of speech production. Parametric representation of speech: AR Model, ARMA model. LPC Analysis (LPC model, Auto correlation method). Fundamentals of Speech recognition and Text-to-speech conversion. Speech coding, speech enhancement, Speaker Verification, Language Identification

UNIT II **9 Hours**

SPEECH ANALYSIS

Speech Analysis: Short-Time Speech Analysis, Time domain analysis (Short time energy, short time zero crossing Rate, ACF) Frequency domain analysis (Filter Banks, STFT, Spectrogram), Cepstral Analysis, MFCC.

UNIT III **9 Hours**

SIGNAL PROCESSING MODELS OF AUDIO PERCEPTION

Basic anatomy of hearing System. Auditory Filter Banks, Psycho-acoustic analysis: Critical Band Structure, Absolute Threshold of Hearing, Simultaneous Masking, Temporal Masking, Quantization Noise Shaping, MPEG psycho-acoustic model

UNIT IV **9 Hours**

AUDIO COMPRESSION METHODS

Sampling rate and bandwidth requirement for digital audio, Redundancy removal and perceptual irrelevancy removal, Transform coding of digital audio: MPEG2-AAC coding standard, MDCT and its properties, Pre-echo and pre-echo suppression, Loss less coding methods

UNIT V **9 Hours**

SPATIAL AUDIO PERCEPTION AND RENDERING

The physical and psycho-acoustical basis of sound localization and space perception. Spatial audio standards. Audio quality analysis: Objective quality analysis, Subjective quality analysis.

Total: 45 Hours

Reference(s)

1. Douglas O Shaughnessy, Speech Communications: Human & Machine, IEEE Press, Hardcover 2/e, 2016
2. Yu, D., Deng, L. Automatic Speech Recognition: A Deep Learning Approach. United Kingdom: Springer London. 2014
3. Ellis, D., Gold, B., Morgan, N. Speech and Audio Signal Processing: Processing and Perception of Speech and Music. Germany: Wiley. 2011
4. Schafer, R. W., Rabiner, L. R. Introduction to Digital Speech Processing. Netherlands: 2007

22BM002 BIOMETRIC SYSTEMS 3 0 0 3

Course Objectives

- To understand the general principles, design of biometric systems and the underlying trade-offs.
- To study the technologies of fingerprint, iris, face and speech recognition
- To study of evaluation of biometrics systems

Program Outcomes (POs)

PO1. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. 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.
PO3. 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.
PO4. 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.
PO12. 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.
PSO1. Apply knowledge on foundation in Life Science, engineering, mathematics and current biomedical engineering practices with an ability to demonstrate advanced knowledge of a selected area within Biomedical Engineering.
PSO2. Critically analyse the current healthcare systems and develop innovative solutions effectively through problem specific design and development using modern hardware and software tools.
PSO3. Hands-on knowledge on cutting edge hardware and software tools to acquire real time data, model and simulate physiological processes and analyse limitations on real time implementations.

Course Outcomes (COs)

1. Outline the concepts and characteristics of biometric systems
2. Apply fingerprint recognition technique for a real time application
3. Apply face and hand geometry recognition techniques for feature extraction and classification applications
4. Implement suitable methodology for iris recognition of a person
5. Analyse the features of voice signal and multimodal biometric systems

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	1	-	-	-	-	-	-	-	-	-	-	3	2	1
2	-	2	3	1	-	-	-	-	-	-	-	1	3	2	1
3	-	2	3	1	-	-	-	-	-	-	-	1	3	2	1
4	-	2	3	1	-	-	-	-	-	-	-	1	3	2	1
5	-	3	2	1	-	-	-	-	-	-	-	1	3	2	1

UNIT I **9 Hours**

INTRODUCTION TO BIOMETRICS

Introduction and back ground, biometric technologies, passive biometrics, active biometrics, Biometric characteristics, Biometric applications, Biometric Authentication systems, Taxonomy of Application Environment, Accuracy in Biometric Systems, False match rate, False non-match rate, Failure to enroll rate, Derived metrics, Biometrics and Privacy

UNIT II **9 Hours**

FINGERPRINT TECHNOLOGY

History of fingerprint pattern recognition, General description of fingerprints, fingerprint sensors, fingerprint enhancement, Feature Extraction, Ridge orientation, ridge frequency, fingerprint matching techniques- correlation based, Minutiae based, Ridge feature based, fingerprint classification, Applications of fingerprints, Finger scan, strengths and weaknesses, Evaluation of fingerprint verification algorithms

UNIT III **9 Hours**

FACE RECOGNITION AND HAND GEOMETRY

Introduction to face recognition, face recognition using PCA, LDA, face recognition using shape and texture, face detection in color images, 3D model based face recognition in video images, Neural networks for face recognition, Hand geometry, scanning, Feature Extraction, classification

UNIT IV **9 Hours**

IRIS RECOGNITION

Introduction, Anatomical and Physiological underpinnings, Iris sensor, Iris representation and localization, Daugman and Wildes approach, Iris matching, Iris scan strengths and Weaknesses, System performance, future directions

UNIT V **9 Hours**

VOICE SCAN AND MULTIMODAL BIOMETRICS

Voice scan, speaker features, short term spectral feature extraction, Mel frequency cepstral coefficients, speaker matching, Gaussian mixture model, NIST speaker Recognition Evaluation Program, Introduction to multimodal biometric system, Integration strategies, Architecture, level of fusion, combination strategy, examples of multimodal biometric systems, Securing and trusting a biometric transaction, matching location, local host, authentication server, match on card (MOC)

Total: 45 Hours

Reference(s)

1. James Wayman& Anil Jain, Biometric Systems- Technology Design and Performance Evaluation, SPRINGER (SIE), 1st Edition, 2011.
2. S.Y. Kung, S.H. Lin, M.W., Biometric Authentication: A Machine Learning Approach, Prentice Hall, 2004
3. Paul Reid, Biometrics for Network Security, Pearson Education, 2004
4. Nalini K Ratha, Ruud Bolle, Automatic fingerprint recognition system, Springer, 2003
5. L C Jain, I Hayashi, S B Lee, U Halici, Intelligent Biometric Techniques in Fingerprint and Face Recognition, CRC Press, 1st Edition, 1999

22BM003 PATTERN RECOGNITION TECHNIQUES

3 0 0 3

Course Objectives

- To understand different supervised learning techniques
- To understand different unsupervised learning techniques
- To obtain sound knowledge in the recent advancement on pattern recognition techniques

Program Outcomes (POs)

PO1. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. 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.
PO3. 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.
PO4. 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.
PSO1. Apply knowledge on foundation in Life Science, engineering, mathematics and current biomedical engineering practices with an ability to demonstrate advanced knowledge of a selected area within Biomedical Engineering.
PSO2. Critically analyse the current healthcare systems and develop innovative solutions effectively through problem specific design and development using modern hardware and software tools.
PSO3. Hands-on knowledge on cutting edge hardware and software tools to acquire real time data, model and simulate physiological processes and analyse limitations on real time implementations.

Course Outcomes (COs)

1. Implement the fundamental concepts of pattern recognition techniques in classification
2. Apply the unsupervised learning techniques for pattern classification
3. Apply suitable algorithm for structural pattern recognition
4. Apply appropriate technique to extract the feature from image
5. Analyse the advanced neural network structures for pattern recognition

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	1	1	-	1	-	-	-	-	-	-	-	-	-	-	-
2	2	3	-	1	-	-	-	-	-	-	-	-	-	-	-
3	2	1	-	1	-	-	-	-	-	-	-	-	2	-	-
4	1	3	1	1	-	-	-	-	-	-	-	-	-	-	-
5	2	2	2	1	-	-	-	-	-	-	-	-	1	1	2

UNIT I **9 Hours**

PATTERN CLASSIFIER

Overview of pattern recognition, Discriminant functions, Supervised learning, Parametric estimation, Maximum likelihood estimation, Bayesian parameter estimation, Perceptron algorithm, LMSE algorithm, Problems with Bayes approach, Pattern classification by distance functions, Minimum distance pattern classifier.

UNIT II **9 Hours**

UNSUPERVISED CLASSIFICATION

Clustering for unsupervised learning and classification, Clustering concept, C-means algorithm - Hierarchical clustering procedures, Graph theoretic approach to pattern clustering, Validity of clustering solutions.

UNIT III **9 Hours**

STRUCTURAL PATTERN RECOGNITION

Elements of formal grammars, String generation as pattern description, Recognition of syntactic description, Parsing, Stochastic grammars and applications.

UNIT IV **9 Hours**

FEATURE EXTRACTION AND SELECTION

Entropy minimization, Karhunen, Loeve transformation, Feature selection through functions approximation, Binary feature selection.

UNIT V **9 Hours**

NEURAL PATTERN RECOGNITION

Neural network structures for Pattern Recognition, Neural network based Pattern associators, Unsupervised learning in neural Pattern Recognition.

Total: 45 Hours

Reference(s)

1. Earl Gose, Richard Johnsonbaugh Steve Jost, Pattern Recognition and Image Analysis, Prentice Hall of India Pvt Ltd., NewDelhi,2015
2. Duda R.O., Hart.P.E., and Strok, Pattern Classification, Second Edition Wiley, New York,2012.
3. Freeman J. A., and Skapura B.M, Neural networks, algorithms, applications and programming techniques, Addison Wesley,2003
4. RobertJ.Schalkoff, PatternRecognition: Statistical, Structural and Neural Approaches, JohnWiley&Sons Inc., New York,2007.
5. Tou and Gonzales, Pattern Recognition Principles, Wesley Publication Company, London,1974.

22BM004 BRAIN COMPUTER INTERFACE 3 0 0 3

Course Objectives

- To understand the basics for Brain Computer Interface
- To classify different types of BCI system based on Biosignal acquisition
- To familiarize the medical and non-medical application of BCI

Program Outcomes (POs)

PO1. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. 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.
PO4. 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.
PO8. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO12. 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.
PSO1. Apply knowledge on foundation in Life Science, engineering, mathematics and current biomedical engineering practices with an ability to demonstrate advanced knowledge of a selected area within Biomedical Engineering.
PSO2. Critically analyse the current healthcare systems and develop innovative solutions effectively through problem specific design and development using modern hardware and software tools.
PSO3. Hands-on knowledge on cutting edge hardware and software tools to acquire real time data, model and simulate physiological processes and analyse limitations on real time implementations.

Course Outcomes (COs)

1. Understand the concepts of neuroscience and Brain Computer Interface systems
2. Categorize Brain Computer Interface systems
3. Analyze the Non-Invasive BCIs and categorize it based on its functions
4. Apply stimulation techniques for advanced BCIs
5. Analyse the ethical principles of BCIs for medical and non-medical fields.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	3	-	1	-	-	-	-	-	-	-	-	3	2	2
2	1	2	-	3	-	-	-	-	-	-	-	-	3	2	2
3	1	3	-	2	-	-	-	-	-	-	-	-	3	2	2
4	1	3	-	2	-	-	-	-	-	-	-	-	3	2	2
5	1	3	-	2	-	-	-	3	-	-	-	1	3	2	2

UNIT I **9 Hours**

INTRODUCTION

Introduction to Neuroscience: Neurons, action potential generation, Recording and simulation of Brain, Review of signal processing techniques applied for EEG signal, building a BCI: Major Types of BCIs, Brain Responses Useful for Building BCIs, Conditioned Responses, Population Activity, Imagined Motor and Cognitive Activity, Stimulus-Evoked Activity

UNIT II **9 Hours**

INVASIVE BCI AND SEMI-INVASIVE BCIS

Two Major Paradigms in Invasive Brain-Computer Interfacing, invasive BCIs in Animals, Invasive BCIs in Humans, Long-Term Use of Invasive BCIs, Semi-Invasive BCIs: Electrocorticographic (ECoG) BCIs, BCIs Based on Peripheral Nerve Signals

UNIT III **9 Hours**

NON-INVASIVE BCIS

Electroencephalographic (EEG) BCIs: Oscillatory Potentials and ER, Slow Cortical Potential, Stimulus-Evoked Potentials, BCIs Based on Cognitive Tasks, Error Potentials in BCI, Co-adaptive BCI, Hierarchical BCIs, Other Non-invasive BCIs: fMRI, MEG, and fNIR, Functional Magnetic Resonance Imaging-Based BCI, Magnetoencephalography-Based BCIs, Functional Near Infrared and Optical BCIs

UNIT IV **9 Hours**

BIDIRECTIONAL, RECURRENT BCI AND STIMULATION

Cursor Control with Direct Cortical Instruction via Stimulation, Active Tactile Exploration Using a BCI and Somatosensory Stimulation, Bidirectional BCI Control of a Mini-Robot, Cortical Control of Muscles via Functional Electrical Stimulation, Establishing New Connections between Brain Region, Sensory Restoration, Restoring Hearing: Cochlear Implants, Restoring Sight: Cortical and Retinal Implants, Motor Restoration, Deep Brain Stimulation (DBS) and Sensory Augmentation

UNIT V **9 Hours**

APPLICATIONS AND ETHICS

Medical Applications: Sensory Restoration, Motor Restoration, Cognitive Restoration and Rehabilitation, Restoring Communication with Menus, Cursors, and Spellers, Brain-Controlled Wheelchairs, Nonmedical Applications: Web Browsing and Navigating Virtual Worlds, Robotic Avatars Mnemonic and Cognitive Amplification, Applications in Space, Gaming and Entertainment, Brain-Controlled Art, Ethics of Brain-Computer Interfacing: Medical, Health, and Safety Issues, Abuse of BCI Technology

Total: 45 Hours

Reference(s)

1. Chang S. Nam, Anton Nijholt, Fabien Lotte, Brain Computer Interfaces Handbook: Technological and Theoretical Advances, CRC Press, UK. 2018
2. Maureen Clerc, Laurent Bougrain, Fabien Lotte, Brain Computer Interfaces 2: Technology and Applications, Wiley Publisher, 2016.
3. Rajesh P. N. Rao, Brain Computer Interfacing: An Introduction, 1st Edition, Cambridge University Press, 2018.
4. Christian Kothe, Introduction to Modern Brain Computer Interface design video lectures, https://sccn.ucsd.edu/wiki/Introduction_To_BrainComputer_Interface_Design.

22BM005 ADVANCED MEDICAL IMAGE ANALYSIS 3 0 0 3

Course Objectives

- To understand the principles of basic imaging modalities and properties of image construction.
- To assess the quality of medical images based on image acquisition process
- To implement advanced medical imaging techniques during the development of image modalities

Program Outcomes (POs)

PO1. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. 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.
PO3. 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.
PO4. 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.
PO6. 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.
PO8. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO12. 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.
PSO1. Apply knowledge on foundation in Life Science, engineering, mathematics and current biomedical engineering practices with an ability to demonstrate advanced knowledge of a selected area within Biomedical Engineering.
PSO2. Critically analyse the current healthcare systems and develop innovative solutions effectively through problem specific design and development using modern hardware and software tools.
PSO3. Hands-on knowledge on cutting edge hardware and software tools to acquire real time data, model and simulate physiological processes and analyse limitations on real time implementations.

Course Outcomes (COs)

1. Analyze the radiographic imaging techniques based on its nature and properties
2. Apply projection radiography in medical imaging
3. Analyze the computer tomography imaging technique based on image quality
4. Analyse the mechanics of nuclear medical imaging and the effects of image quality
5. Outline the concept of MRI imaging and reconstruction

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	1	3	2	2	-	1	-	1	-	-	-	1	3	2	2
2	1	2	2	2	-	1	-	1	-	-	-	1	3	2	2
3	1	3	2	2	-	1	-	1	-	-	-	1	3	2	2
4	1	3	2	2	-	1	-	1	-	-	-	1	3	2	2
5	1	3	1	2	-	1	-	1	-	-	-	1	3	2	2

UNIT I **9 Hours**

RADIOGRAPHIC IMAGING

Basic imaging principles - Image quality - Physics of radiography - Ionization - forms of ionization radiation - nature and properties - Attenuation of electromagnetic radiation - radiation dosimetry

UNIT II **9 Hours**

PROJECTION RADIOGRAPHY

Instrumentation: X-ray tubes, filtration, contrast agents, film screen detectors, image intensifiers, Digital radiography, mammography - Image formation: Geometric effects, blurring effects, film characteristics - Noise and Scattering: Signal to noise ratio, quantum scattering, Compton scattering

UNIT III **9 Hours**

COMPUTED TOMOGRAPHY

CT Instrumentation: Generations, dual energy CT - Image formation: Line integrals, CT numbers, CT reconstruction techniques (fan beam, parallel ray, helical, cone beam) - Image quality: Resolution, noise and artifacts

UNIT IV **9 Hours**

NUCLEAR MEDICINE IMAGING

Physics of nuclear medicine: Radioactive decay, modes of decay, radiotracers - Planar Scintigraphy: Instrumentation, Image capture, Image formation: Event position estimation, Acquisition modes, Anger camera imaging equation, Image quality: Resolution, noise, Sensitivity, uniformity, energy resolution, factors affecting count rate

UNIT V **9 Hours**

MAGNETIC RESONANCE IMAGING

Instrumentation - MRI data acquisition: slice selection, frequency encoding, gradient echoes, pulse repetition interval - Image reconstruction: rectilinear data, polar data, imaging equations, Image quality: Sampling, resolution, SNR, artifacts - Advanced contrast mechanisms

Total: 45 Hours

Reference(s)

1. Jerry L Prince, Jonathan M Links, Medical Imaging Signals and Systems, Prentice Hall Publications, 2015.
2. Wolfgang Birkfellner, Applied medical Image Processing- A basic course, Second Edition, CRC Press, 2014.
3. Rafael C. Gonzales, Richard E. Woods, Digital Image Processing, Fourth Edition, Pearson Education, 2018.
4. Anil Jain K. Fundamentals of Digital Image Processing, PHI Learning Pvt. Ltd., 2011.
5. William K. Pratt, Introduction to Digital Image Processing, CRC Press, 2013.

22BM006 MACHINE VISION 3 0 0 3

Course Objectives

- To review image processing techniques for machine vision.
- To understand the concept of shape, region and motion analysis.
- To study object recognition techniques.

Program Outcomes (POs)

PO1. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. 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.
PO3. 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.
PO4. 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.
PSO1. Apply knowledge on foundation in Life Science, engineering, mathematics and current biomedical engineering practices with an ability to demonstrate advanced knowledge of a selected area within Biomedical Engineering.

Course Outcomes (COs)

1. Assess the fundamental concepts of machine vision
2. Apply suitable techniques for filtering images to reduce the undesired components
3. Analyze the performance of various edge detection techniques in machine vision
4. Implement the motion detection process using moving camera
5. Outline the process of object recognition using patterns and features

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	2	-	1	-	-	-	-	-	-	-	-	2	-	-
2	1	2	3	2	-	-	-	-	-	-	-	-	1	-	-
3	-	3	2	2	-	-	-	-	-	-	-	-	1	-	-
4	-	3	2	2	-	-	-	-	-	-	-	-	1	-	-
5	-	3	2	2	-	-	-	-	-	-	-	-	1	-	-

UNIT I **9 Hours**

MACHINE VISION FUNDAMENTALS

Machine Vision- Relationships to Other Fields-Role of Knowledge-Image Geometry-Perspective Projection-Coordinate Systems-Levels of Computation - Thresholding, Geometric Properties, Size, Position, Orientation, Projections, Run-Length Encoding, Binary Algorithms, Morphological Operators, Optical Character Recognition

UNIT II **9 Hours**

REGION AND FILTERING BASED PROCESSING

Regions and Edges - Region Segmentation - Region Representation - Split and Merge - Region Growing - Image Filtering - Histogram Modification - Linear Systems - Linear Filters - Median Filter - Gaussian Smoothing

UNIT III **9 Hours**

EDGE DETECTION

Gradient - Steps in Edge Detection - Comparison- Second Derivative Operators: Laplacian Operator, Second Directional Derivative, Laplacian of Gaussian, Image Approximation - Gaussian Edge Detection, Canny Edge Detector - Subpixel Location Estimation - Edge Detector Performance - Methods for Evaluating Performance - Figure of Merit - Sequential Methods - Line Detection

UNIT IV **9 Hours**

DYNAMIC VISION

Change Detection - Change Detection - Segmentation using Motion - Motion Correspondence - Image flow - Segmentation using a Moving Camera - Tracking - Shape from Motion

UNIT V **9 Hours**

OBJECT RECOGNITION

System Components - Complexity of Object Recognition - Object Representation: Observer-Centered Representations, Object-Centered Representations - Feature Detection - Recognition Strategies: Classification, Matching, Feature Indexing - Verification: Template Matching, Morphological Approach, Symbolic, Analogical Methods

Total: 45 Hours

Reference(s)

1. Ramesh Jain, Ramesh C Jain, Machine Vision, pp., McGraw Hill, 1995.
2. Fabio Solari, Manuela Chessa, Silvio P. Sabatini, Machine vision Applications and Systems, BoD Books on Demand, 2012.
3. J. Shi and C. Tomasi, Good Features to Track. In IEEE Conference on Computer Vision and Pattern Recognition, 1994.
4. D. G. Lowe, Distinctive Image Features from Scale-Invariant Keypoints. In International Journal of Computer Vision, 2004.
5. D. Comaniciu and P.Meer, Robust analysis of feature spaces: Color image segmentation. IEEE Conference on Computer Vision and Pattern Recognition, June 1997, 750-755.

22BM007 DEEP LEARNING TECHNIQUES 3 0 0 3

Course Objectives

- To understand the theoretical foundations, algorithms and methodologies of Machine Learning Algorithms
- To design and develop an application using specific deep learning models
- To provide practical knowledge in handling and analyzing real world applications.

Program Outcomes (POs)

PO1. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. 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.
PO3. 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.
PO4. 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.
PSO1. Apply knowledge on foundation in Life Science, engineering, mathematics and current biomedical engineering practices with an ability to demonstrate advanced knowledge of a selected area within Biomedical Engineering.
PSO2. Critically analyse the current healthcare systems and develop innovative solutions effectively through problem specific design and development using modern hardware and software tools.
PSO3. Hands-on knowledge on cutting edge hardware and software tools to acquire real time data, model and simulate physiological processes and analyse limitations on real time implementations.

Course Outcomes (COs)

1. Apply the concepts of Machine Learning Algorithms to solve real world problems
2. Apply the Deep Learning Architectures to classify the unstructured data.
3. Analyze the Convolutional Neural Networks and transfer learning models to obtain an optimal solution
4. Develop a Recurrent Neural Networks, Recursive Nets models and classify the given inputs with reduced cost and time
5. Design a model using Auto encoders and Generative models for image generation

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	1	2	3	-	-	-	-	-	-	-	-	-	1	-	-
2	2	2	3	-	-	-	-	-	-	-	-	-	1	-	-
3	2	3	2	1	-	-	-	-	-	-	-	-	2	-	-
4	2	1	3	1	-	-	-	-	-	-	-	-	2	-	-
5	2	2	3	1	-	-	-	-	-	-	-	-	2	1	2

UNIT I **9 Hours**

MACHINE LEARNING BASICS

Learning algorithms, Maximum likelihood estimation, Building machine learning algorithm, Basic Machine Learning Algorithms: Naive Bayes, Support Vector Machine, Decision Tree, Random Forest, Neural Networks - Multilayer Perceptron, Back-propagation algorithm and its variants stochastic gradient decent, Curse of Dimensionality.

UNIT II **9 Hours**

DEEP LEARNING ARCHITECTURES

Machine Learning and Deep Learning, Representation Learning, Width and Depth of Neural Networks, Activation Functions: RELU, LRELU, ERELU, Unsupervised Training of Neural Networks, Restricted Boltzmann Machines, Auto Encoders, Deep Learning Applications.

UNIT III **9 Hours**

CONVOLUTIONAL NEURAL NETWORKS AND TRANSFER LEARNING

Architectural Overview, Motivation, Layers, Filters, Parameter sharing, Regularization, Popular CNN Architectures ResNet, AlexNet, Applications Transfer Learning Techniques, Variants of CNN DenseNet, PixelNet.

UNIT IV **9 Hours**

SEQUENCE MODELING RECURRENT AND RECURSIVE NETS

Recurrent Neural Networks, Bidirectional RNNs, Encoder decoder sequence to sequence architectures BPTT for training RNN, Long Short Term Memory Networks, Neural style transfer in Keras

UNIT V **9 Hours**

AUTOENCODERS AND DEEP GENERATIVE MODELS

Under complete Auto encoder, Regularized Auto encoder, stochastic Encoders and Decoders, Contractive Encoders - Deep Belief networks, Boltzmann Machines, Deep Boltzmann Machine, Generative Adversarial Networks.

Total: 45 Hours

Reference(s)

1. Umberto Michelucci Applied Deep Learning. A Case-based Approach to Understanding Deep Neural Networks press, 2018.
2. Ian Goodfellow, Yoshua Bengio and Aaron Courville, Deep Learning, MIT Press, 2017.
3. Josh Patterson, Adam Gibson Deep Learning: A Practitioner's Approach, O'Reilly Media, 2017
4. Ethem Alpaydin, Introduction to Machine Learning, MIT Press, Prentice Hall of India, Third Edition 2014.
5. Kevin P. Murphy Machine Learning: A Probabilistic Perspective, The MIT Press, 2012.

22BM008 BIOMATERIALS AND ASSISTIVE DEVICES **3 0 0 3**

Course Objectives

- To understand the theoretical foundations, algorithms and methodologies of Machine Learning Algorithms
- To provide practical knowledge in handling and analyzing real world applications.

Program Outcomes (POs)

PO1. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. 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.
PO3. 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.
PO4. 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.
PO6. 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.
PO8. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO12. 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.
PSO1. Apply knowledge on foundation in Life Science, engineering, mathematics and current biomedical engineering practices with an ability to demonstrate advanced knowledge of a selected area within Biomedical Engineering.
PSO2. Critically analyse the current healthcare systems and develop innovative solutions effectively through problem specific design and development using modern hardware and software tools.
PSO3. Hands-on knowledge on cutting edge hardware and software tools to acquire real time data, model and simulate physiological processes and analyse limitations on real time implementations.

Course Outcomes (COs)

1. Outline the structure of bio-materials and their bio-compatibility.
2. Categorize the implant materials based on their properties and its application in the medical field.
3. Integrate the soft and hard tissue replacement implants in biomedical applications.
4. Outline the functions and characteristics of advanced assistive devices
5. Implement the suitable noise reduction techniques for hearing aids

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	2	-	-	-	1	-	1	-	-	-	1	1	-	-
2	2	2	3	2	-	1	-	1	-	-	-	1	1	-	-
3	2	3	3	2	-	1	-	1	-	-	-	1	2	-	-
4	2	3	1	2	-	1	-	1	-	-	-	1	2	-	-
5	2	2	3	2	-	1	-	1	-	-	-	1	2	1	2

UNIT I **9 Hours**

STRUCTURE OF BIO-MATERIALS AND BIO-COMPATIBILITY

Definition and classification of bio-materials, mechanical properties, viscoelasticity, wound healing process, body response to implants, blood compatibility, HLA compatibility.

UNIT II **9 Hours**

IMPLANT MATERIALS

Metallic implant materials, stainless steels, Ti-based alloys, ceramic implant materials, aluminium oxides, hydroxyapatite, glass ceramics, carbons. Polymerization, polyamides, Acrylic polymers, Hydrogels, rubbers, high strength, thermoplastics, medical applications. Bio polymers: collagen and elastin. Materials for ophthalmology: contact lens, Intra ocular lens. Membranes for plasma separation and blood oxygenation

UNIT III **9 Hours**

TISSUE REPLACEMENT IMPLANTS

Small intestinal submucosa and other decellularized matrix biomaterials for tissue repair. Soft tissue replacements, types of transplant by stem cell, sutures, surgical tapes, Tissue adhesive/glue. Percutaneous and skin implants, maxillofacial augmentation, Vascular grafts, hard tissue replacement Implants, point replacements.

UNIT IV

EXTRACORPOREAL DEVICES **9 Hours**

Principle of External counter pulsation techniques, intra-aortic balloon pump, Auxiliary ventricle and schematic for temporary bypass of left ventricle, prosthetic heart valves. Artificial kidney, Dialysis action, haemodialysis unit, membrane dialysis, portable dialyser monitoring and functional parameters

UNIT V **9 Hours**

HEARING AIDS

Common tests audiograms, air conduction, bone conduction, masking techniques, SISI, Hearing aids principles, drawbacks in the conventional unit, Digital Hearing Aid Enhancement and Noise reduction, Artificial middle ears.

9 Hours

Total: 45 Hours

Reference(s)

1. Sujata V. Bhatt, Biomaterials, Narosa Publishing House,7 th Edition,2005
2. Park Joseph D. Bronzino, Biomaterials-Principles and Applications, CRC press,2003.
3. BD Ratner, AS Hoffmann, FJ Schoen, JE Lemmons, An introduction to Materials in Medicine, Academic Press,1996.
4. Marion. A. Hersh, Michael A. Johnson, Assistive Technology for visually impaired and blind, Springer Science & Business Media, 1st edition, 12-May-2010
5. Gerr M. Craddock Assistive Technology-Shaping the future, IOS Press, 1st edition, 2003.
6. Tohru Ifukube, Sound based assistive technology- support to hearing, speaking and seeing, Springer International Publications, 2017

22BM009 BIO MEMS AND NANO TECHNOLOGY 3 0 0 3

Course Objectives

- To introduce various MEMS fabrication techniques.
- To impart knowledge on different types of sensors and actuators and their principles of operation at the micro scale level.
- To discuss the applications of MEMS in different fields of medicine

Program Outcomes (POs)

PO1. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. 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.
PO3. 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.
PO4. 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.
PO7. 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.
PO8. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO12. 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.
PSO1. Apply knowledge on foundation in Life Science, engineering, mathematics and current biomedical engineering practices with an ability to demonstrate advanced knowledge of a selected area within Biomedical Engineering.

Course Outcomes (COs)

1. Outline the materials used for MEMS technology and its fabrication process
2. Analyze the different types of sensors and actuators and their principles of operation at the micro scale level.
3. Apply MEMS in different field of medicine
4. Categorize Nano sensors for various applications in biomedical field
5. Analyse the performance of various Nano devices used in medical applications

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
-1	2	1	-	2	-	-	1	1	-	-	-	1	1	-	-
2	2	3	-	2	-	-	1	1	-	-	-	1	1	-	-
3	2	2	3	2	-	-	1	1	-	-	-	1	2	-	-
4	2	2	-	2	-	-	1	1	-	-	-	1	2	-	-
5	2	3	-	2	-	-	1	1	-	-	-	1	2	-	-

UNIT I **9 Hours**

MEMS MATERIALS AND FABRICATION

Typical MEMs and Microsystems, materials for MEMS - active substrate materials-Silicon and its compounds, Silicon piezo resistors, Gallium Arsenide, quartz, polymers. Micromachining - photolithography, thin film deposition, doping, etching, bulk machining, wafer bonding, LIGA.

UNIT II **9 Hours**

SENSORS AND ACTUATORS

Mechanics for MEMs design - static bending of thin plates, mechanical vibration, thermo mechanics, fracture and thin film mechanics. Mechanical sensors and actuators - beam and cantilever - microplates, strain, pressure and flow measurements, Thermal sensors and actuators - actuator based on thermal expansion, thermal couples, thermal resistor, Shape memory alloys - Inertia sensor, flow sensor. Properties of piezoelectric materials, Piezoelectric sensor and actuator - inchworm motor.

UNIT III **9 Hours**

THE PROSPECT OF NANOMEDICINE

Current Medical Practice, The Evolution of Scientific Medicine - Volitional Normative Model of Disease - Treatment Methodology - Evolution of Bedside Practice - The Nano medical Perspective, Nanomedicine and Molecular Nanotechnology -Pathways to Molecular Manufacturing - Molecular Transport and Sortation

UNIT IV **9 Hours**

NANOSENSORS

Nanosensor Technology - Chemical and Molecular Nanosensor - Displacement and Motion Sensors - Force Nanosensor - Thermal Nanosensor - Electric and Magnetic Sensing - Cellular Bio scanning - Macrosensing - intergated nanosensor technologies, genomics & proteomics - real time & in vivo medical monitoring

UNIT V **9 Hours**

NANODEVICES FOR MEDICINE

Nanodevices for Clinical Nanodiagnostics, Nanoendoscopy, Nanobiotechnology and Drug Delivery Devices - Tools for Nanosurgery, Nanoscale Laser Surgery, Nanorobotics for Surgery - Nanotechnology for Detection of Cancer, QDs, Dendrimers for Sensing Cancer Cell Apoptosis, Gold Nanoparticles for Cancer Diagnosis, Nanotubes for Detection of Cancer Proteins, Nanoparticles for the Optical Imaging of Tumours.

Total: 45 Hours

Reference(s)

1. Chang Liu,‟ Foundations of MEMS‟, Pearson Education International, New Jersey, USA, 2nd Edition, 2011
2. Robert .A. Freital.Jr, “ Nanomedicine “ Landes Bioscience Press 2010.
3. Wanjun Wang, Stephen A.Soper,‖BioMEMs: Technologies and applications‖, CRC Press, New York, 2007.
4. Robert A. Freitas, “Nanomedicine, Volume IIA: Biocompatibility”, Landes Bioscience, 2011.
5. Jain.K.K, “Handbook of Nanomedicine” Springer, 2012.

22BM010 VIRTUAL INSTRUMENTATION 3 0 0 3

Course Objectives

- Design basic Virtual Instrumentation Systems using LabVIEW
- Interface DAQ systems with Computer through LabVIEW
- Analyze Signals using Virtual Instrumentation Systems.

Program Outcomes (POs)

PO1. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. 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.
PO3. 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.
PO4. 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.
PO5. 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.
PSO2. Critically analyse the current healthcare systems and develop innovative solutions effectively through problem specific design and development using modern hardware and software tools.

Course Outcomes (COs)

1. Outline the building blocks of a Graphical Programming Tool.
2. Apply the concepts of loops and arrays to design simple GUI based applications using LabVIEW.
3. Implement the concepts of Data Acquisition using DAQ Systems for interfacing it with PC.
4. Design basic virtual instrumentation systems using LabVIEW.
5. Analyze the signals using a Virtual Instrumentation System

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	1	2	2	3	3	-	-	-	-	-	-	-	-	3	-
2	1	2	3	2	3	-	-	-	-	-	-	-	-	3	-
3	1	2	2	2	2	-	-	-	-	-	-	-	-	3	-
4	1	2	3	3	2	-	-	-	-	-	-	-	-	3	-
5	1	2	3	3	3	-	-	-	-	-	-	-	-	3	-

UNIT I 9 Hours

FUNDAMENTALS OF VIRTUAL INSTRUMENTATION

LabVIEW - graphical user interfaces- controls and Indicators - programming - data types - data flow programming - Editing Debugging and Running a Virtual Instrument- Graphical programming palettes and tools - Front panel objects.

UNIT II **9 Hours**

GRAPHICAL PROGRAMMING ENVIRONMENT IN VI

FOR Loops, WHILE loops, Shift Registers, CASE structure, formula nodes -Sequence structures- Arrays and Clusters- Array operations - Bundle, Unbundle - Bundle/Unbundle by name, graphs and charts - string and file I/O - High level and Low level file I/Os.

UNIT III **9 Hours**

INTERFACING DAQ SYSTEM WITH PC

Basics of DAQ Hardware and Software - Concepts of Data Acquisition and terminology - Installing Hardware, installing drivers -Configuring the Hardware - addressing the hardware in LabVIEW- Digital and Analog I/O function - Buffered I/O.

UNIT IV **9 Hours**

SIMPLE PROGRAMMING IN VI

Simple programs in VI- Advanced concepts in LabVIEW- TCP/IP VIs, Synchronization - other elements of Virtual Instrumentation - Bus extensions - PXI - Computer based instruments.

UNIT V **9 Hours**

ANALYSIS TOOLS AND SIMPLE APPLICATIONS IN VI

Fourier transform - Power spectrum - Filtering tools - CRO emulation - Audio signal processing using Signal Processing Toolkit-Virtual instrumentation application in Biomedical, Process Control and Mechatronics.

Total: 45 Hours

Reference(s)

1. Jovitha Jerome, Virtual Instrmentation using LabVIEW, PHI, 2010.
2. Garry M. Johnson, LabVIEW Graphical Programming, Tata McGraw Hill, 1996.
3. Labview Basics I and II Manual, National Instruments.
4. Barry Paton, Sensor, Transducers and LabVIEW, PHI, 2000.
5. Lisa K Wlls, LabVIEW for Everyone,PHI,1996.

22BM011 REHABILITATION AND ROBOTICS ENGINEERING

3 0 0 3

Course Objectives

- To understand the sensory rehabilitation systems.
- To learn the use of the orthopedic prosthetics and orthotics in rehabilitation.
- To understand rehabilitation medicine and advocacy.

Program Outcomes (POs)

PO1. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. 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.
PO3. 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.
PO4. 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.
PO6. 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.
PO8. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PSO2. Critically analyse the current healthcare systems and develop innovative solutions effectively through problem specific design and development using modern hardware and software tools.

Course Outcomes (COs)

1. Assess the concepts of rehabilitation devices and their design considerations.
2. Apply suitable orthotic and prosthetic devices for rehabilitation based on their functional advancements.
3. Outline the features and configurations of wheel mobility and the therapeutic exercise technique in rehabilitation
4. Analyse the role of Robotics for automation in biomedical engineering
5. Analyse the functions of rehabilitation robotics

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	3	-	3	-	-	-	-	-	-	-	-	-	3	-
2	1	2	-	2	-	-	-	-	-	-	-	-	-	3	-
3	1	3	-	2	-	-	-	-	-	-	-	-	-	3	-
4	1	3	-	3	-	-	-	-	-	-	-	-	-	3	-
5	1	3	-	3	-	-	-	-	-	-	-	-	-	3	-

UNIT I **9 Hours**

INTRODUCTION TO REHABILITATION

Engineering Concepts in Sensory Rehabilitation, Motor Rehabilitation - Rehabilitation Engineering Technologies: The Conceptual Frameworks - The Provision Process - Education and Quality Assurance - Specific Impairments and Relates Technologies- Future Developments - Design Considerations - Sensory augmentation and substitution- Visual system, Auditory system, Tactual system

UNIT II **9 Hours**

PROSTHETIC AND ORTHOTIC DEVICES

Engineering concepts in motor rehabilitation, Fundamentals - Amputation - Lower extremity prosthetics - Upper limb prosthetics (trans radial), (trans humeral) - Ankle foot orthoses (AFO) - Knee Ankle Foot Orthoses (KAFO) - Truncal and Cervical orthoses - Assistive Devices - Applications

UNIT III **9 Hours**

WHEELED MOBILITY AND THERAPEUTIC EXERCISE TECHNIQUE

Introduction - Categories of Wheelchairs - Wheelchair Prescriptions - Wheelchair Structure and Component Design - Ergonomics of Wheelchair Propulsion - Power Wheelchair Electrical Systems - Personal Transportation - Wheelchair Safety, Standards and Testing. Rehab-Therapy - Co-ordination exercises - Frenkels exercises - Gait Training - Relaxation exercises - Strengthening exercises - Mobilization exercises - Endurance exercises

UNIT IV **9 Hours**

INTRODUCTION OF ROBOTICS

Introduction to Robotics and its history, Overview of robot subsystems, Degrees of freedom, configurations and concept of workspace, Automation, Mechanisms and movements, Dynamic Stabilization-Applications of robotics in medicine

UNIT V **9 Hours**

REHABILITATION ROBOTICS

Fundamentals of Robot Technology - Automation and Robotics - Robot anatomy - Work volume - Precision of movement - End effectors - Sensors. human-robot interaction, Functions of rehabilitation robotics, rehabilitation robotics in recent areas - exoskeletons, Neuroplasticity, robotic therapy

Total: 45 Hours

Reference(s)

1. Robinson C.J, “Rehabilitation Engineering”, CRC Press, 2006
2. Rory A Cooper, “Rehabilitation Engineering Applied To Mobility And Manipulation”, IOP Publishing Ltd 1995.
3. Joseph D Bronzino,"The Biomedical Engineering Handbook", 2nd edition, CRC Press,2000.
4. John Iovine, "Robots, Android and Animatronics", McGraw-Hill, 2nd Edition, 2012.
5. Robert J. Schilling, "Fundamentals of Robotics- Analysis and Control", Pearson Education, 2006.

22BM012 CRITICAL CARE EQUIPMENT 3 0 0 3

Course Objectives

- To offer clear understanding of various intensive care equipment and their working.
- To understand the necessity of different operation theatre equipment.
- To know about different dialyzers and ventilators.

Program Outcomes (POs)

PO1. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. 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.
PO4. 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.
PO6. 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.
PO8. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PSO1. Apply knowledge on foundation in Life Science, engineering, mathematics and current biomedical engineering practices with an ability to demonstrate advanced knowledge of a selected area within Biomedical Engineering.
PSO2. Critically analyse the current healthcare systems and develop innovative solutions effectively through problem specific design and development using modern hardware and software tools.
PSO3. Hands-on knowledge on cutting edge hardware and software tools to acquire real time data, model and simulate physiological processes and analyse limitations on real time implementations.

Course Outcomes (COs)

1. Apply suitable design techniques in new monitoring devices for ICU and assist the medical personnel's during emergency situations
2. Analyze the working of various operation theatre equipment and suggest suitable surgical instruments and operational devices.
3. Compare the various techniques for clinical diagnosis, therapy and surgery, and its recent methods
4. Assess the centralized systems required during critical care environment
5. Analyze the conditions of critical care equipment in the aspect of patient safety.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	3	-	1	-	1	-	1	-	-	-	-	1	1	1
2	2	3	-	2	-	1	-	1	-	-	-	-	2	1	1
3	2	2	-	2	-	1	-	1	-	-	-	-	2	1	1
4	1	2	-	1	-	1	-	1	-	-	-	-	1	1	1
5	1	3	-	1	-	2	-	1	-	-	-	-	2	1	1

UNIT I **9 Hours**

INTENSIVE CARE UNIT EQUIPMENT

Suction apparatus, Different types; Sterilizers, Chemical, Radiation, Steam for small and large units. ICU ventilators. Automated drug delivery systems, Infusion pumps, components of drug infusion system, closed loop control infusion system, implantable infusion system. BMD Measurements - SXA - DXA -Quantitative ultrasound bone densitometer.

UNIT II **9 Hours**

OPERATION THEATRE EQUIPMENT

Craniotomy, Electrosurgical Machines (ESU), electrosurgical analysers, surgical aspirator, Instruments for operation. Anaesthesia Machine, Humidification, Sterilization aspects, Boyles apparatus. Endoscopy - Laparoscopy - Cryogenic Equipment - Anaesthesia gas, Anaesthesia gas monitor - surgical Microscope.

UNIT III **9 Hours**

ASSISTIVE CRITICAL CARE EQUIPMENT

Defibrillators, Haemodialysis Machine, Different types of Dialyzers, Membranes, Machine controls and measurements. Heart Lung Machine, different types of oxygenators, peristaltic pumps, Incubators.

UNIT IV **9 Hours**

CENTRALISED SYSTEMS

Centralized Oxygen, Nitrogen, Air supply & Suction. Centralized Air Conditioning, Operation Theatre table & Lighting. C Arm.

UNIT V **9 Hours**

PATIENT SAFETY

Patient electrical safety, Types of hazards, Natural protective mechanisms against electricity, Leakage current, Inspection of grounding and patient isolation, Hazards in operation rooms, ICCU and IMCUs, Opto couplers and Pulse transformers.

Total: 45 Hours

Reference(s)

1. John G. Webster, " Medical Instrumentation Application and Design", 4th edition, Wiley India PvtLtd, New Delhi, 2015
2. Joseph J. Carr and John M. Brown, "Introduction to Biomedical Equipment Technology", Pearson education, 2012
3. Khandpur. R.S.,"Handbook of Biomedical Instrumentation",Second Edition. Tata McGrawHill Pub. Co.,Ltd. 2003
4. L.A Geddes and L.E.Baker, "Principles of Applied Biomedical Instrumentation", 3rd Edition, 2008.
5. Antony Y.K.Chan, "Biomedical Device Technology, Principles and design",Charles Thomas Publisher Ltd, Illinois, USA, 2008.
6. Leslie Cromwell, "Biomedical Instrumentation and Measurement",Pearson Education, New Delhi, 2007.

22BM013 NUCLEAR MEDICINE 3 0 0 3

Course Objectives

- To understand the basic of various imaging modalities in nuclear medicine
- Study the diagnostics and therapeutic applications of nuclear medicine and radiation safety procedures and regulations

Program Outcomes (POs)

PO1. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. 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.

PO4. 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.

PO6. 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.

PO7. 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.

PO8. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PSO1. Apply knowledge on foundation in Life Science, engineering, mathematics and current biomedical engineering practices with an ability to demonstrate advanced knowledge of a selected area within Biomedical Engineering.

PSO2. Critically analyse the current healthcare systems and develop innovative solutions effectively through problem specific design and development using modern hardware and software tools.

PSO3. Hands-on knowledge on cutting edge hardware and software tools to acquire real time data, model and simulate physiological processes and analyse limitations on real time implementations.

Course Outcomes (COs)

1. Outline the concepts of physics applied in nuclear medicine.
2. Categorize the radiopharmaceuticals based on its characteristics, diagnosis and treatment methods
3. Analyze the performance of nuclear medicine instruments
4. Assess the radionuclides and analyse its medical applications.
5. Analyze the biological effects of radiation and safety aspects in nuclear medicine.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	2	-	1	-	1	1	1	-	-	-	-	1	1	1
2	2	3	-	2	-	1	1	1	-	-	-	-	2	1	1
3	2	2	-	3	-	1	1	1	-	-	-	-	2	1	1
4	1	2	-	2	-	1	1	1	-	-	-	-	1	1	1
5	1	3	-	2	-	2	1	1	-	-	-	-	2	1	1

UNIT I **9 Hours**

NUCLEAR MEDICINE PHYSICS

Basic Elementary introduction to structure of matter -elements - molecules and atoms - Radioactivity and interaction of radiation: Alpha, Beta and gamma emission, Laws of radioactive decay, Mechanisms of radioactive delay, Radiation intensity and exposure, Decay schemes and energy levels, Compton scattering, Pair productions, Particle interactions

UNIT II **9 Hours**

RADIOPHARMACEUTICALS

Radionuclide production, 99Mo/99mTc generator, Mechanism of localization, Types of radiopharmaceuticals, characteristics of radio pharmaceuticals, Radiopharmaceuticals for diagnosis and treatments in human, Dispensing of radio pharmaceuticals.

UNIT III **9 Hours**

PHYSICS OF NUCLEAR MEDICINE INSTRUMENTATION

Construction and principle operation of Gamma camera, Rectilinear scanner, Basic principles of pulse height analyser, Radiation detectors-Ionization chamber, Geiger Muller counter, Semiconductor detectors, Scintillation detectors, Electronic Instrumentation for radiation detection system

UNIT IV **9 Hours**

DIAGNOSTIC AND THERAPEUTIC APPLICATIONS OF RADIONUCLIDE

Invitro and Invivo Diagnostic techniques - PET - CT, Single photon emission computed tomography (SPECT), Radio iodine therapy for Thyrotoxicosis , Differentiated thyroid cancers, Palliative treatment for bone metastasis - 32P and 89 Strontium Dosage-Intravascular particulate radio nuclide Therapy, Receptor targeted therapy, 131I - MIBG Therapy, Targeted internal radiation in HCC: 90 Y, Radio - synovectomy using Yttrium

UNIT V **9 Hours**

RADIATION BIOLOGY AND SAFETY

Biological effects of radiation-Somatic and hereditary effects of radiation-Radiation protection indifferent nuclear isotope therapy procedures, Management of radiation accidents, Radiation effect on pregnancy and fertility, Diagnosis, evaluation and treatment of radiation overexposure, Instruments used in radiation survey & monitoring, Handling of radioactive patients, Role of national and international bodies in radiation safety, ICRP recommendations, BARC regulations regarding limits of radiation exposure.

Total: 45 Hours

Reference(s)

1. Simon Cherry, James Sorenson, Michael Phelps. "Physics in Nuclear Medicine", Elsevier Saunders, 4th Edition, 2012
2. Jerrold T Bushberg, J.Anthony Seibert, Edwin M Leidholdt,John M Boone, Lippincott, "The Essential Physics of Medical Imaging", Williams & Wilkins, 3rd edition, 2011
3. Fred A Mettler, Milton J Guiberteau, "Essentials of nuclear Medicine and molecular imaging", 7th Edition, Elseiver, 2018.
4. Gopal B.Saha, " Physics and Radiation biology of Nuclear Medicine", 2006

22BM014 CELL BIOLOGY 3 0 0 3

Course Objectives

- To provide a basic understanding of cell, its structure, function, types and about its culture.
- To understand the concepts in Cell Biology.
- To compare cellular processes and regulation
- To carry out the recent trends in cell and molecular research

Program Outcomes (POs)

PO1. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. 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.

PO3. 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.

PO4. 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.

PSO1. Apply knowledge on foundation in Life Science, engineering, mathematics and current biomedical engineering practices with an ability to demonstrate advanced knowledge of a selected area within Biomedical Engineering.

PSO2. Critically analyse the current healthcare systems and develop innovative solutions effectively through problem specific design and development using modern hardware and software tools.

Course Outcomes (COs)

1. Integrate structural information of cells to differentiate Eukaryotic cell and prokaryotic cell
2. Categorize cell organelles based on its types and functions
3. Outline the transportation of action potential from one cell to another
4. Analyse the cause, and methods of cell signalling and signal transduction.
5. Determine the cell culture preparation process

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	1	2	2	2	-	-	-	-	-	-	-	-	1	1	-
2	1	3	2	2	-	-	-	-	-	-	-	-	1	1	-
3	1	3	-	2	-	-	-	-	-	-	-	-	1	1	-
4	1	3	-	2	-	-	-	-	-	-	-	-	1	1	-
5	1	3	-	2	-	-	-	-	-	-	-	-	1	1	-

UNIT I **9 Hours**

CELL STRUCTURE

Cells - definition, Eukaryotic cell and prokaryotic cell -differences and key organelles, Relationship and evolution of Eukaryotic cell and prokaryotic cell, plant cells and animal cells - differences and general structure - Cellular environment, tissues, various types of cell, Extra cellular matrix, cytoskeletal proteins, Cell Cycle - Mitosis and meiosis.

UNIT II **9 Hours**

CELL ORGANELLES

Cell Organelles and function - Nucleus, Cytoplasm, Endoplasmic reticulum, Golgi complex, lysosomes, cell membranes, chloroplast, mitochondria - structure, importance and function.

UNIT III **9 Hours**

CELLULAR TRANSPORT

Transport across cell membranes - importance, classification - Active and passive, passive transport - movement of water, small lipid across membrane. Active - Na+ K+ ATPase Pump, Lysosomal and Vacuolar pumps. Cotransport - Symport, antiport - examples, Endocytosis and Exocytosis transport across prokaryotic membrane, entry of viruses and toxins.

UNIT IV **9 Hours**

CELL SIGNALING AND SIGNAL TRANSDUCTION

Cell signaling - process importance, various kinds of Receptors and ligands - Examples, Different modes of action of ligands, Qualification and characterization of receptors, different modes of signal transduction and amplification with examples, signaling through G-Proteins (Monomeric and trimeric), signaling for growth factors, second messengers, protein kinases, Ca ions and cAMP molecule in signaling.

UNIT V **9 Hours**

CELL CULTURE

Definition, Media preparation, Propagation of eukaryotic and prokaryotic cell, cell lines, primary cultures, stock cell cultures, maintenance of cell lines in cell culture, explants cultures, differentiation and contamination

Total: 45 Hours

Reference(s)

1. James E Darnell, Harvey F Lodish, David Baltimore, " Molecular Biology of the Cell" , W.H. Freeman publishers, 2012
2. Geoffrey Cooper, "The Cell: A molecular approach", OUP USA; 8th edition, 2019.
3. Vermaand Aggarval," Cytology", S. Chand Publications, 2003.
4. Bruce Alberts, Alexander Johnson, Julian Lewis and Martin Raff, "Molecular Biology of the cell", fifth edition, Taylor and Francis group, 2012.
5. De Robertis & De Robertis, "Cell Biology", 4th Edition, 2010.
6. Gerald Karp," Cell and Molecular Biology" , John Wiley and sons Inc, 2013.

22BM015 TISSUE ENGINEERING 3 0 0 3

Course Objectives

- To study Cell cycle and differentiation
- To understand the basics about stem cells and its applications
- To familiarize different synthetic and natural biomaterials in tissue replacements

Program Outcomes (POs)

PO1. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. 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.
PO3. 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.
PO6. 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.
PO8. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PSO1. Apply knowledge on foundation in Life Science, engineering, mathematics and current biomedical engineering practices with an ability to demonstrate advanced knowledge of a selected area within Biomedical Engineering.
PSO2. Critically analyse the current healthcare systems and develop innovative solutions effectively through problem specific design and development using modern hardware and software tools.

Course Outcomes (COs)

1. Outline the fundamental concepts of Tissue Engineering
2. Implement the concepts of stem cell, gene therapy in healthcare systems
3. Apply Engineering design methods to tissue engineering
4. Select suitable material for designing artificial organs using tissue engineering
5. Analyse the characteristics of Biomaterials in Tissue engineering

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	2	-	-	-	-	-	-	-	-	-	-	3	-	-
2	1	2	3	-	-	1	-	-	-	-	-	-	2	2	-
3	1	2	3	-	-	1	-	-	-	-	-	-	2	2	-
4	1	2	2	-	-	1	-	1	-	-	-	-	2	3	-
5	1	3	2	-	-	1	-	-	-	-	-	-	2	3	-

UNIT I **9 Hours**

FUNDAMENTALS OF TISSUE ENGINEERING

Particles, waves, probability amplitudes, Schrodinger equation, wave packets solutions, operators, expectation values, Eigen functions, piecewise constant potentials

UNIT II **9 Hours**

STEM CELLS AND GENE THERAPY

Embryonic stem cells - Liver stem cells - adult epithelial tissue stem cells - mesenchymal stem cells - strategies of gene therapy - Ex vivo Vs in vivo gene therapy, gene transfer vector, cell - specific targeting strategies, combining gene transfer with stem cell strategies, challenges to gene therapy for tissue engineering

UNIT III **9 Hours**

ENGINEERING METHODS AND DESIGN

Soft lithography, self-assembled monolayer, micro fluidic patterning, laminar flow patterning, cells interaction with polymers, cell interaction with three dimensional polymer scaffolds and gels - polymer scaffolds fabrications, electrospinning, freeze drying, microfabrication of cell seeded scaffolds - three dimensional scaffold design and engineering

UNIT IV **9 Hours**

MATERIALS IN TISSUE ENGINEERING

Biological materials, degradable and non-degradable, extra cellular matrix decellularization, Polymers: synthetic and natural, cell interaction with polymers, applications of polymer, Ceramics and Metals.

UNIT V **9 Hours**

APPLICATIONS

Replacement Engineering: Bone, cartilage, skin, blood, pancreas, kidney, heart valve and liver, Regenerative engineering: peripheral Nerve regeneration, cardiac tissue regeneration, muscle regeneration, Tissue Engineered Food. Regulation, Commercialization and Patenting

Total: 45 Hours

Reference(s)

1. Robert P lanza, Robert Langer and Joseph Vacanti, "Principles of tissue engineering", Academic Press, California, 2007
2. W. Mark Saltzman, "Tissue Engineering: Engineering principles for design of replacement organs and tissue", Oxford University Press Inc New York, 2004
3. Gary E. Wnek, Gary L Browlin, "Encyclopedia of Biomaterials and Biomedical Engineering" , Marcel Dekker Inc, New York, 2008
4. R. Lanza, Anthony Atala (Eds), "Essential of Stem Cell Biology", Academic Press, USA, 2013
5. Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, Peter Walter, "Molecular Biology of the Cell" , Garland Science Publications, New York, 2008

22BM016 GENETIC ENGINEERING 3 0 0 3

Course Objectives

- To understand the concepts of Genetics
- To introduce the practice of recombinant DNA technologies
- To solve genetic engineering problems and design target gene expression with advanced genetic engineering techniques.
- To explore with genetic engineering techniques for cloning target gene or protein expression.

Program Outcomes (POs)

PO1. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. 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.

PO3. 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.

PO6. 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.

PO8. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO12. 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.

PSO1. Apply knowledge on foundation in Life Science, engineering, mathematics and current biomedical engineering practices with an ability to demonstrate advanced knowledge of a selected area within Biomedical Engineering.

PSO2. Critically analyse the current healthcare systems and develop innovative solutions effectively through problem specific design and development using modern hardware and software tools.

Course Outcomes (COs)

1. Integrate the concepts of Genetics
2. Implement Recombinant DNA technology for gene cloning methods and for construction of Gene Libraries
3. Apply the polymerase chain reaction in disease diagnosis, forensic science and genetic Engineering
4. Analyse the advancements in genetic Engineering
5. Assess genetic engineering concepts in drugs and vaccine preparation and its ethical issues.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	2	-	-	-	-	-	-	-	-	-	1	3	-	-
2	1	2	3	-	-	1	-	1	-	-	-	1	2	2	-
3	1	2	3	-	-	1	-	1	-	-	-	1	2	2	-
4	1	3	2	-	-	1	-	1	-	-	-	1	2	3	-
5	1	3	2	-	-	1	-	3	-	-	-	1	2	3	-

UNIT I **9 Hours**

BASICS OF GENETICS

Biomolecules: Carbohydrates, Proteins, Lipid, Amino acid and Nucleic acids. Nucleic acids: Introduction, History, DNA and RNA- genetic material, types, mutation. Chromosome, Gene, Expression of genetic information, Regulation of mRNA stability.

UNIT II **9 Hours**

RECOMBINANT DNA TECHNOLOGY

Gene cloning - concept and basic steps; Restriction modification enzymes used in recombinant DNA technology, endonucleases, ligases and other enzymes useful in gene cloning; Vectors: plasmid, bacteriophage and other viral vectors, cosmids, artificial chromosomes, Ti plasmid, shuttle vectors, expression vectors; DNA delivery methods; Construction of genomic and cDNA libraries; Techniques for selection, screening and characterization of transformants.

UNIT III **9 Hours**

ROLE OF POLYMERASE CHAIN REACTION

Concept of PCR; DNA polymerases; primer designing, linkers, adapters, setting up PCR reactions; Various types of PCR; Applications of PCR in disease diagnostics, forensic sciences and genetic engineering.

UNIT IV **9 Hours**

ADVANCED APPROACHES IN GENETIC ENGINEERING

Gene expression in prokaryotes & eukaryotes, Tissue specific promoter, wound inducible promoters, Strong and regulatable promoters, promoter analysis (EMSA and DNA foot printing), gene expression profiling (real time PCR, SAGE, differential display, Microarray); DNA sequencing methods; Molecular markers: RAPD, RFLP, AFLP, SNP; Site directed mutagenesis, gene silencing techniques.

UNIT V **9 Hours**

APPLICATIONS OF GENETIC ENGINEERING

Genetic engineering and Biotechnology; Creation of recombinant microorganisms, transgenic plants and animals; cloning of sheep (Dolly) & other mammals; applications in conservation; therapeutic vs. reproductive cloning; ethical issues and the prospects for human cloning; Gene therapy; DNA drugs and vaccines.

Total: 45 Hours

Reference(s)

1. Patrick Faraday, "Genetic Engineering: Emerging concepts and Technologies", Syrawood Publishers, 2018.
2. "The Biotech Primer: An Insider"s Guide to the Science Driving the Biopharma Industry", The Biotech Primer For Non-Scientists Series, November 15, 2019
3. Sandhya Mitra, "Genetic Engineering", Mcgraw Hill, 2nd edition, 2017.
4. R. W Old," Principles of gene manipulation - An introduction to genetic engineering", Distributors, USA, Publishers" Business Services, 1989.
5. Desmond S. T. Nicholl, "An Introduction to Genetic Engineering", Cambridge University Press, 2023.

22BM017 CANCER BIOLOGY 3 0 0 3

Course Objectives

- To import knowledge on Cancer Biology fundamentals and principles of carcinogenesis.
- To discuss about molecular cancer cell biology and metastasis
- To introduce various therapeutic procedures for treating carcinoma
- To emphasize knowledge of the historical background for the development of the tumor microenvironment

Program Outcomes (POs)

PO1. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. 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.
PO3. 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.
PO6. 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.
PO8. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO12. 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.
PSO1. Apply knowledge on foundation in Life Science, engineering, mathematics and current biomedical engineering practices with an ability to demonstrate advanced knowledge of a selected area within Biomedical Engineering.
PSO2. Critically analyse the current healthcare systems and develop innovative solutions effectively through problem specific design and development using modern hardware and software tools.

Course Outcomes (COs)

1. Apply the concepts of cancer biology to understand different forms of cancers.
2. Analyse the molecular mechanisms behind carcinogenesis
3. Outline the processes of Mutation of cancer cell genomes of living cells
4. Evaluate the treatment procedures currently available for cancer.
5. Categorize different therapeutic techniques used for cancer

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	2	-	-	-	1	-	-	-	-	-	1	2	1	-
2	1	3	3	-	-	1	-	-	-	-	-	1	2	2	-
3	1	3	3	-	-	1	-	-	-	-	-	1	2	2	-
4	1	3	2	-	-	1	-	1	-	-	-	1	2	2	-
5	1	3	2	-	-	1	-	1	-	-	-	1	2	2	-

UNIT I **9 Hours**

FUNDAMENTALS OF CANCER BIOLOGY

Regulation of cell cycle, Mutations that cause changes in signal molecules, Cancer genes - Tumour suppressor genes, oncogenes and their mutations, Modulation of cell cycle in cancer, Different forms of cancers, Clinical examination, Radiological examination, Biopsy and its type, Prediction of aggressiveness of cancer, tumour markers, Molecular tools for early diagnosis

UNIT II **9 Hours**

PRINCIPLES OF CARC INOGENESIS

Theory of carcinogenesis, Chemical carcinogenesis, Metabolism of carcinogemnesis, Principles of physical carcinogenesis, X-ray radiation, Mechanisms of radiation carcinogenesis, Diet and cancer

UNIT III **9 Hours**

PRINCIPLES OF MOLECULAR CELL BIOLOGY OF CANCER

Signal targets and cancer, Activation of kinases, Oncogens, Identification of oncogens, Retroiruses and Oncogens, Detection of oncogens, Oncogens/Proto oncogen activity, Growth factors related to transformation, Telomerases.

UNIT IV **9 Hours**

PRINCIPLES OF CANCER METASTASIS

Clinical significances of inasion, Heterogeneity of metastatic phenotype, metastatic cascade, Basement description, Proteinases and tumour cell inasion

UNIT V **9 Hours**

NEW MOLECULES FOR CANCER THERAPY

Different forms of therapy, Chemotherapy, Radiation therapy, Detection of cancers, Use of signal targets towards a therapy of cancer, Gene therapy, Cancer resistance to chemotherapy, Advancement in cancer therapy, Nano systems for drug delivery, Enzyme inhibitors in relation to cancer therapy

Total: 45 Hours

Reference(s)

1. David Kerr, Francesco Pezzella, Mahvash Tavassoli, Cancer Biology, Oxford University Press, 2019.
2. Aysha Divan, Janice Royds, Cancer Biology and Treatment, Oxford University Press, 2020.
3. Momna Hejmadi, Introduction to Cancer Biology, bonbooks, 2023
4. Carsten Carlberg, Eunike Velleuer, Cancer Biology: How Science Works, Springer International Publishing 2021.
5. Walter M. Stadler , Cancer Biology Review A Case-Based Approach, Demos Medical Publishing, 2013

22BM018 BIO COMPUTATIONAL TECHNIQUES 3 0 0 3

Course Objectives

- To introduce the biocomputational techniques
- To familiarize the protein structure, modelling and simulation
- To introduce advanced computational techniques in Biology

Program Outcomes (POs)

PO1. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. 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.

PO3. 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.

PO5. 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.

PSO1. Apply knowledge on foundation in Life Science, engineering, mathematics and current biomedical engineering practices with an ability to demonstrate advanced knowledge of a selected area within Biomedical Engineering.

PSO3. Hands-on knowledge on cutting edge hardware and software tools to acquire real time data, model and simulate physiological processes and analyse limitations on real time implementations.

Course Outcomes (COs)

1. Apply the concept of sequencing in physiology
2. Implement distance and character based methods for phylogenetic tree construction
3. Use modelling and simulation concept to study protein structure
4. Develop suitable machine learning approaches for system engineering and modelling procedures
5. Apply perl programming for biological data analytics

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	1	1	2	-	-	-	-	-	-	-	-	-	2	-	2
2	2	2	3	-	-	-	-	-	-	-	-	-	2	-	2
3	2	2	3	-	2	-	-	-	-	-	-	-	2	-	2
4	2	1	3	-	2	-	-	-	-	-	-	-	2	-	2
5	2	2	3	-	2	-	-	-	-	-	-	-	2	-	2

UNIT I **9 Hours**

INTRODUCTION TO COMPUTATIONAL BIOLOGY AND SEQUENCE ANALYSIS

Molecular sequences, Genome sequencing: pipeline and data, Next generation sequencing data, Biological databases: Protein and Nucleotide databases, Sequence Alignment, Dynamic Programming for computing edit distance and string similarity, Local and Global Alignment, Needleman Wunsch Algorithm, Smith Waterman Algorithm, BLAST family of programs, FASTA algorithm, Functional Annotation, Progressive and Iterative Methods for Multiple sequence alignment, Applications.

UNIT II **9 Hours**

PHYLOGENETICS

Introduction to Phylogenetics, Distance and Character based methods for phylogenetic tree construction: UPGMA, Neighbour joining, Ultrametric and Min ultrametric trees, Parsimonous trees, Additive trees, Bootstrapping.

UNIT III **9 Hours**

PROTEIN STRUCTURE, MODELLING AND SIMULATIONS

Protein Structure Basics, Visualization, Prediction of Secondary Structure and Tertiary Structure, Homology Modelling, Structural Genomics, Molecular Docking principles and applications, Molecular dynamics simulations.

UNIT IV **9 Hours**

MACHINE LEARNING, SYSTEMS BIOLOGY AND OTHER ADVANCED TOPICS

Machine learning techniques: Artificial Neural Networks and Hidden Markov Models: Applications in Protein Secondary Structure Prediction and Gene Finding, Introduction to Systems Biology and its applications in whole cell modelling, Microarrays and Clustering techniques for microarray data analysis, informatics in Genomics and Proteomics, DNA computing.

UNIT V **9 Hours**

PERL FOR BIOINFORMATICS

Variables, Data types, control flow constructs, Pattern Matching, String manipulation, arrays, lists and hashes, File handling, Programs to handle biological data and parse output files for interpretation

Total: 45 Hours

Reference(s)

1. Dan Gusfield. Algorithms on Strings Trees and Sequences, Cambridge University Press. 2019
2. David W. Mount Bioinformatics: Sequence and Genome Analysis, Cold Spring Harbor Laboratory Press, Second Edition, 2004.
3. Arthur M. Lesk, Introduction to Bioinformatics by Oxford University Press, 2008.
4. Tisdall, James, Beginning PERL for Bioinformatics, O Reilley Publications, 2001
5. Andrew R. Leach, Molecular Modelling Principles And Applications, Second Edition, Prentice Hall 2009

22BM019 NEUROSCIENCE 3 0 0 3

Course Objectives

- To understand the basics of nervous systems and its functions
- To characterize neuronal cells
- To identify the effect of neuronal functions and the neural disorders
- To select suitable testing methods for analysing neural behaviour

Program Outcomes (POs)

PO1. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. 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.

PO3. 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.

PO12. 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.

PSO1. Apply knowledge on foundation in Life Science, engineering, mathematics and current biomedical engineering practices with an ability to demonstrate advanced knowledge of a selected area within Biomedical Engineering.

PSO2. Critically analyse the current healthcare systems and develop innovative solutions effectively through problem specific design and development using modern hardware and software tools.

PSO3. Hands-on knowledge on cutting edge hardware and software tools to acquire real time data, model and simulate physiological processes and analyse limitations on real time implementations.

Course Outcomes (COs)

1. Assess the concept of action potential propagation to understand neuron Synaptic potentials and Receptor potentials
2. Analyse the characteristics of neuronal cells based on its characterisation
3. Outline the effect of neuronal function based on the neurotransmission models
4. Compare the different types of neurological disorders and its causes
5. Analyse the neuronal behavioural using appropriate testing methods

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	1	2	3	-	-	-	-	-	-	-	-	1	1	1	1
2	2	3	2	-	-	-	-	-	-	-	-	1	1	1	1
3	2	3	2	-	-	-	-	-	-	-	-	1	2	1	1
4	2	3	2	-	-	-	-	-	-	-	-	1	2	1	1
5	2	3	2	-	-	-	-	-	-	-	-	1	2	1	2

UNIT I **9 Hours**

INTRODUCTION TO NERVOUS SYSTEM

Nervous system: Introduction, Central and peripheral nervous system, Signalling molecules, First growth factor, First Neuro transmitters in brain, functional organization, Synaptic potentials and Receptor potentials.

UNIT II **9 Hours**

NEURO ANATOMY

Structures and functions of neurons, Synapse: function, signals produced by neurons, Sensors function, Glial cells, molecular and cellular organization of neuronal differentiation, characterization of neuronal cells.

UNIT III **9 Hours**

NEUROPHYSIOLOGY AND NEUROPHARMACOLOGY

Resting and action potentials; Mechanism of action potential conduction; Voltage dependent channels; nodes of Ranvier; Chemical and electrical synaptic transmission. Synaptic transmission, neurotransmitters and their release; fast and slow neurotransmission; characteristics of neurites; hormones and their effect on neuronal function.

UNIT IV **9 Hours**

NEUROLOGICAL DISORDERS

Pathogenesis, Genetic basis of neurological disorders, Psychiatric Disorders: Psychiatric epidemiology, Unipolar depression, Bipolar depression, Seasonal affective disorder, Panic disorder, Autism, Stroke, Huntington disease

UNIT V **9 Hours**

BEHAVIOUR SCIENCE

Neuronal mechanism of behaviour, Animal behaviour, Behaviour in various environments, Behavioural and cognitive neuroscience, Behavioural studies using animal model, Testing motor functions, Grip Strength Test, Testing Cognitive Functions, Learning and memory related test

Total: 45 Hours

Reference(s)

1. Georg Goldenberg, Bruce L. Miller - Neuropsychology and Behavioral Neurology_ Handbook of Clinical Neurology, Elsevier - libgen.lc., 2008
2. Michael J. Aminoff, Handbook of Clinical Neurology, Elsevier, London, 2012
3. Mason P., Medical Neurobiology, Oxford University Press, 2011
4. Mathews G.G. Neurobiology, 2nd edition, Blackwell Science, UK, 2000
5. Gordon M. Shepherd G.M, and Shepherd Neurobiology, 3rd Edition Oxford University Press, USA, 1994

22BM020 CARDIOVASCULAR ENGINEERING 3 0 0 3

Course Objectives

- To understand the basics of cardiovascular system
- To analyse events of cardiac cycle
- To learn hemodynamics of cardiac systems

Program Outcomes (POs)

PO1. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. 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.

PO3. 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.

PO4. 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.

PO12. 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.

PSO1. Apply knowledge on foundation in Life Science, engineering, mathematics and current biomedical engineering practices with an ability to demonstrate advanced knowledge of a selected area within Biomedical Engineering.

PSO2. Critically analyse the current healthcare systems and develop innovative solutions effectively through problem specific design and development using modern hardware and software tools.

Course Outcomes (COs)

1. Outline the concepts and controls of cardiovascular system.
2. Integrate the mechanical events related to human cardiac cycle
3. Analyze the cardiac excitation and contraction process
4. Evaluate the cardiac output for the specific events using suitable methods
5. Determine the Hemodynamics with respect to cardiovascular system

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	1	2	2	-	-	-	-	-	-	-	-	1	-	-	-
2	1	3	2	2	-	-	-	-	-	-	-	1	2	1	-
3	1	3	2	2	-	-	-	-	-	-	-	1	2	2	-
4	1	3	2	2	-	-	-	-	-	-	-	1	2	1	-
5	1	3	2	2	-	-	-	-	-	-	-	1	2	1	-

UNIT I **9 Hours**

OVERVIEW OF THE CARDIOVASCULAR SYSTEM

Functions of the cardiovascular system, Circulation of blood, Central control of the cardiovascular system

UNIT II **9 Hours**

CARDIAC CYCLE

Mechanical events, Arterial cycle and central venous pressure cycle, Clinical aspects of human cardiac cycle

UNIT III **9 Hours**

CARDIAC EXCITATION AND CONTRACTION

Mechanism of contraction, Sinoatrial node function, cardiac conduction system, Atrioventricular node function, Autonomic regulation of the heart rate

UNIT IV **9 Hours**

ASSESSMENT OF CARDIAC OUTPUT

Fick principle, Thermodilution and indicator dilution methods, Pulse Doppler methods, miscellaneous methods

UNIT V **9 Hours**

HEMODYNAMICS

Relationship between pressure, flow and resistance, Frank-Starling law, Preload, afterload and contractility, Control of stroke volume and cardiac output

Total: 45 Hours

Reference(s)

1. Anne Waugh, Allison Grant, Ross and Wilson Anatomy and Physiology, Elsevier, edition 14. 2018.
2. George A Stouffer, J Larry Klein, Cardiovascular Hemodynamics for the clinician, First edition, John Willey & Sons, 2017
3. Joseph D.Bronzino, Biomedical Engineering Fundamentals, Taylor& Francis, 2006
4. John Enderle, Susan blanchard, Joseph Bronzino, Introduction to Biomedical Engineering, Elsevier, 2005.
5. Michel R Labrosse, Cardiovascular Mechanics, First edition, CRC press, Taylor and Francis Group, 2019

22BM021 PHYSIOLOGICAL MODELLING 3 0 0 3

Course Objectives

- To introduce system concept to physiology
- To introduce relationship between engineering control system and physiological control system
- To familiarize lumped and distributed parametric modelling techniques for understanding physiology
- To model dynamically varying physiological system

Program Outcomes (POs)

PO1. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. 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.
PO3. 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.
PO4. 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.
PO12. 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.
PSO1. Apply knowledge on foundation in Life Science, engineering, mathematics and current biomedical engineering practices with an ability to demonstrate advanced knowledge of a selected area within Biomedical Engineering.
PSO2. Critically analyse the current healthcare systems and develop innovative solutions effectively through problem specific design and development using modern hardware and software tools.
PSO3. Hands-on knowledge on cutting edge hardware and software tools to acquire real time data, model and simulate physiological processes and analyse limitations on real time implementations.

Course Outcomes (COs)

1. Implement engineering system concept for human physiological systems.
2. Assess system transfer function and the feedback approach to derive mathematical model of a Physiological system
3. Show the vital homeostatic mechanisms as closed loop control system
4. Develop suitable models for analysing Cardiopulmonary System
5. Analyse Respiratory physiology using mathematical model and its simulation

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	2	3	2	-	-	-	-	-	-	-	1	3	2	1
2	2	3	2	2	-	-	-	-	-	-	-	1	3	2	1
3	2	3	2	2	-	-	-	-	-	-	-	1	3	2	1
4	2	2	3	2	-	-	-	-	-	-	-	1	3	2	1
5	2	3	2	2	-	-	-	-	-	-	-	1	3	2	1

UNIT I **9 Hours**

SYSTEM CONCEPT

Purpose of physiological modelling and signal analysis, Characterization of simple physiological system, System properties: Resistance, linear resistance analysis, static and dynamic resistance, Storage, system with volume storage, electrical analog of compliance, combined hollow elastic element, cylindrical elements, storage in thermal systems, storage in mechanical systems Distributed Vs lumped parametric model, unmyelinated nerve fiber model simulation

UNIT II **9 Hours**

SYSTEM ANALYSIS AND FEEDBACK

Review: transfer function, First and second order system transfer function and step response transfer function, sinusoidal analysis of second order system. Difference between engineering and physiological control systems. Muscle reflux system Open vs closed loop system. Positive and negative feedback system

UNIT III **9 Hours**

PHYSIOLOGICAL CONTROL SYSTEMS AND ANALYSIS

Homeostasis: Body temperature, Glucose regulation, Blood pressure regulation, Fight-Flight response, Body fluid, pH regulation, electrolyte regulation, Transient and steady state response - Steady state operating point- the steady-state characteristics

UNIT IV **9 Hours**

MODELLING OF CARDIOPULMONARY SYSTEM AND OTHER MODELS

Review of cardiovascular anatomy and physiology, two-element and three element Windkessel model, cardiac muscle model, Model of Isovolumic ventricle and ejection effect Simplified model of heart with heart valves- Baroreflex Model- simplified circulatory model.

UNIT V **9 Hours**

RESPIRATORY SYSTEM AND OTHER MODELS

Review of Respiratory system anatomy and physiology, Lung modelling, Pressure Model, Linear lung model with sinusoidal airway dynamics, Gas model, chemical regulation of ventilation, Cheyne-Stoke breathing, biot breathing, Hodgin-Huxley model, Thermal system

Total: 45 Hours

Reference(s)

1. Benjamin C Kuo, Automatic control systems, Tenth Edition, McGraw-Hill Education, 2017
2. Michel C Khoo, Physiological Control Systems -Analysis, simulation and estimation, Prentice Hall of India, 2001
3. Marmarelis, Nonlinear Dynamic Modeling of Physiological Systems, Wiley-IEEE Press,2004
4. Bernhard Graimann, Brendan Allison, GertPfurtscheller, Brain-Computer Interfaces: Revolutionizing Human-Computer Interaction, Springer, 2010
5. David T Westwick, Robert E. Kearney, Identification of Nonlinear Physiological Systems, Wiley-IEEE Press, 2003

22BM022 PROSTHETIC AND ORTHOTIC DEVICES 3 0 0 3

Course Objectives

- To introduce appropriate assist device suitable for specific disorder
- To Develop new assist devices for the needy
- Understand orthopaedic prosthetics and orthotics in rehabilitation

Program Outcomes (POs)

PO2. 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.

PO3. 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.

PO4. 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.

PO6. 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.

PO8. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO12. 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.

PSO1. Apply knowledge on foundation in Life Science, engineering, mathematics and current biomedical engineering practices with an ability to demonstrate advanced knowledge of a selected area within Biomedical Engineering.

PSO2. Critically analyse the current healthcare systems and develop innovative solutions effectively through problem specific design and development using modern hardware and software tools.

PSO3. Hands-on knowledge on cutting edge hardware and software tools to acquire real time data, model and simulate physiological processes and analyse limitations on real time implementations.

Course Outcomes (COs)

1. Apply suitable assistive technology (AT) for human mobility
2. Analyse sensory impairment of vision and hearing and suggest suitable aiding device
3. Outline the recent advancements in assistive technology for Vital organs
4. Develop an assistive device for a given organ impairment
5. Evaluate the performance of an implant design based on its performance parameters

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	-	2	3	2	-	1	-	1	-	-	-	1	2	3	2
2	-	2	2	3	-	1	-	1	-	-	-	1	2	3	2
3	-	2	2	3	-	1	-	1	-	-	-	1	2	3	2
4	-	1	3	2	-	1	-	1	-	-	-	1	2	3	2
5	-	2	2	3	-	1	-	1	-	-	-	1	2	3	2

UNIT I **9 Hours**

ASSISTIVE TECHNOLOGY FOR MOBILITY

Basic assessment and evaluation for mobility, Control systems, navigation in virtual space by wheelchairs, Wheel chair seating and pressure ulcers, Fuzzy logic expert system for automatic tuning of myoelectric prostheses, Intelligent prosthesis

UNIT II **9 Hours**

ASSISTIVE TECHNOLOGY AND SENSORY IMPAIRMENTS

Visual and auditory impairment, assessment methods, Libraille, GRAB, mathematical Braille, Augmentative and alternative methods for hearing impairment, Use of multimedia technology to help hard of hearing children, Haptic as a substitute for vision

UNIT III **9 Hours**

ASSIST DEVICES FOR VITAL ORGANS AND ADVANCEMENTS IN TECHNOLOGY

Cardiac assist devices, Intra-Aortic Balloon Pump (IABP), auxiliary ventricles, Dialysis for kidneys, Intermittent positive pressure breathing (IPPB) type assistance for lungs, Latest use of assistive technology for chronic heart diseases and healthcare, Information technology, telecommunications, new media in assisting healthcare, Future trends in assistive technology, virtual reality based training system for disabled children

UNIT IV **9 Hours**

PRINCIPLES OF IMPLANT DESIGN

Principles of implant design, cardiac implants, Clinical problems requiring implants for solution, Permanent versus absorbable devices, the missing organ and its replacement, Tissue engineering, scaffolds, cells and regulators criteria for materials selection, Case study of organ regeneration

UNIT V **9 Hours**

IMPLANT DESIGN PARAMETERS AND ITS SOLUTION

Biocompatibility, local and systemic effects of implants, Design specifications for tissue bonding and modulus matching, Degradation of devices, natural and synthetic polymers, corrosion, wear and tear, Implants for Bone, Devices for nerve regeneration, dental and otologic implants

Total: 45 Hours

Reference(s)

1. Yadin David, Wolf W. von Maltzahn, Michael R. Neuman, Joseph.D, Bronzino, Clinical Engineering, CRC Press, 1st edition,2010
2. Kenneth J. Turner, Advances in Home Care Technologies: Results of the match Project, Springer, 1st edition, 201
3. Gerr, M. Craddock, Assistive Technology-Shaping the future, IOS Press, 1st edition, 2003
4. Marion. A. Hersh, Michael A. Johnson, Assistive Technology for visually impaired and blind, Springer Science & Business Media, 1st edition, 2010

22BM023 REGENERATIVE MEDICINE AND ERGONOMICS

3 0 0 3

Course Objectives

- To familiarize nature and significance of stem cells and its applications
- To Explain the Molecular therapy for regeneration
- To outline the basics of Biomechanical, physiological and anthropometric background.

Program Outcomes (POs)

PO1. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. 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.
PO3. 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.
PO4. 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.
PO6. 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.
PO8. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO10. 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.
PO12. 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.
PSO1. Apply knowledge on foundation in Life Science, engineering, mathematics and current biomedical engineering practices with an ability to demonstrate advanced knowledge of a selected area within Biomedical Engineering.
PSO2. Critically analyse the current healthcare systems and develop innovative solutions effectively through problem specific design and development using modern hardware and software tools.
PSO3. Hands-on knowledge on cutting edge hardware and software tools to acquire real time data, model and simulate physiological processes and analyse limitations on real time implementations.

Course Outcomes (COs)

1. Outline the concept of regenerative medicine and its applications
2. Assess the usage of stem cells in various clinical applications and injuries
3. Integrate suitable biomaterials for designing regenerative medicine
4. Structure the Anthropometric design principles utilization in regenerative medicine
5. Analyze the ergonomic impacts in Human physiology

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	-	-	1	-	1	-	1	-	1	-	1	1	1	1
2	-	3	1	2	-	1	-	1	-	1	-	1	1	3	2
3	-	1	3	2	-	1	-	1	-	1	-	1	1	2	2
4	-	3	1	2	-	1	-	1	-	1	-	1	1	3	2
5	-	3	1	2	-	1	-	1	-	1	-	1	1	3	2

UNIT I **9 Hours**

REGENERATIVE MEDICINE

Regenerative Therapy, Introduction-Large scale manufacturing of cells, tissues and organs, Artificial organs, Gene therapy Applications-Engineered Tissues and Regenerative Medicine, Molecular therapy for regeneration, Personalized therapies in Regenerative Medicine, Applications of Regenerative Medicine

UNIT II **9 Hours**

STEM CELL BIOLOGY

Introduction, Types & sources of stem cell with characteristics: hematopoietic differentiation pathway, Potency and plasticity of stem cells, sources, embryonic stem cells, hematopoietic and mesenchymal stem cells, Stem Cell markers, FACS analysis, Differentiation, Stem cell systems- Liver, neuronal stem cells, cancer stem cells, induced pluripotent stem cells.

UNIT III **9 Hours**

BIOMATERIALS AND HUMAN- ENVIRONMENT INTERACTION

Biomaterials: Properties of Biomaterials, Surface, bulk, mechanical and biological properties, Biomechanical, Physiological, Anthropometric background, Posture, Sitting, Standing, Change of posture, Hand and arm postures, Movement, Lifting, carrying, pulling and pushing.

UNIT IV **9 Hours**

ANTHROPOMETRY

Anthropometric design principles, work space envelope, factors in design of work space surfaces, principles of seat design, principles of control panel, reducing accidents by altering behaviour.

UNIT V **9 Hours**

HUMAN FACTORS AND ERGONOMICS

Standards, Applications in healthcare, Neuro-ergonomics in human-system interaction, Case Study Biomedical Application, Design optimization of Medical Equipment.

Total: 45 Hours

Reference(s)

1. HosseinBaharvand (Editor), Nasser Aghdami (Editor). Regenerative Medicine and Cell Therapy (Stem Cell Biology and Regenerative Medicine). Humana Press; 2013 edition
2. Pascale Carayon, Handbook of Human Factors and Engineering, Second Edition, CRC Press, 2011
3. Raphael G., Richard S., Stem Cell-Based Tissue Repair, Cambridge RSC Publishing, 1st Edition, 2011
4. Lanza R., Gearhart J. et al. Essential of Stem Cell Biology, Elsevier Academic, 1st Edition, 2006.
5. Gavriel Salvendy, Handbook of Human Factors and Ergonomics, John Wiley & Sons, Fourth Edition 2012.
6. Stephen Pheasant, Christine M. Haslegrave, Bodyspace: Anthropometry, Ergonomics and the Design of Work, CRC Press, Third Edition, 2016

22BM024 FINITE ELEMENT ANALYSIS 3 0 0 3

Course Objectives

- To introduce the concepts of finite element methods for biomechanical analysis
- To familiarize beam elements and scalar problem in two dimension
- To explain analysis approach to field problems

Program Outcomes (POs)

PO1. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. 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.
PO3. 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.
PO4. 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.
PO12. 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.
PSO1. Apply knowledge on foundation in Life Science, engineering, mathematics and current biomedical engineering practices with an ability to demonstrate advanced knowledge of a selected area within Biomedical Engineering.
PSO2. Critically analyse the current healthcare systems and develop innovative solutions effectively through problem specific design and development using modern hardware and software tools.

Course Outcomes (COs)

1. Integrate the concept of modeling to derive one-dimensional and two-dimensional equations for Finite Element Modeling (FEM) techniques.
2. Apply the beam element and scalar problem in two dimensional FEM approaches
3. Implement the finite element analysis in biomechanical research
4. Analyze the characteristics of non-linear real time problems with FEM
5. Analyse the impact of physiological model for the given force using FEM

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	2	1	2	-	-	-	-	-	-	-	1	1	1	-
2	-	2	1	2	-	-	-	-	-	-	-	1	2	1	-
3	-	2	1	2	-	-	-	-	-	-	-	1	2	1	-
4	-	3	1	2	-	-	-	-	-	-	-	1	2	2	-
5	-	3	1	2	-	-	-	-	-	-	-	1	2	2	-

UNIT I **9 Hours**

INTRODUCTION TO MODELLING

Historical Background, Mathematical Modelling of field problems in Engineering, Governing Equations, Natural and Essential Boundary conditions - Basic concepts of the Finite Element Method. One Dimensional Second Order Equations, Discretization, element types- Linear and Higher order Elements Derivation of Shape functions and Stiffness matrices and force vectors.

UNIT II **9 Hours**

BEAM ELEMENTS AND SCALAR PROBLEM IN TWO DIMENTION

Fourth Order Beam Equation Transverse deflections, Natural frequencies of beams and longitudinal vibration. Second Order 2D Equations involving Scalar Variable Variation Formulation Finite Element Formulation Triangular Elements Shape functions and element matrices and vectors. Application to Field Problems in Bio mechanics, Quadrilateral elements.

UNIT III **9 Hours**

APPLICATIONS TO FIELD PROBLEMS

Higher order elements. Natural co-ordinate systems Isoparametric elements Shape functions for isoparametric elements One, two and three dimensions Serendipity elements Numerical integration and application to plane stress problems transformation in coordinates- Jacobian of transformation order of convergence- numerical integration example problems- shape functions in natural coordinates- rectangular elements- Lagrange family.

UNIT IV **9 Hours**

NON-LINEAR ANALYSIS

Introduction to Nonlinear problems, some solution methods, computational procedure, simple material nonlinearity, stress stiffening, contact interfaces, problems of gaps and contact, geometric nonlinearity, modelling considerations.

UNIT V **9 Hours**

IMPACT ANALYSIS

Mechanical properties of biological and commonly used biomedical engineering materials, Critical reviews of finite element analysis in biomechanical research. Modelling and force analysis of musculoskeletal systems Stress calculations

Total: 45 Hours

Reference(s)

1. King-Hay Yang, Basic Finite Element Method as Applied to Injury Biomechanics, Elsevier Academic Press. 2017
2. Connie McGuire, Finite Element Analysis: Biomedical Aspects, NY Research press, 2015
3. Moratal D., Finite Element Analysis from Biomedical Applications to Industrial Developments, InTech Publisher, 2014
4. J N Reddy, Finite element methods, Tata McGrawHill, 2003
5. Seshu, Text Book of finite element analysis, Prentice Hall, New Delhi, 2003

22BM025 HAPTICS **3 0 0 3**

Course Objectives

- To introduce Haptic concepts
- To familiarize different classifications of Haptics and its applications
- To Explain building technology of Haptics

Program Outcomes (POs)

PO1. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. 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.

PO3. 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.

PO4. 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.

PO6. 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.

PO8. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO12. 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.

PSO1. Apply knowledge on foundation in Life Science, engineering, mathematics and current biomedical engineering practices with an ability to demonstrate advanced knowledge of a selected area within Biomedical Engineering.

PSO2. Critically analyse the current healthcare systems and develop innovative solutions effectively through problem specific design and development using modern hardware and software tools.

PSO3. Hands-on knowledge on cutting edge hardware and software tools to acquire real time data, model and simulate physiological processes and analyse limitations on real time implementations.

Course Outcomes (COs)

1. Find suitable display devices for Haptic device based on their performances
2. Apply Human perceptual parameters in Haptics technology
3. Implement appropriate haptic sensors for Machine Haptics
4. Outline the design of computer haptics
5. Analyze the role of haptic systems in medical and nonmedical fields

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	1	2	2	3	-	1	-	-	-	-	-	1	1	2	-
2	1	2	3	2	-	1	-	-	-	-	-	1	1	2	-
3	1	2	1	3	-	1	-	-	-	-	-	1	1	2	-
4	1	3	2	2	-	1	-	-	-	-	-	1	1	2	-
5	1	2	1	3	-	1	-	1	-	-	-	1	2	2	2

UNIT I **9 Hours**

INTRODUCTION

Touch, Sense of Touch, Perception of world through touch, Haptics, Tactile system, Tactile receptors, Sensory and Motor specialization of Hand, Haptic perception, Haptic Illusion, Tactile and Haptic Displays, Haptic exploration, Concepts and terminologies

UNIT II **9 Hours**

HUMAN HAPTIC PERCEPTION

Introduction, Touch and cognition, Human Haptic system: Mechanical structure of Arm, Hand haptics system, Human sensory system, The motor system, Haptic cognition, Haptic exploration, Concept of Illusion, Human perceptual parameters for Haptics: Interface development, Perception Thresholds

UNIT III **9 Hours**

MACHINE HAPTICS

Introduction, Haptic Interfaces: Robotic perspective, Haptic interface system, HAVE sensor: Electromechanic sensors, Optical sensors, Capacitive sensor, Resistive sensor, Force sensors, strain gauge sensors, Magnetic sensor, HAVE actuators: Magnetic Levitation Devices, Nonholonomic devices, Magnetic sensors and parallel mechanisms, performance specifications: physical attributes, special attributes and temporal attributes

UNIT IV **9 Hours**

COMPUTER HAPTICS

Introduction, Haptic rendering subsystems, Polygon, based representation and scene graph, collision detection techniques and bounding volumes, control methods for Haptic systems: Impedance control architecture, Feed, forward impedance control architecture, positive feedback Impedance control architecture, Hybrid compensation Impedance control architecture, Admittance control architecture

UNIT V **9 Hours**

HAPTICS APPLICATIONS

Introduction, Haptics for Medical Applications: Surgical simulation, stoke based rehabilitation, support of the visually impaired, Tele, surgery, Media: Haptic broadcasting. E, commerce, Video games, other application: Mobile Haptics, Haptics and VR, Introduction to Wearable Haptic devices

Total: 45 Hours

Reference(s)

1. Lynette Jones, Haptics, The MIT Press, 2018
2. Abdulmotaleb El Saddik, Mauricio Orozco, Mohamad Eid, Jongeun Cha, Haptics Technologies: Bringing Touch to Multimedia, Springer Science & Business Media, 2011
3. Tom Bruno, Wearable Technology: Smart Watches to Google Glass for Libraries, Rowman & Littlefield Publishers, Lanham, Maryland, 2015.
4. Hiroyuki Kajimoto, Masashi Konyo, Shoichi Hasegawa, Takuya Nojima, Ki-Uk Kyung, Haptic Interaction: Science, Engineering and Design. (2017). Switzerland: Springer Nature Singapore.
5. Abdulmotaleb El Saddik, Mauricio Orozco, Mohamad Eid, Jongeun Cha, Haptics TechnologiesBringing Touch to Multimedia, Springer, 2011

22BM026 MEDICAL TEXTILES 3 0 0 3

Course Objectives

- To learn about different types of Biomaterials
- To understand the Biomedical application of different textile structures
- To analyze the Functional requirements of textile structures for specific end use
- To understand the Selection and characterization of textile materials used for biomedical applications

Program Outcomes (POs)

PO1. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. 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.
PO4. 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.
PO6. 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.
PO8. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PSO1. Apply knowledge on foundation in Life Science, engineering, mathematics and current biomedical engineering practices with an ability to demonstrate advanced knowledge of a selected area within Biomedical Engineering.
PSO2. Critically analyse the current healthcare systems and develop innovative solutions effectively through problem specific design and development using modern hardware and software tools.

Course Outcomes (COs)

1. Categorize medical textiles based on the material used and its usage in medical field
2. Integrate material properties of biopolymers suitable for implantable, non, implantable and drug delivery textiles
3. Implement textile technology to implantable and drug delivery systems
4. Use appropriate textile technology to wound care and dressing applications
5. Analyse the components of smart textile and ethical issues of textile technology

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	3	-	2	-	1	-	-	-	-	-	-	2	1	-
2	2	2	-	2	-	1	-	-	-	-	-	-	2	1	-
3	2	2	-	2	-	1	-	-	-	-	-	-	2	1	-
4	1	2	-	2	-	1	-	-	-	-	-	-	2	1	-
5	1	3	-	2	-	1	-	2	-	-	-	-	2	1	-

UNIT I **9 Hours**

INTRODUCTION

Medical textiles, classification, current market scenario in international and national level, government initiatives; antimicrobial fibres and finishes; Nano fibrous materials and films; super absorbent polymers; operating room garments; personal health care and hygiene products and their testing methods; applications of non, wovens in medicine; textiles in infection prevention control.

UNIT II **9 Hours**

BIOPOLYMERS

Biopolymers: classification and their properties, requirements, and applications, testing methods; In vitro tests, direct contact, agar diffusion & elution methods, in vivo assessment of tissue compatibility. Tissue engineering: properties and materials of scaffolds, relationship between textile architecture and cell behaviour, applications of textile scaffolds in tissue engineering.

UNIT III **9 Hours**

IMPLANTABLES, NON, IMPLANTABLES AND DRUG DELIVERY

Bandages, types, properties and applications; compression garments, types, properties and applications; sutures: types and properties; implantable textiles: hernia mesh, vascular prostheses, stents; Extra corporeal materials: Cartilage nerves, liver ligaments, kidney, tendons, cornea; Drug delivery textiles: classification, mechanism various fabrication methods, characterization, applications.

UNIT IV **9 Hours**

WOUND CARE AND REUSABLE MEDICAL TEXTILES

Wound: types and healing mechanism, textile materials for wound dressing, bio active dressing, anti-microbial textiles dressing, composite dressing, testing of wound care materials; Wound 97 compression textiles; Reusable medical textiles: types, advantages, physical properties and performance reusable processing methods.

UNIT V **9 Hours**

SMART MEDICAL TEXTILES AND LEGAL ISSUES

Smart textiles, types, characteristics, smart textiles in wound care; applications of phase change and shape memory materials, monitoring pregnancy, children and cardio patients, mobile health monitoring; electronics in medical textiles; Smart textiles in rehabilitation and applications; textile sensors for healthcare; legal and ethical values involved in the medical textile materials

Total: 45 Hours

Reference(s)

1. Joon B. Park., and Joseph D. Bronzino., Biomaterials, Principles and Applications, CRCPress, Boca Raton London, New York, Washington, D.C. 2002.
2. Anand S.C., Kennedy J.F.,Miraftab M., and Rajendran S., Medical Textiles and Biomaterials for Health Care , Wood head Publishing Ltd., 2006
3. Horrocks A R, Anand S C, Handbook of Technical Textiles, Woodhead Publishing and Textile Institute, USA, 2000.
4. Adanur S., Wellington Sears Handbook of Industrial Textiles, Technomic Publishing Co. Inc., Lancaster Pennylvania, 1995, ISBN 1, 56676, 340, 1 4
5. Michael Szycher and Steven James Lee, Modern Wound Dressing: A Systematic Approach to Wound Healing, Journal of Biomaterials Applications, 1992

22BM027 WEARABLE SYSTEMS AND BODY AREA NETWORKS **3 0 0 3**

Course Objectives

- To provide an overview of the technical background of Body Area Networks (BAN) and its application in health care using mobile technology
- To explain the hardware requirement of BAN
- To familiarize the communication and security aspects in the BAN

Program Outcomes (POs)

PO1. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. 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.

PO4. 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.

PO6. 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.

PO8. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PSO1. Apply knowledge on foundation in Life Science, engineering, mathematics and current biomedical engineering practices with an ability to demonstrate advanced knowledge of a selected area within Biomedical Engineering.

PSO2. Critically analyse the current healthcare systems and develop innovative solutions effectively through problem specific design and development using modern hardware and software tools.

Course Outcomes (COs)

1. Analyse the performance and challenges of body area networks (BAN) for healthcare
2. Integrate the suitable hardwares for BAN
3. Assess the wearable sensors and standards for BAN
4. Find mobile devices for healthcare monitoring
5. Analyze the mobile health technology used for various healthcare applications

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	1	3	-	2	-	1	-	1	-	-	-	-	2	1	-
2	1	3	-	2	-	1	-	1	-	-	-	-	2	1	-
3	1	3	-	2	-	1	-	1	-	-	-	-	2	1	-
4	1	2	-	2	-	1	-	1	-	-	-	-	2	1	-
5	1	3	-	2	-	1	-	1	-	-	-	-	2	1	-

UNIT I **9 Hours**

BODY AREA NETWORKS

BAN and healthcare, Technical challenges, sensor design, Biocompatibility, energy supply, energy scavenging methods, optimal node placement, number of nodes, networks for BAN, System security and reliability, standards. BAN Architecture

UNIT II **9 Hours**

HARDWARE FOR BAN

Processor, Low Power MCUs, mobile computing MCUs, Integrated processor with radio transceiver, memory types and ranges, Antenna types, PCB antenna, wire antenna, ceramic antenna, external antenna, Sensor interface, power sources, batteries and fuel cells for sensor nodes.

UNIT III **9 Hours**

WEARABLE SENSORS AND STANDARDS FOR BAN

Wearables fundamentals and role of wearable sensors, Attributes of wearable, flexible electronics, meta, wearable, Future of wearable, research road map, Wireless personal area network technologies, Zigbee, coexistence issues with BAN.

UNIT IV **9 Hours**

MOBILE DEVICES FOR HEALTHCARE

Wearable system for ECG Monitoring, Evaluation of night time performance, smart phone based health care monitoring system, Phone based fall risk prediction, RFID based personal mobile medical assistance, Secure medical sensor network

UNIT V **9 Hours**

MOBILE HEALTH TECHNOLOGIES AND APPLICATIONS

Mobile nutrition tracking, case study, accessing existing virtual electronic patient record, mobile personal health records, Monitoring hospital patients, sensing vital signs and transmission using wireless networks, Context aware healthcare applications with case study

Total: 45 Hours

Reference(s)

1. Annalisa Bonfiglio, Danilo De Rossi, "Wearable Monitoring Systems", Springer, 2011.
2. Sandeep K.S. Gupta,Tridib Mukherjee, Krishna Kumar Venkata Subramanian, Body Area Networks Safety, Security, and Sustainability, Cambridge University Press, 2013.
3. Canjun Yang, G.S.Virk, Huayong yang , Wearable sensors and Robots , Proceeding of international conference on wearable sensors and robots, 2017
4. Zhang, Yuan, Ting, Wearable Medical Sensors and Systems, Springer, 2013
5. Guang, ZhongYang(Ed.), Body Sensor Networks, Springer, 2006.
6. Mehmet R. Yuce, Jamil Y.Khan, Wireless Body Area Networks Technology, Implementation, and Application, Pan Stanford Publishing Pte. Ltd., Singapore, 2012

22BM028 TELEMEDICINE AND IOT 3 0 0 3

Course Objectives

- To understand the principles, practices and areas of application in Hospital management.
- To understand the telemedicine in different sectors
- To introduce the relevance of Telemedicine to the existing technology through demonstrations, case studies, simulations in the field of Telemedicine and IoT

Program Outcomes (POs)

PO1. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. 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.
PO3. 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.
PO4. 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.
PO6. 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.
PO8. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO12. 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.
PSO1. Apply knowledge on foundation in Life Science, engineering, mathematics and current biomedical engineering practices with an ability to demonstrate advanced knowledge of a selected area within Biomedical Engineering.

Course Outcomes (COs)

1. Apply the concepts and multimedia principles used in telemedicine.
2. Outline telemedicine standards and regulations in device design
3. Implement mobile technology in Tele healthcare
4. Integrate appropriate peripherals and communication protocol of IOT in Tele medicine
5. Find suitable technology in tele medicine for real time scenario

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	1	-	2	-	-	1	-	-	-	-	-	1	-	-	-
2	1	-	2	2	-	1	-	2	-	-	-	1	2	-	-
3	1	2	3	2	-	1	-	-	-	-	-	1	2	-	-
4	1	2	3	2	-	1	-	-	-	-	-	1	2	-	-
5	1	2	3	2	-	1	-	-	-	-	-	1	2	-	-

UNIT I **9 Hours**

TELEMEDICAL TECHNOLOGY

Evolution of telemedicine, Functional diagram of telemedicine system, Telemedicine, Telehealth, Tele care, Organs of telemedicine, Principles of Multimedia, PSTN, POTS, ANT, ISDN, Internet, Air wireless communications, Types of Antenna, Integration and operational issues, Communication infrastructure for telemedicine. Mobile hand held devices and mobile communication. Internet technology and telemedicine using world wide web (www). Clinical data, local and centralized

UNIT II **9 Hours**

TELEMEDICAL STANDARDS

Data Security and Standards, Mechanisms of encryption, phases of Encryption. Protocols: TCP/IP, ISO:OSI, Standards to followed DICOM, HL7, H. 320 series (Video phone based ISBN) T. 120, H.324 (Video phone based PSTN), Video Conferencing, Real, time Telemedicine integrating doctors / Hospitals, Clinical laboratory data, Radiological data, and other clinically significant biomedical data, Administration of centralized medical data, security and confidentially of medical records and access control, Cyber laws related to telemedicine

UNIT III **9 Hours**

MOBILE TELEMEDICINE

Tele radiology: Definition, Basic parts of tele radiology system, Tele pathology, multimedia databases, color images of sufficient resolution, Dynamic range, spatial resolution, compression methods, Interactive control of color, Medical information storage and management for telemedicine, patient information medical history, test reports, medical images diagnosis and treatment. Hospital information system, Doctors, paramedics, facilities available. Pharmaceutical information system

UNIT IV **9 Hours**

INTRODUCTION TO IOT

Introduction to Internet of Things (IoT). Review of CC3200 core and its architecture, Introduction to advanced ARM Cortex M4 architecture, Peripherals overview, User API, Power challenges with IoT, CC3200 Simple link applications, starting with Code Composer Studio V6. Various wireless protocols and its applications: ZigBee, Bluetooth Low Energy, 6LowPAN, Wi, Fi

UNIT V **9 Hours**

APPLICATIONS

Telemedicine access to health care services, health education and self, care. Introduction to robotics surgery, telesurgery. Tele cardiology, Tele oncology, Telemedicine in neurosciences, Electronic Documentation, e, health services security and interoperability, Telemedicine access to health care services. Introduction to WLAN, WLAN parameters, AP/STATION modes and its Security types, Socket connection, WLAN AP and WLAN STATION configuration settings.

Total: 45 Hours

Reference(s)

1. R.S.Khandpur Telemedicine Technology and Applications (mhealth, Telehealth and ehealth), PHI Learning Pvt.Ltd, Delhi, 2017
2. Wootton, R., Craig, J., Patterson, V., Introduction to Telemedicine, Royal Society of Medicine Press Ltd, Taylor & Francis 2006
3. Latifi, R. Current Principles and Practices of Telemedicine and e, Health, IOHS Press, Washington DC, 2008
4. Bashshur, R.L., Shannon G.W., History of Telemedicine, New Rochelle NY: Mary Ann Liebert Publishers, 2009
5. Victor Lyuboslavsky, Telemedicine and Telehealth 2.0: A Practical Guide for Medical Providers and Patients, CreateSpace Independent Publishing Platform, 1st edition, 2015

22BM029 BIOINFORMATICS 3 0 0 3

Course Objectives

- To understand the evolving field of bioinformatics.
- To analyse large biological data sets
- To formulate the usage of biological tools effectively

Program Outcomes (POs)

PO2. 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.
PO3. 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.
PO4. 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.
PO8. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO12. 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.
PSO1. Apply knowledge on foundation in Life Science, engineering, mathematics and current biomedical engineering practices with an ability to demonstrate advanced knowledge of a selected area within Biomedical Engineering.
PSO2. Critically analyse the current healthcare systems and develop innovative solutions effectively through problem specific design and development using modern hardware and software tools.

Course Outcomes (COs)

1. Implement Bioinformatics in data generation
2. Show the appropriate biological data base for various analysis
3. Apply suitable analytical techniques to Biological data for research.
4. Integrate the concepts of genomic technology in bioinformatics
5. Assess the genetic variability of clinical data

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	-	2	2	3	-	-	-	-	-	-	-	1	1	2	-
2	-	2	3	2	-	-	-	-	-	-	-	1	1	2	-
3	-	2	3	2	-	-	-	-	-	-	-	1	1	2	-
4	-	2	3	2	-	-	-	-	-	-	-	1	1	2	-
5	-	2	1	3	-	-	-	1	-	-	-	1	1	2	-

UNIT I **9 Hours**

INTRODUCTION TO BIOINFORMATICS AND DATA GENERATION

Bioinformatics and its relation with molecular biology. Examples of tools (FASTA, BLAST, BLAT, RASMOL), databases (GENBANK, PubMed, PDB), Data generation; Generation of large scale molecular biology data, Genome sequencing, Protein sequencing, Gel electrophoresis, NMR Spectroscopy, X, Ray Diffraction, and microarray, Applications of Bioinformatics

UNIT II **9 Hours**

BIOLOGICAL DATABASE AND ITS TYPES

General Introduction of Biological Databases; Nucleic acid databases (NCBI, DDBJ, and EMBL). Protein databases (Primary, Composite, and Secondary). Specialized Genome databases: (SGD, TIGR, and ACeDB). Structure databases (CATH, SCOP, and PDB sum).

UNIT III **9 Hours**

STRUCTURAL BIOINFORMATICS

Fundamentals of X, ray diffraction, NMR spectroscopy of macromolecules, Protein Structure: Primary, Secondary, Super Secondary, Domains, Tertiary, Quaternary, Structural features of RNA: Primary, Secondary, Tertiary, Motif and Domain: Motif databases and analysis tools. Domain databases (CDD, SMART, ProDom) and Analysis tools.

UNIT IV **9 Hours**

DIFFERENT TYPES AND METABOLIC PATHWAYS

Genomics: Genome Annotation, Genome Assembly, Structural and Functional Genomics. Comparative Genomics, Metagenomics: Introduction, metagenome, shotgun metagenomics (pyrosequencing), Metabolic pathway database (KEGG pathway database), Concept of metabolome and metabolomics

UNIT V **9 Hours**

GENE EXPRESSION AND REPRESENTATION OF PATTERNS AND RELATIONSHIP

General introduction to Gene expression in prokaryotes and eukaryotes, transcription factors binding sites. SNP, EST, STS. Introduction to Regular Expression, Hierarchies, and Graphical models (including Marcov chain and Bayes notes). Genetic variability and connections to clinical data.

Total: 45 Hours

Reference(s)

1. Introduction to Bioinformatics Algorithms by Neil Jones and Pavel Pevzner. 2015.
2. Bioinformatics by David Mount, 2016.
3. Bioinformatics: Principles and Applications by Zhumur Ghosh and BibekanandMallick, 2010.
4. Bioinformatics: Sequence and Genome Analysis by Mount and David W, 2005.

22BM030 VIRTUAL AND AUGMENTED REALITY IN HEALTHCARE **3 0 0 3**

Course Objectives

- To introduce the relevance of this course to the existing technology through demonstrations, case studies and applications with a futuristic vision along with socio, economic impact and issues
- To understand virtual reality, augmented reality and using them to build Biomedical engineering applications.
- To know the intricacies of these platform to develop PDA applications with better optimality

Program Outcomes (POs)

PO1. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. 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.
PO3. 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.
PO4. 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.
PSO1. Apply knowledge on foundation in Life Science, engineering, mathematics and current biomedical engineering practices with an ability to demonstrate advanced knowledge of a selected area within Biomedical Engineering.
PSO2. Critically analyse the current healthcare systems and develop innovative solutions effectively through problem specific design and development using modern hardware and software tools.

Course Outcomes (COs)

1. Assess the principle and functions of Virtual Reality (VR)
2. Apply modelling procedures to develop VR applications
3. Design and configure Haptic model in regard to human parameters
4. Assess the principle and components of Augmented Reality (AR)
5. Integrate utility of computer vision and techniques in Augmented Reality (AR)

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	3	-	2	-	-	-	-	-	-	-	-	2	2	-
2	2	2	3	2	-	-	-	-	-	-	-	-	2	2	-
3	2	2	3	2	-	-	-	-	-	-	-	-	2	2	-
4	2	2	3	2	-	-	-	-	-	-	-	-	2	2	-
5	2	3	2	2	-	-	-	-	-	-	-	-	2	2	-

UNIT I **9 Hours**

INTRODUCTION TO VIRTUAL REALITY

Definition of Virtual Reality (VR), Principles of VR, Main components, the five classic components of a VR system - Input Devices: (Trackers, Navigation, and Gesture Interfaces): Three-dimensional position trackers, navigation and manipulation-interfaces and gesture Interfaces-Output Devices: Graphics displays-sound displays & haptic feedback, Physiological data recording, Position and movement measuring systems, Problems in VR.

UNIT II **9 Hours**

VR DEVELOPMENT PROCESS & CONTENT CREATION CONSIDERATIONS

Geometric modelling - kinematics modelling- physical modelling - behaviour modelling - model Management. Methodology and terminology-user performance studies-VR health and safety issues - Usability of virtual reality system- cyber sickness -side effects of exposures to virtual reality environment

UNIT III **9 Hours**

VR ON THE WEB & VR ON THE MOBILE

JS-pros and cons-building blocks (WebVR, WebGL, Three.js, device orientation events)- frameworks (A-frame, React VR)-Google VR for Android-Scripts, mobile device configuration, building to android-cameras and interaction-teleporting-spatial Audio-Assessing human parameters-device development and Drivers-Design Haptics.

UNIT IV **9 Hours**

INTRODUCTION TO AUGMENTED REALITY WITH AR HARDWARE

Defining augmented reality, history of augmented reality, Augmented Reality Hardware – Displays – Audio Displays, Haptic Displays, Visual Displays, Other sensory displays, Visual Perception, Requirements and Characteristics, Spatial Display Model. Processors – Role of Processors, Processor System Architecture, Processor Specifications. Tracking & Sensors - Tracking, Calibration, and Registration, Characteristics of Tracking Technology, Stationary Tracking Systems, Mobile Sensors, Optical Tracking, Sensor Fusion.

UNIT V **9 Hours**

COMPUTER VISION FOR AR & AR TECHNIQUES

Computer Vision for Augmented Reality - Marker Tracking, Multiple-Camera Infrared Tracking, Natural Feature Tracking by Detection, Simultaneous Localization and Mapping, Outdoor Tracking Augmented Reality Software - Introduction, Major Software Components for Augmented Reality Systems, Software used to Create Content for the Augmented Reality Application, AR Techniques – Marker based and Marker Less approach.

Total: 45 Hours

Reference(s)

1. Jason Jerald. 2015. The VR Book: Human, Centred Design for Virtual Reality. Association for Computing Machinery and Morgan & Claypool, New York, NY, USA.
2. C. Burdea & Philippe Coiffet, Virtual Reality Technology, Second Edition, Gregory, John Wiley & Sons, Inc.,2008.
3. Augmented Reality: Principles and Practice (Usability) by Dieter Schmalstieg & Tobias Hollerer, Pearson Education (US), Addison, Wesley Educational Publishers Inc, New Jersey, United States, 2016. ISBN: 9780321883575.
4. Wadee Alhalabi, Virtual Reality Implementation in Healthcare Settings, Medical Information Science Reference, 2017.
5. James Roland, Virtual Reality and Medicine, Reference Point Press, Incorporated, 2018.

22BM031 MEDICAL OPTICS **3 0 0 3**

Course Objectives

- To introduce the basic instrumentation related to photonics
- To familiarize the practical applications of optics related to medicine
- To analyze the diagnostic and therapeutic applications in medical optics

Program Outcomes (POs)

PO1. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. 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.
PO3. 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.
PO4. 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.
PO8. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PSO1. Apply knowledge on foundation in Life Science, engineering, mathematics and current biomedical engineering practices with an ability to demonstrate advanced knowledge of a selected area within Biomedical Engineering.
PSO2. Critically analyse the current healthcare systems and develop innovative solutions effectively through problem specific design and development using modern hardware and software tools.

Course Outcomes (COs)

1. Outline the concepts of photonics and essential instruments used in medical optics.
2. Analyze the optical properties of tissues for visualizing its structure.
3. Use appropriate Laser for surgical applications.
4. Implement the concept of optics for Non, thermal diagnostic applications
5. Integrate the therapeutic applications of Lasers.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	3	-	2	-	-	-	1	-	-	-	-	2	2	-
2	2	2	3	2	-	-	-	1	-	-	-	-	2	2	-
3	2	2	2	2	-	-	-	1	-	-	-	-	2	2	-
4	1	2	3	2	-	-	-	1	-	-	-	-	2	2	-
5	1	2	3	2	-	-	-	1	-	-	-	-	2	2	-

UNIT I **9 Hours**

INSTRUMENTATION IN PHOTONICS

Review of basic properties of light, Reflection, Refraction, Scattering, fluorescence and phosphorescence. Instrumentation for absorption, Scattering and emission measurements, excitation light sources, high pressure arc lamp, LEDs, Lasers. Optical filters. Optical detectors, Time resolved and phase resolved detectors, optical tweezers.

UNIT II **9 Hours**

OPTICAL PROPERTIES OF THE TISSUES

Light transport inside the tissue, optical properties of tissue. Laser Characteristics as applied to medicine and biology, Laser tissue Interaction, Chemical, Thermal, and Electromechanical. Photo ablative processes.

UNIT III **9 Hours**

SURGICAL APPLICATIONS OF LASERS

Lasers in ophthalmology, Dermatology, Dentistry, Urology, Otolaryngology, Laser Tissue welding, Case study.

UNIT IV **9 Hours**

NON THERMAL DIAGNOSTIC APPLICATIONS

Phototherapy, Photodynamic therapy (PDT), Principle and mechanism, Oncological and non, oncological applications of PDT, Bio stimulation effect, applications, Laser Safety Procedures.

UNIT V **9 Hours**

THERAPEUTIC APPLICATIONS

Pulsed Laser use in Cardiology, Dentistry and oral surgery, Ophthalmology, Optical Tweezers, Vascular welding, Cosmetic Surgery, Soft tissue treatment, Dermatology Fetal surgery.

Total: 45 Hours

Reference(s)

1. Tuan VoDinh , Biomedical photonics Handbook, CRC Press LLC, 2014
2. MarkolfH Niemz, Laser Tissue Interaction Fundamentals and Applications, Springer, 2007
3. Paras N. Prasad, Introduction to Bio photonics, A John Wiley and sons, Inc. Publications, 2003
4. Mark E Brezinski, Optical Coherence Tomography Principles and Applications, Academic Press, 2006
5. R Splinter and B A Hooper, An Introduction to Biomedical Optics, Taylor and Francis, 2007

22BM032 / 22BMM32/ 22BMH32
MEDICAL WASTE MANAGEMENT **3 0 0 3**

Course Objectives

- To introduce the healthcare hazard control and accidents
- To familiarize biomedical waste management
- To explain facility guidelines, infection control and patient safety

Program Outcomes (POs)

PO2. 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.
PO3. 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.
PO6. 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.
PO8. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO11. Project Management and Finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO12. 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.
PSO1. Apply knowledge on foundation in Life Science, engineering, mathematics and current biomedical engineering practices with an ability to demonstrate advanced knowledge of a selected area within Biomedical Engineering.
PSO2. Critically analyse the current healthcare systems and develop innovative solutions effectively through problem specific design and development using modern hardware and software tools.
PSO3. Hands-on knowledge on cutting edge hardware and software tools to acquire real time data, model and simulate physiological processes and analyse limitations on real time implementations.

Course Outcomes (COs)

1. Categorize the consequences of medical hazard in environment
2. Implement the Legal guidelines on Waste Disposals
3. Select appropriate procedure for generation and segregation of medical waste
4. Apply proper guidelines for medical waste transportation, treatment and disposal
5. Analyse the effective practices to minimize the medical waste and financial commitment

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	-	2	-	-	-	1	-	2	-	2	1	2	1	2	1
2	-	2	-	-	-	3	-	2	-	2	1	1	1	2	2
3	-	3	2	-	-	1	-	1	-	2	1	2	1	1	1
4	-	3	2	-	-	1	-	2	-	2	1	2	1	2	2
5	-	3	2	-	-	1	-	1	-	3	1	2	2	1	1

UNIT I **9 Hours**

INTRODUCTION

Introduction, Need for disposal of biomedical Waste, Definition, general and hazardous health care waste, infectious waste, genotoxic waste, waste sharps, biomedical waste, categories, composition of biomedical waste, specification of materials, sources, hospitals, health care establishments, others.

UNIT II **9 Hours**

IMPACTS AND LEGISLATION POLICIES

Health impacts, direct and indirect hazards, potential hazards, infection, infection agents, legislation and policies, biomedical waste handling, rules, CPCB guidelines, BARC guidelines, radioactive waste disposal, WHO guidelines, management in developing countries

UNIT III **9 Hours**

GENERATION AND SEGREGATION

Colour coding, yellow, red, blue, white, contents of waste bag, label, biomedical waste, minimize, collection and handling, infection control system, needle sticks injury, hospital policy, segregation, decontaminating, disinfection unit, autoclaving, sharp waste containers, shredding, incrimination, biomedical symbol, microwave, hydro, pulping, plasma torch.

UNIT IV **9 Hours**

TRANSPORTATION, TREATMENT AND DISPOSAL

Central storage, Onsite pre, treatment, mechanical treatment, chemical disinfection, offsite transportation, offsite and onsite, treatment, common treatment, liquid waste treatment, Conventional treatment, wet thermal technology, incineration, alternative treatment technology, microwave technology, rotaclave system, hydroclave, ETP, process electron beam treatment, plasma pyrolysis , gastification systems, non, infectious waste, treatment, composting, rotating jumbling system, French composting, vermin composting, disposal, sharp disposal, deep burial, secured landfill.

UNIT V **9 Hours**

MANAGEMENT ISSUES

Waste minimization, recycling, reuse, health and safety practices, protective equipment usage, occupational health programmers, safety, emergency practices, management, non-clinical support devices, Quality improvement tools and strategies, budget allocation, maintenance, records, annual reports

Total: 45 Hours

Reference(s)

1. D.B. Acharya, Meeta Singh, "The Book of Hospital Management", Minerva Press, 2003
2. Mohd Faisal Khan, "Hospital Waste Management: Principle and Guidelines", Kanishka Publishers, 2010
3. Madhuri Sharma, "Hospital Waste Management and its Monitoring", Jaypee Brothers Medical Publishers, 2007
4. Mohammad Mohsin, "Hospital: Waste Management", VDM Publishing, 2010
5. Domiel A Vallero, "Biomedical Ethics for Engineers", Elsevier Publications, 1st Edition, 2007

22BM033 / 22BMM33 / 22BMH33
MEDICAL ETHICS **3 0 0 3**

Course Objectives

- To introduce the legal and ethical principles in health care settings
- To familiarize the professional ethics to be followed by Biomedical Engineers
- To explore the patient safety and regulatory aspects followed in hospitals

Program Outcomes (POs)

PO2. 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.
PO3. 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.
PO4. 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.
PO8. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO11. Project Management and Finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one’s own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO12. 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.
PSO2. Critically analyse the current healthcare systems and develop innovative solutions effectively through problem specific design and development using modern hardware and software tools.

Course Outcomes (COs)

1. Implement legal and professional guidelines for the health professions
2. Apply regulatory codes of ethics in healthcare systems
3. Implement medical device safety aspects based on quality systems requirement
4. Demonstrate success and failure aspects of bioethics
5. Analyze the need of sustainable bioethics

Articulation Matrix

CO No	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2	PSO 3
1	-	2	2	2	-	-	-	3	-	2	2	-	1	-	-
2	-	2	2	2	-	-	-	3	-	2	2	-	1	-	-
3	-	2	2	2	-	-	-	3	-	2	2	-	1	-	-
4	-	3	2	2	-	-	-	3	-	2	2	-	1	-	-
5	-	3	2	2	-	-	-	3	-	2	2	-	1	-	-

UNIT I **9 Hours**

INTRODUCTION TO MEDICAL ETHICS

Definition of Medical ethics, Scope of ethics in medicine, International code of Ethics for occupational health professionals, Ethical Theories, Deontology & Utilitarianism, Casuist theory, Virtue theory, The Right Theory. Role of ethics in Healthcare workplace, Autonomy, Non Malfeasance, Beneficence, Veracity, Justice, OSHA, Decision Model for Healthcare Dilemmas, Applications of Plus decision making model.

UNIT II **9 Hours**

CODE OF ETHICS FOR BIOMEDICAL ENGINEERS

Bioethics-The principle of Double effect, Code of Hammurabi, Engineering Competence, Ethical Issues in biomedical research Cloning and stem cell research, Neuro ethics, Organ Transplantation, Hypothetico deductive method, Research Conflict of Interest.

UNIT III **9 Hours**

MEDICAL DEVICE SAFETY

Shared Responsibility for Medical device safety. WHO International Health Regulations (IHR), Stages of regulatory control of medical devices, Ethics committee, its members and functions, Global Harmonization Task Force (GHTF). Quality systems requirement, ISO, Voluntary and mandatory standards, Collateral Standards EMC radiation protection & programmable medical device system, Particular Standards-type of medical device.

UNIT IV **9 Hours**

BIOETHICAL SUCCESS AND FAILURE

Measurements of success and Failure, Technological Success and failure, Risk as a bioethical concept, Safety, risk and reliability in design, Reliability An ethics metric, reducing risk, risk as an ethical concept, risk based ethics. Medical device failure, Five failure types, Bio-terrorism.

UNIT V **9 Hours**

SUSTAINABLE BIOETHICS

Introduction to Sustainable Bioethics Rational ethics, Life cycles and Concurrent Engineering, Bioethics of Combustion, Systematic Bioethics Seveso Plant disaster, Poverty and Pollution, Interdependence, Macro ethics and Micro ethics, The Humble Engineer.

Total: 45 Hours

Reference(s)

1. William Charney, Handbook of Modern Hospital Safety, CRC Press, 2nd Edition, 2009.
2. AlmiraBadnjevic, Mario Cifrek, RatkoMagjarevic, ZijadDzemic, Inspection of Medical Devices: For Regulatory Purposes, Springer Nature, 2018.
3. Daniel A Vallero, Biomedical Ethics for Engineers, Elsevier Publications, 1st Edition, 2007.
4. Eileen E. Morrison, Ethics in Health Administration: A Practical Approach for Decision Makers, Jonnes and Bartletts Publication, 2nd Edition, 2011.
5. Robert M Veatch, Basics of Bio Ethics, Prentice Hall, Inc., 2nd Edition, 2003

22BM034 / 22BMM34/ 22BMH34
PATIENT SAFETY AND STANDARDS **3 0 0 3**

Course Objectives

- To introduce the safety procedures in healthcare organizations
- To familiarize the Health care organization structure and responsibilities
- To explore the safety standard to be followed in hospitals

Program Outcomes (POs)

PO2. 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.
PO3. 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.
PO4. 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.
PO6. 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.
PO8. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO12. 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.
PSO2. Critically analyse the current healthcare systems and develop innovative solutions effectively through problem specific design and development using modern hardware and software tools.

Course Outcomes (COs)

1. Apply safety procedures in healthcare organizations
2. Assess safety norms in different departments in healthcare sector according to their working environments
3. Analyze the Health care organization structure and the responsibilities of different levels to implement safety
4. Implement the regulatory standards for medical device maintenance
5. Outline the accreditation protocols for a hospital and its safety standards

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	-	2	2	2	-	1	-	2	-	-	1	-	2	-	-
2	-	2	2	2	-	1	-	2	-	-	1	-	2	-	-
3	-	3	2	2	-	1	-	2	-	-	1	-	2	-	-
4	-	3	2	2	-	1	-	2	-	-	1	-	2	-	-
5	-	2	2	2	-	1	-	2	-	-	1	-	2	-	-

UNIT I **9 Hours**

INTRODUCTION

Guidelines and safety practices for improving patient safety, Human error and patient safety, safer care, patients for patient safety, Human factors, patient safety from the perspective of medical residents, patient safety in the world, Infection prevention and control, Adverse event investigation and Risk assessment.

UNIT II **9 Hours**

PATIENT SAFETY IN DIFFERENT HEALTHCARE DEPARTMENTS

Patient safety in Intensive care and Anaesthesiology, Safe surgery, Emergency department clinical risk, obstetric safety patient, patient safety in internal medicine, risks in oncology and radiation therapy, patient safety in orthopaedics and Traumatology, patient safety in paediatrics, patient safety in paediatrics and ophthalmology.

UNIT III **9 Hours**

HEALTH ORGANIZATION

Community and Primary Care, Complexity Science as a Frame for Understanding the Management and Delivery of High Quality and Safer Care, Measuring Clinical Workflow to Improve Quality and Safety, shift work Organization, Non-technical Skills in Healthcare, Medication Safety, Digital Technology and Usability, Coping with the COVID-19 Pandemic: Roles and Responsibilities for Preparedness.

UNIT IV **9 Hours**

REGULATORY STANDARDS FOR MEDICAL DEVICE MAINTENANCE

International Standards, Medical Device Directive 93/42/EEC, Medical Electrical Equipment ISO 60601, Safety Testing of Medical Devices ISO 62353, Medical Device Inspection ISO17020. Indian Standards, National Health Mission, Biomedical Equipment Management and Maintenance Program (BMMP), ISO 9001-2008, AERB Compliance, Radiation protection.AE(RP)R-2004, Safety Code AE/RF-MED/SC-3.

UNIT V **9 Hours**

HOSPITAL ACCREDITATION AND SAFETY STANDARDS

Accreditation, JCI Accreditation & its Policies. Life Safety Standards- Protecting Occupants, Protecting the Hospital and Individuals from Fire, Smoke, and Heat. Managing Hazardous Medical Material and Waste, Laboratory and Radiation safety, Health and safety hazards of shift work. Patient Safety, Human factors, Reliability, Evidence based Medicine, Root cause Analysis.

Total: 45 Hours

Reference(s)

1. Donaldson L, Ricciardi W, Sheridan S, Tartaglia R, editors. Textbook of Patient Safety and Clinical Risk Management [Internet].
2. Cham (CH): Springer; 2021. PMID: 36315660.
3. William Charney, Handbook of Modern Hospital Safety, CRC Press, 2nd Edition, 2009.
4. Almira Badnjevic, Mario Cifrek, Ratko Magjarevic, Zijad Dzemic, Inspection of Medical Devices: For Regulatory Purposes, Springer Nature, 2018

22BM035 / 22BMM35/ 22BMH35
MEDICAL DEVICE REGULATIONS **3 0 0 3**

Course Objectives

- To introduce the regulations in medical device design
- To discuss the regulations of medical device design in various medical industries

Program Outcomes (POs)

PO2. 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.
PO4. 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.
PO6. 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.
PO7. 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.
PO8. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO12. 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.
PSO1. Apply knowledge on foundation in Life Science, engineering, mathematics and current biomedical engineering practices with an ability to demonstrate advanced knowledge of a selected area within Biomedical Engineering.
PSO2. Critically analyse the current healthcare systems and develop innovative solutions effectively through problem specific design and development using modern hardware and software tools.

Course Outcomes (COs)

1. Outline the basic concepts of medical device regulations
2. Apply the global policies on medical device regulations
3. Assess the implications of the regulations
4. Integrate the Standards and Regulations used for medical devices
5. Analyze the software and Quality system regulation in medical device design

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	-	2	1	2	1	1	1	2	1	-	1	1	1	2	-
2	1	2	1	2	1	1	1	2	1	-	1	1	1	2	-
3	1	3	1	2	1	1	1	2	1	-	1	1	1	2	-
4	1	3	1	2	1	1	1	2	1	-	1	1	1	2	-
5	1	3	1	2	1	1	1	2	1	-	1	1	1	2	-

UNIT I **9 Hours**

INTRODUCTION

Defining the device, Overview of quality function deployment, Business proposal Reliability: Definition, Quality Vs Reliability Vs Unreliability, Types of Reliability, Optimizing reliability, Reliability's effects on medical devices. Concept of Failure: Causes of Failure, Practical aspects of failure, Failure rates, Hardware failure, Software Failure. Safety and Risk Management: Medical device safety and risk management, Effectiveness/performance of medical devices, Phases in the life span of a medical device

UNIT II **9 Hours**

DRUG MANUFACTURING PRACTICES

Global Harmonization Task Force (GHTF): Objectives, Scope of the four GHTF study groups, Benefits of the GHTF, Global Medical Device Nomenclature (GMDN) The Food and Drug Administration: Device classification, Registration and listing, The 510 (k) Process, Declaration of conformity, The PMA application,Investigational Device Exemptions (IDEs), Good Manufacturing Practices(GMPs).

UNIT III **9 Hours**

MEDICAL DEVICE DIRECTIVES

The European Union: European Directives, European Standardization Bodies, European Standards Development Process, Other European Standards Considerations, Conformity Assessment and Testing, European Organization for Testing and Certification. The Medical Devices Directives: Process, Choosing the appropriate directive, Identifying the applicable essential requirements

UNIT IV **9 Hours**

STANDARDS AND REGULATIONS

Standards and Regulation: Voluntary and mandatory standards, Standards development process, Conformity assessment with standards, National and international standards systems, Identification of standards, Current trends in the use of standards in medical device regulations. The ISO 9000 Series of Standards

UNIT V **9 Hours**

SOFTWARES AND QUALITY SYSTEM REGULATIONS

Software and Quality system regulation: Software as a Technology, Domestic and International Software Regulations and Standards. Design controls, Document controls, Purchasing controls, Identification and traceability, Production and process controls, Acceptance activities, Non-conforming product, Corrective and preventive action

Total: 45 Hours

Reference(s)

1. Michael Cheng, Medical Device Regulations Global Overview and Guiding Principles, World Health Organization, 2003.
2. Des O'Brien, Medical Device Regulations Roadmap A Beginners Guide, Create Space Independent Publishing Platform, 2017.
3. Aakash Deep, Medical Device Regulations A Complete Guide, Elsevier Science, 2022.
4. Jack Wong, Raymond Tong, Jenny Stanford Publishing Handbook of Medical Device Regulatory Affairs in Asia, Second Edition, 2018.
5. G.R Higson, Medical Device Safety, The Regulation of Medical Devices for Public Health and Safety, 2001.

22BM036 / 22BMM36 / 22BMH36
FORENSIC SCIENCE IN HEALTHCARE **3 0 0 3**

Course Objectives

- To explain the basic principles of forensic science, crime and criminal justice system, police organization, the role of investigator and tools and techniques used in crime science
- To emphasize the importance of scientific methods in crime identification and detection.
- To deal with the modus operandi and role of modus operandi bureau in crime investigation

Program Outcomes (POs)

PO2. 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.
PO4. 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.
PO6. 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.
PO8. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO12. 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. Implement the principles and laws of Forensic Science in Forensic Examination
2. Apply the scientific tools and techniques to the investigation of crimes
3. Outline the Criminal Justice System and Police organization in India
4. Evaluate the forensic evidences in crime scene and the role of investigator in sketching and examination of crime scene
5. Analyse and examine the modus operandi and role of modus operandi bureau in crime investigation

Articulation Matrix

CO No	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
1	-	2	-	1	-	2	-	3	-	-	1	-	-	-	-
2	-	2	-	2	-	2	-	3	-	-	1	-	-	-	-
3	-	2	-	2	-	2	-	3	-	-	1	-	-	-	-
4	-	3	-	2	-	2	-	3	-	-	1	-	-	-	-
5	-	3	-	2	-	2	-	3	-	-	1	-	-	-	-

UNIT I **9 Hours**

INTRODUCTION TO FORENSIC SCIENCE

Introduction, Definition, Principles, Laws of Forensic Science, Historical Background of Forensic Science in India, Need of Forensic Science in present scenario, Organizational set up of Forensic Science Laboratories at state and central level, their types and Divisions, Forensic Examination.

UNIT II **9 Hours**

TOOLS AND TECHNIQUES IN FORENSIC SCIENCE

Branches of Forensic Science, Forensic science in international perspectives, including set up of INTERPOL and FBI, Duties of Forensic Scientists, Code of conduct for Forensic Scientists, Qualifications of Forensic Scientists, Data depiction, Report writing

UNIT III **9 Hours**

CRIME AND POLICE ORGANIZATION

Definition, types of crime, causes of crime, prevention of crime, Difference in blue and white collar crime, Introduction of Cybercrime, Criminal Justice System, Organizational set up of Police at central and state level, Functions of Police, Functions of Police in analyzing a crime scene, Different paramilitary forces in India

UNIT IV **9 Hours**

CRIME SCENE

Introduction, Significance Role of Investigator, Evaluation of crime scene, protection of crime scene, Photography of Crime scene, Tools and techniques, Significance of Photography and Videography, Introduction of Sketching, Purpose of Sketching, Making of Sketches

UNIT V **9 Hours**

FORENSIC EVIDENCES AND ANALYSIS AND MODUS OPERANDI

Hair analysis, Fiber analysis, Ballistics & Tool marks: Soil, Glass and Paint, Footprints and tyre impressions, Bite Marks, Finger prints, Blood Spatter Analysis, DNA analysis, Forensic Anthropology and Entomology, Investigation & examination procedure of various types of cases, Murder, Burglary, Railway & Air Crashes, Road Accidents etc.

Total: 45 Hours

Reference(s)

1. W.J. Tilstone, M.L. Hastrup and C. Hald, Fishers, Techniques of Crime Scene Investigation, CRC Press, Boca Raton (2013).
2. Saferstein, Richard. Criminalistics An Introduction to Forensic Science, 11th ed. Prentice Hall, Saddle River, NJ. 2011
3. H.B. Baldwin and C.P. May in, Encyclopedia in Forensic Science, Volume 1, J.A. Siegel, P.J. Saukko and G.C. Knupfer (Eds.), Academic Press, London (2000).
4. V.J. Geberth, Practical Homicide Investigation, CRC Press, Boca Raton (2006).
5. T. Bevel and R.M. Gardner, Bloodstain Pattern Analysis, 3rd Edition, CRC Press, Boca Raton (2008).

22BM037 / 22BMM37/ 22BMH37
CLINICAL ENGINEERING **3 0 0 3**

Course Objectives

- To provide a basic understanding of the clinical engineering profession, qualifications, roles, activities, and expectations
- To practice medical equipment and analyze challenges with their healthcare technology
- To explore the Health Technology Management systems with medical devices and supportive services with advanced application.

Program Outcomes (POs)

PO1. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. 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.
PO3. 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.
PO4. 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.
PO8. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO12. 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.
PSO1. Apply knowledge on foundation in Life Science, engineering, mathematics and current biomedical engineering practices with an ability to demonstrate advanced knowledge of a selected area within Biomedical Engineering.
PSO2. Critically analyse the current healthcare systems and develop innovative solutions effectively through problem specific design and development using modern hardware and software tools.
PSO3. Hands-on knowledge on cutting edge hardware and software tools to acquire real time data, model and simulate physiological processes and analyse limitations on real time implementations.

Course Outcomes (COs)

1. Assess the roles and responsibilities of Clinical Engineering in healthcare
2. Implement Engineering knowledge in medical technology management practices
3. Analyse the impact of health care technology package (EHTP) in healthcare
4. Assess the clinical engineering program indicators
5. Outline the advances technologies implementation for patient safety

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	3	2	2	-	-	-	1	-	-	-	1	1	1	1
2	2	2	3	2	-	-	-	1	-	-	-	1	1	1	1
3	2	3	2	2	-	-	-	1	-	-	-	1	2	1	1
4	2	3	2	2	-	-	-	1	-	-	-	1	2	1	1
5	2	2	2	2	-	-	-	1	-	-	-	1	2	1	2

UNIT I **9 Hours**

INTRODUCTION

Clinical engineering: Definition, Evolution, Role, Responsibilities, Functional status, History of clinical engineering and Technology in Health Care System, Enhancing patient safety.

UNIT II **9 Hours**

MEDICAL TECHNOLOGY MANAGEMENT PRACTICES

Strategic Medical Technology Planning, Scope , Clinical necessity operational support, strategic planning process Technology assessment: Technology audit, Budget strategies, Prerequisite for medical technology assessment, Management Practice for Medical Equipment, Device evaluation, Risk reduction, Asset management, ESHTA

UNIT III **9 Hours**

ESSENTIAL HEALTH CARE TECHNOLOGY PACKAGE (EHTP)

Introduction, Health care technology management, Package development: Methodology, Logical framework, Implementation, Information promotion and dissemination, EHTP Justification, EHTP matrix, EHTP advantages, Impact Analysis

UNIT IV **9 Hours**

CLINICAL ENGINEERING PROGRAM INDICATOR

Clinical engineering: program services, Program database, Clinical Engineering Program management, Program indicator, managing clinical engineering performance using program indicators, Indicator management process

UNIT V **9 Hours**

ADVANCED TECHNOLOGY FOR PATIENT SAFETY

Factors Contributing to Medical Errors: Heath Care Reimbursement, Health Care Failure Mode and Effect Analysis (HFMEA), Patient Safety Best Practices Model Bar coding, Computerized Physician Order Entry (CPOE), and Clinical data repositories, Process analysis, Methodology. Computerized medical equipment management systems.

Total: 45 Hours

Reference(s)

1. Ernesto Iadanza, Joseph Dyro, Clinical Engineering Handbook, Elsevier Academic Press, 2014
2. Robert Miniati, Clinical Engineering from Devices to Systems, Academic Press, 23-Dec-2015 - Technology & Engineering
3. Ernesto Iadanza, Clinical Engineering Handbook, 2nd Edition, Elsevier, Academic Press, November 2019, ISBN 9780128134672
4. Jacobson B and Webster J G Medical and Clinical Engineering Prentice Hall of India New Delhi 1999
5. Cesar A. Cacere& Albert Zana, The Practice of Clinical Engg. Academic press, New York, 1977. Webster J.G and Albert M.Cook, Clinical Engg, Principles & Practices, Prentice Hall Inc., Engle wood Cliffs, New Jersy, 1979.

22BM038 MEDICAL DEVICE DESIGN 3 0 0 3

Course Objectives

- Students will be able to know about the Medical product design and development
- Patient safety and regulatory aspects followed in hospitals
- Professional ethics to be followed by Biomedical Engineers

Program Outcomes (POs)

PO2. 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.
PO3. 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.
PO4. 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.
PO8. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO12. 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.
PSO2. Critically analyse the current healthcare systems and develop innovative solutions effectively through problem specific design and development using modern hardware and software tools.

Course Outcomes (COs)

1. Implement Good Design Practice in medical product design
2. Apply appropriate methodologies for Product development
3. Outline the important regulatory schemes to be followed in medical device design
4. Show testing, validation and market analysis for developed product
5. Analyse challenges in converting innovation into product in Healthcare sector

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	-	3	2	1	-	-	-	1	-	-	-	2	-	2	-
2	-	2	2	2	-	-	-	1	-	-	-	2	-	2	-
3	-	3	2	2	-	-	-	1	-	-	-	2	-	2	-
4	-	3	2	2	-	-	-	1	-	-	-	2	-	2	-
5	-	2	2	2	-	-	-	1	-	-	-	2	-	2	-

UNIT I **9 Hours**

INTRODUCTION TO MEDICAL PRODUCT DESIGN

Definition, History and Modern Practice, Designs; Design and Product Life Cycle, Design Process, Understanding the innovation cycle, Good Design Practice. Understanding, analysing and validating user needs, Screening Needs, Technical Requirements, Concept Generation, Innovation Survey Questionnaire, Morphological Matrix, QFD, Concept Analysis and validation, Concept Modelling, Concept Screening & Validation.

UNIT II **9 Hours**

PRODUCT DEVELOPMENT

Breakthrough Products, Platform Products, Front End of Innovations, Fuzzy Front End, Generic Product Development Process, Variants of Development Processes, Good Documentation Practice, and Prototyping Specifications, Prototyping, Medical Device standards, Quality management systems (ISO 13485), Medical Device Classification, Design of Clinical Trials.

UNIT III **9 Hours**

REGULATORY SCHEMES

Design Control & Regulatory Requirements, Documentation in Medical Devices, Regulatory pathways, Biomedical Evaluation of Medical Devices, ISO Medical Devices, Applications of Risk Management to Medical Devices (ISO 14971), Electrical Safety Standard, IEC60601-1, IEC60601-2, IEC60601-6, Protection of Electrical and Electronic Parts, Assemblies and Equipments (ESD S20.20-2014).

UNIT IV **9 Hours**

SCALABLE PRODUCT DEVELOPMENT

Design for manufacturing, Design for assembly, Design for Serviceability, Design for usability, Medical Device Verification & Validation, Product Testing & Regulatory compliance, Clinical trial & validation, Device Certification.

UNIT V **9 Hours**

PRACTICAL CHALLENGES ON MEDICAL DEVICE DEVELOPMENT

Product life cycle, challenges in Practicing International Regulatory Requirements, Risk Management: Integration of Risk Management into the supporting QMS, Use of Codes to Identify Medical Devices, Application of Risk Management throughout product life cycle.

Total: 45 Hours

Reference(s)

1. John G. Webster, Medical Instrumentation: Application and Design, 5th Edition, June 2020
2. Peter J. Ogrodnik, Medical Device Design: Innovation from Concept to Market, Academic Press is an imprint of Elsevier, 1st edition 2013
3. Paul H. King, Richard C. Fries, Arthur T. Johnson, Design of Biomedical Devices and Systems, CRC Press, Tailor and Francis Group, 3rd Edition, 2015
4. Andres D. Lantada, Handbook on Advanced Design and Manufacturing Technologies for Biomedical Devices, Springer London 2013
5. Paul G. Yock, StefanosZenios, Joshua Makower, Todd J. Brinton, Uday N. Kumar, F. T. Jay Watkins, Lyn Denend, Thomas M. Krummel, Christine Kurihara, Biodesign: The Process of Innovating Medical Technologies, Cambridge University Press; 2nd edition, 2 February 2015

22BM039 MEDICAL EQUIPMENT MAINTENANCE AND TROUBLESHOOTING **3 0 0 3**

Course Objectives

- To troubleshoot and quality control in medical equipment for biomedical engineering students
- To provide knowledge about the troubleshooting of various equipment used in hospitals and quality standard of medical equipment

Program Outcomes (POs)

PO2. 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.
PO4. 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.
PO8. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PSO1. Apply knowledge on foundation in Life Science, engineering, mathematics and current biomedical engineering practices with an ability to demonstrate advanced knowledge of a selected area within Biomedical Engineering.
PSO2. Critically analyse the current healthcare systems and develop innovative solutions effectively through problem specific design and development using modern hardware and software tools.

Course Outcomes (COs)

1. Apply the common troubleshooting procedures in testing electronic equipment
2. Analyze and identify the fault in given analog and digital circuits using appropriate procedures
3. Implement troubleshooting procedures to find faults in medical equipment
4. Asses the quality of medical devices by applying suitable procedures
5. Evaluate the medical device regulation procedure in device design

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	-	2	-	3	-	-	-	-	-	-	-	-	1	2	-
2	-	3	-	3	-	-	-	-	-	-	-	-	1	2	-
3	-	2	-	3	-	-	-	-	-	-	-	-	1	2	-
4	-	3	-	3	-	-	-	2	-	-	-	-	1	2	-
5	-	2	-	3	-	-	-	2	-	-	-	-	1	2	-

UNIT I **9 Hours**

FUNDAMENTAL TROUBLESHOOTING TESTING PROCEDURES

Equipment failure and its causes, Functional block diagram of a troubleshooting system, troubleshooting process & fault finding aids, troubleshooting techniques and their correction action, Testing of active and passive components: resistor, capacitor, inductor, BJT, JFET, & MOSFET

UNIT II **9 Hours**

FAULT DIAGNOSIS IN INTEGRATED CIRCUITS

Characteristics of ideal op amps, typical op amp based medical circuits, Fault diagnosis in op amp circuits, Digital troubleshooting methods, Digital IC Trouble shooters, logic clip, logic probe, logic pulser, logic current tracer, logic comparator, Circuit board Troubleshooting.

UNIT III **9 Hours**

BIOMEDICAL EQUIPMENT TROUBLESHOOTING

Troubleshooting- ECG Machine, EEG Machine, defibrillator, electrosurgical unit, anaesthesia machine, autoclaves & sterilizers, endoscope, incubators, nebulizer, oxygen concentrators, sphygmomanometers, suction machine, X ray machine.

UNIT IV **9 Hours**

MEDICAL DEVICE DESIGN QUALITY

Definition of quality, essence of quality, Quality operating system and the device life cycle, Evolution of quality, Business excellence: a value proposition, Health care quality.

UNIT V **9 Hours**

DESIGN FOR SIX SIGMA AND MEDICAL DEVICE REGULATION

Global Perspective on medical device regulations, medical device classification (USA, Europe & GHTF). Medical device safety, medical device quality management systems requirements, Medical device regulation throughout the product development life cycle, Purpose of ISO 9001:2001&ISO 13485.

Total: 45 Hours

Reference(s)

1. Khandpur R S, Troubleshooting Electronic Equipment- Includes Repair & Maintenance, Tata McGrawHill, 2nd edition, 2009.
2. Basem S EL-Haik& Khalid S Mekki, Medical Device Design for Six Sigma: A Road Map for Safety and Effectiveness, John Wiley & Sons, 1st edition, 2008
3. Nicholas Cram & Selby Holder, Basic Electronic Troubleshooting for Biomedical Technicians, TSTC Publishing, 2nd edition, 2010.
4. Dan Tomal& Neal Widmer, Electronic Troubleshooting, McGraw Hill, 3rd edition, 2004.
5. World Health Organisation, Maintenance & Repair of Laboratory, Diagnostic imaging & Hospital Equipment, Geneva, 1994.

22BM040 ADVANCED BIOSENSORS 3 0 0 3

Course Objectives

- To familiarize with the concepts of biosensors
- To Study the operating principle of transducers for measurement of physical quantities
- To Study the operating principle of optical sensors

Program Outcomes (POs)

PO1. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. 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.
PO3. 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.
PO4. 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.
PO6. 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.
PSO1. Apply knowledge on foundation in Life Science, engineering, mathematics and current biomedical engineering practices with an ability to demonstrate advanced knowledge of a selected area within Biomedical Engineering.
PSO2. Critically analyse the current healthcare systems and develop innovative solutions effectively through problem specific design and development using modern hardware and software tools.

Course Outcomes (COs)

1. Assess the static, dynamic characteristics and errors associated with given sensor/Transducer
2. Use suitable sensor to measure physical industrial quantities
3. Assess the working principle of a given biosensor
4. Show suitable biosensors in healthcare applications
5. Integrate advanced sensing technologies for improved sensing accuracy

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	3	2	-	-	-	-	-	-	-	-	-	2	2	-
2	2	2	2	2	-	-	-	-	-	-	-	-	2	2	-
3	1	3	2	-	-	-	-	-	-	-	-	-	2	2	-
4	1	2	2	2	-	2	-	-	-	-	-	-	2	2	-
5	1	3	2	3	-	-	-	-	-	-	-	-	2	2	-

UNIT I **9 Hours**

INTRODUCTION

Transducer Introduction, Definition, Classification and Characteristics of transducers, Selection criteria, Static Characteristics, Dynamic Characteristics, Standards, Calibration, types, Need for Calibration.

UNIT II **9 Hours**

TRANSDUCERS FOR MEASUREMENT OF PHYSICAL QUANTITIES

Strain Gauge: Principle, Classification, Gauge factor, Derivation, Load cell: Principle, Construction and Operation, LVDT: Principle, Construction and Operation, Piezoelectric Sensor: Principle, Construction and Operation, Medical applications of Piezoelectric sensors, Flex sensors: Principle, Construction and Operation, Hall effect transducer: Principle, Construction and Operation and Applications.

UNIT III **9 Hours**

PRINCIPLES OF BIOSENSORS

Biosensors: Definition, Block diagram, Genesis of Biosensors, Classification of Biosensors, Types, Immobilization of Bio receptor, Enzyme immobilization, Biocatalysts based biosensors: Introduction, principle, Glucose biosensor: Principle, Construction and Operation, Bioaffinity based sensor: Principle, Microbe biosensor: Principle, Construction and Operation.

UNIT IV **9 Hours**

APPLICATIONS OF BIOSENSORS

Electrochemical biosensor: Principle, Construction and Operation, Biosensors for pathogen detection, Biosensors for cancer detection, Saliva based biosensors, DNA Biosensors, Biochips, Biosensors for environmental monitoring, Biosensors for disaster management, Futuristic approach of Biosensors.

UNIT V **9 Hours**

ADVANCE IN SENSING TECHNOLOGIES

Smart Sensors: Introduction, Need, Architecture, Salient features, Lab on Chip (LoC): Architecture, e-Nose: System description, OFC: Introduction, Total Internal reflection, Concepts of SPR, SPR sensors, Evanescence Sensor: Concepts, Grating sensors: principle and applications.

Total: 45 Hours

Reference(s)

1. Sawhney A.K, A Course in electrical and electronic measurements and instrumentation, Dhanpat Rai & Co (P) Ltd, Educational and Technical Publishers, 19th Revised edition 2011, Reprint 2014.
2. Patranabis D, Sensors and transducers, PHI, 2nd edition, 2004
3. Murty DVS, Transducer and instrumentation, PHI, 2nd edition, 2010.
4. U.A. Bakshi, A.V. Bakshi, Measurements and instrumentation, Technical Publications, 3rd revised edition, 2010
5. Paras N, Prasad, Introduction to biophotonics, John Wiley & Sons, 1st edition, 2003

22BM041 DRUG DELIVERY SYSTEM 3 0 0 3

Course Objectives

- To explain the basic principles for development of novel drug delivery systems.
- To emphasize the importance of various drug delivery systems and their usage in hospitals.
- To deal with the formulation and evaluation of Novel drug delivery systems

Program Outcomes (POs)

PO2. 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.
PO3. 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.
PO4. 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.
PO6. 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.
PO12. 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.
PSO1. Apply knowledge on foundation in Life Science, engineering, mathematics and current biomedical engineering practices with an ability to demonstrate advanced knowledge of a selected area within Biomedical Engineering.
PSO2. Critically analyse the current healthcare systems and develop innovative solutions effectively through problem specific design and development using modern hardware and software tools.

Course Outcomes (COs)

1. Apply Ficks laws for controlled drug delivery systems
2. Design and analyze the technology based CR systems
3. Apply biomaterial knowledge to design implantable therapeutic systems
4. Outline the transdermal drug delivery evaluation and implementation process
5. Analyse the modern technology to facilitate targeted drug delivery

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	-	2	2	-	-	1	-	-	-	-	-	1	2	2	-
2	-	2	3	2	-	1	-	-	-	-	-	1	2	2	-
3	-	2	2	2	-	1	-	-	-	-	-	1	2	2	-
4	-	3	2	2	-	1	-	-	-	-	-	1	2	2	-
5	-	3	2	3	-	1	-	-	-	-	-	1	2	2	-

UNIT I **9 Hours**

CONTROLLED DRUG DELIVERY

Fundamentals of Controlled Release (CR) Drug Delivery, Rationale of sustained/controlled drug delivery, Physicochemical and biological factors influencing design and performance of CR products, therapeutic status of CDDS. Theory of mass transfer, Ficks first and second laws and their applications in drug release and permeation. Pharmacokinetic and pharmacodynamic basis of controlled drug delivery, bio availibility assessment of CR systems.

UNIT II **9 Hours**

DESIGN AND FABRICATION OF TECHNOLOGY BASED CR SYSTEMS

Strategies and design of oral controlled release delivery systems , oral systems based on dissolution, diffusion and dissolution, Ion exchange resins, Ph independent formulations ,altered density formulations, Bucco /mucoadhesive systems. Osmotic controlled oral drug delivery, Feedback regulated Drug Delivery Systems

UNIT III **9 Hours**

PARENTERAL SYSTEM

Parenteral systems, biopharmaceutic considerations, design and development, polymeric microspheres dispersed drug delivery, Implantable therapeutic systems, Biocompatibility of polymers and carriers, Intrauterine devices and intravaginal devices

UNIT IV **9 Hours**

TRANSDERMAL DRUG DELIVERY SYSTEM

Transdermal therapeutic systems (TTS) Drug absorption through skin, permeation enhancers, basic components of TTS, Approaches to development and kinetic evaluation, testing of transdermal patches, pressure sensitive adhesives, Iontophoresis, Sonophoresis and electroporation. Formulation and evaluation of TTS

UNIT V **9 Hours**

TARGETED DRUG DELIVERY

History concept, Types and key elements, ideal carrier system and approach with special reference to organ targeting (e.g. brain, tumor, lung, liver and lymphatics), Basics of temperature, pH and magnetically induced targeting tactics. Vaccine delivery systems

Total: 45 Hours

Reference(s)

1. Tozer T N, Rowland M, Introduction of Pharmacokinetics and Pharmacodynamics The Quantitative Basis of Drug Therapy, Williams & Wilkins, 2006.
2. Howard C. Ansel, NIcholos G. Popvich, lyold V. Allen , Pharmaceutical dosage forms and Drug Delivery system, 1st edition, 2014.
3. Jain N.K and Sharma S.N. A text book of professional pharmacy, 1st edition 1995.
4. Samuel Harder and GlennV. Buskirk. Pilot Plant Scale-Up Techniques. In The Theory and Practice of Industrial Pharmacy. 3rd edition., 1991
5. Remington, The Science and Practice of pharmacy, 20 th Edn, vol.I, pg.no.903- 913.

22BM042 ELECTROMAGNETIC INTERFERENCE AND COMPATIBILITY

3 0 0 3

Course Objectives

- To instil knowledge on the EMI coupling mechanism and its mitigation techniques
- To impart comprehensive insight about the current EMC standards
- To acquire knowledge on various measurement techniques for EMI mechanisms

Program Outcomes (POs)

PO1. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. 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.

PO3. 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.

PO4. 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.

PO8. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO12. 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.

PSO1. Apply knowledge on foundation in Life Science, engineering, mathematics and current biomedical engineering practices with an ability to demonstrate advanced knowledge of a selected area within Biomedical Engineering.

PSO2. Critically analyse the current healthcare systems and develop innovative solutions effectively through problem specific design and development using modern hardware and software tools.

Course Outcomes (COs)

1. Assess the impact of electromagnetic interference and its effects in human
2. Implement the suitable coupling mechanisms to reduce electromagnetic interference and compatibility
3. Apply appropriate methods to assess the electromagnetic interferences
4. Analyse the standards and regulations to be followed in electromagnetic interference generating systems
5. Integrate instrumentation knowledge to test electromagnetic interferences

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	1	3	2	2	-	-	-	1	-	-	-	1	1	3	-
2	1	2	2	2	-	-	-	1	-	-	-	1	1	2	-
3	1	2	2	2	-	-	-	1	-	-	-	1	1	3	-
4	1	3	2	2	-	-	-	1	-	-	-	1	1	3	-
5	1	2	2	2	-	-	-	1	-	-	-	1	1	2	-

UNIT I **9 Hours**

BASIC CONCEPTS

Definition of EMI and EMC, Intra and Inter system EMI, Sources and victims of EMI, Conducted and Radiated EMI emission and susceptibility, Transient & ESD, Case Histories, Radiation Hazards to humans.

UNIT II **9 Hours**

COUPLING MECHANISM

Common made coupling, Differential mode coupling, Common impedance coupling, Ground loop coupling, Field to cable coupling, Cable to cable coupling, Power mains and Power supply coupling.

UNIT III **9 Hours**

EMI MITIGATION TECHNIQUES

Shielding - principle, choice of materials for H, E and free space fields, and thickness, EMI gaskets, Bonding, Grounding circuits, system and cable grounding, Filtering, Transient EMI control devices and applications, PCB Zoning, Component selection, mounting, trace routing.

UNIT IV **9 Hours**

STANDARDS AND REGULATION

Units of EMI; National and International EMI Standardizing Organizations - IEC, ANSI, FCC, CISPR, BIS, CENELEC; FCC standards; EN Emission and Susceptibility standards and specifications; MIL461E Standards.

UNIT V **9 Hours**

EMI TEST METHODS AND INSTRUMENTATION

EMI test sites - Open area site; TEM cell; Shielded chamber; Shielded Anechoic chamber; EMI test receivers; Spectrum Analyzer; Transient EMI Test wave Simulators; EMI coupling Networks - Line Impedance Stabilization Networks; Feed through capacitors; Antennas and factors; Current probes and calibration factor; MIL-STD test methods; Civilian STD Test methods, Government policies.

Total: 45 Hours

Reference(s)

1. V.P. Kodali, Engineering EMC Principles, Measurements and Technologies, IEEE Press, Network, 2nd Edition, 2010.
2. Henry W.Ott., Noise Reduction Techniques in Electronic Systems, A Wiley Inter Science Publications, John Wiley and Sons, Network, 2009.
3. layton Paul, Introduction to Electromagnetic Compatibility, Wiley Interscience, 2006.
4. Daryl Gerke and William Kimmel, EDNs Designers Guide to Electromagnetic Compatibility, Elsevier Science and Technology Books, 2002.
5. Dr Kenneth L Kaiser, The Electromagnetic Compatibility Handbook, CRC Press 2005.

22BM043 INTERVENTIONAL AND DIAGNOSTIC RADIOLOGY **3 0 0 3**

Course Objectives

- To impart knowledge on the radiation techniques
- To impart comprehensive insight about the interventional radiology in different medical field
- To acquire knowledge on various practices in diagnostic radiology

Program Outcomes (POs)

PO1. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. 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.
PO3. 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.
PO4. 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.
PO8. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO12. 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.
PSO1. Apply knowledge on foundation in Life Science, engineering, mathematics and current biomedical engineering practices with an ability to demonstrate advanced knowledge of a selected area within Biomedical Engineering.
PSO2. Critically analyse the current healthcare systems and develop innovative solutions effectively through problem specific design and development using modern hardware and software tools.

Course Outcomes (COs)

1. Assess the interaction of radiation with tissue
2. Integrate the role of radiology in various diagnosis procedures
3. Implement radiology in assessing vascular and gastrointestinal tract.
4. Assess the role radiology in traumatology
5. Analyze radiology in diagnosis and treatment of various organ system.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	1	2	2	2	-	-	-	1	-	-	-	1	3	2	-
2	1	2	2	2	-	-	-	1	-	-	-	1	3	2	-
3	1	2	2	2	-	-	-	1	-	-	-	1	3	2	-
4	1	2	2	2	-	-	-	1	-	-	-	1	3	2	-
5	1	3	2	2	-	-	-	1	-	-	-	1	3	2	-

UNIT I **9 Hours**

INTRODUCTION

Introduction – Physical basics: Types of radiation, structure of matter and radioactive decay, interaction of radiation and matter, measurement of radiation, The effect of radiation on biological tissue: phases of radiation, radiation damage to the cell, the acute effect of radiation on human body, the chronic effect of radiation, carcinogenesis, the dangers of X-Rays

UNIT II **9 Hours**

RADIOLOGICAL DIAGNOSTIC PROCEDURES

Review of conventional diagnostic radiography: CT, MRI, Angiography and interventions, Ultrasound, contrast agent, Introduction to Neuroradiology: The brain and spinal cord, Mammography imaging and interventional diagnosis of the mammary gland using X-Ray mammography, Breast Sonography and MR mammography.

UNIT III **9 Hours**

INTERVENTIONAL RADIOLOGY IN VASCULAR AND GASTROINTESTINAL TRACK

Vascular diagnostics and interventional techniques, vascular interventional therapy, arterial access of angiography and intervention, arterial thrombolysis and mechanical thrombectomy, Angioplasty and stenting, stent grafting, Gastrointestinal track: Liver, gallbladder and biliary tree, Pancreas, spleen and gastrointestinal system radiological interventions.

UNIT IV **9 Hours**

INTERVENTIONAL RADIOLOGY IN TRAUMATOLOGY

Traumatology: The basics Traumatology- interventional diagnosis: site specific trauma-inflammatory bone diseases, primary and secondary bone tumours, tumour like lesions and systemic skeletal diseases, Diseases of the joints.

UNIT V **9 Hours**

INTERVENTIONAL RADIOLOGY IN OTHER ORGAN SYSTEMS

Interventional uro-radiology, haemodialysis fistula, Hepatobiliary interventions, Interventional radiology in gynaecology, salivary and lacrimal duct interventions, interventions in chest and interventional radiology in transplantation

Total: 45 Hours

Reference(s)

1. Raman Uberoi, Interventional radiology, Oxford University Press, 2009
2. John A Koufman, Michael J Lee, Vascular and Interventional radiology, Elsevier, 2014
3. Debra A. Gervais, Tarun Sabharwal Diagnostic and Interventional Radiology, Springer ,2016
4. Kieran Murphy, Fergus Robertson, Kieran Murphy, Fergus Robertson, Vascular Springer 2013
5. Interventional Radiology: Fundamentals of Clinical Practice Bradley B. Pua, Anne M. Covey, David C. Madoff, Oxford University Press, 2019

22BM044	MULTIMEDIA COMPRESSION TECHNIQUES	L	T	P	C
		3	0	0	3

Pre-requisite

- Discrete Time Signal Processing
- Bio-Signal Processing

Assessment Pattern

Mode of Assessment	Weightage(%)
Continuous Internal Assessment	40
Semester End Examinations	60

Course Objectives

- To Understand the special features and representations of different data types.
- To Analyze different compression techniques for text data and audio signals.
- To Analyze various compression techniques for image and video signals.

Programme Outcomes (POs)

PO1 **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2 **Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences

PO3 **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.

PO4 **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.

PO5 **Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

PO6 **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.

PO8 **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO9 **Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10 **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.

PO11 **Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO12 **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.

PSO1 Apply knowledge on foundation in Life Science, engineering, mathematics and current biomedical engineering practices with an ability to demonstrate advanced knowledge of a selected area within Biomedical Engineering

PSO2 Critically analyze the current healthcare systems and develop innovative solutions effectively through problem specific design and development using modern hardware and software tools

Course Outcomes (COs)

The students will be able to

CO1 Apply the fundamental concepts of multimedia and compression techniques.
CO2 Implement different lossy and lossless coding techniques for text compression.
CO3 Analyze the various lossy and lossless coding techniques for audio compression.
CO4 Apply and analyze the compression techniques for images.
CO5 Integrate the different video compression standards and techniques.

Articulation Matrix

CO. No.	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	3	2	3	2	-	-	-	-	-	-	1	1	1	-
2	3	3	2	3	2	-	-	3	-	-	-	1	1	1	-
3	2	3	3	3	3	2	-	3	2	2		1	1	1	-
4	3	3	2	3	3	-	-	3	2	3	2	1	1	1	-
5	3	3	3	3	3	2	-	3	2	3	2	1	1	1	-

Unit I Introduction 9 Hours

Special features of Multimedia - Graphics and Image Data Representations - Fundamental Concepts in Text, Images, Graphics, Video and Digital Audio - Storage requirements for multimedia applications - Need for Compression - Lossy & Lossless compression techniques

Unit II Text Compression 9 Hours

Compression techniques - Huffman coding - Adaptive Huffman Coding - Arithmetic coding - Shannon- Fano coding - Dictionary techniques - LZ77, LZ78, LZW family algorithms.

Unit III Audio Compression 9 Hours

Audio compression techniques-MU-Law and A-Law companding - Frequency domain and filtering - Basic sub- band coding -DPC M-ADPCM-DM-LPC-CELP -Application to speech coding - G.722 - Application to audio coding - MPEG audio

Unit IV Image Compression 9 Hours

MMR coding - Transform Coding - JPEG Standard - Sub-band coding algorithms - Design of Filter banks - Wavelet based compression - Implementation using filters - EZW, SPIHT coders - JPEG 2000standards - Run length coding.

UNIT V Video Compression 9 Hours

Video compression techniques and standards - MPEG Video Coding I: MPEG-1 and 2 - MPEG Video Coding II - MPEG - 4 and 7 - Motion estimation and compensation techniques - H.261 Standard

Total 45 Hours

References

1. David Salomon, Data Compression,The Complete Reference, Springer Verlang, 2006
2. Colt McAnlis ,Understanding Compression, O""Reilly Media, Inc,2016
3. Khalid Sayood, Introduction to Data Compression, Morgan Kauffman Harcourt India, 2007.
4. Yun Q.Shi and Huifang Sun, Image and Video Compression for Multimedia Engineering. Fundamentals, Algorithms& Standards, CRC press, 2003.
5. Peter Symes, Digital Video Compression, McGraw Hill Publication, 2004.
6. Mark S.Drew and Ze-Nian Li, Fundamentals of Multimedia, PHI, 2003.

Online Resources

1. https://nptel.ac.in/courses/117105083
2. https://nptel.ac.in/courses/117105081

22BM045	**PCB DESIGN AND FABRICATION**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

Pre-requisite

- Basic Electronics
- Analog and Digital Electronics

Assessment Pattern

Mode of Assessment	**Weightage(%)**
Continuous Internal Assessment	40
Semester End Examinations	60

Course Objectives

- Understand the basic concepts involved in PCB design
- Design a circuit schematic and PCB layout
- Prototype the PCB and analyze the manufacturing and assembly techniques

Programme Outcomes (POs)

PO1 **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2 **Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences

PO3 **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.

PO4 **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.

PO5 **Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

PO6 **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.

PO8 **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO9 **Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10 **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.

PO11 **Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one’s own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO12 **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.

PSO1 Apply knowledge on foundation in Life Science, engineering, mathematics and current biomedical engineering practices with an ability to demonstrate advanced knowledge of a selected area within Biomedical Engineering

PSO2 Critically analyze the current healthcare systems and develop innovative solutions effectively through problem specific design and development using modern hardware and software tools

PSO3 Hands-on knowledge on cutting edge hardware and software tools to acquire real time data, model and simulate physiological processes and analyze limitations on real time implementations

Course Outcomes (COs)

The students will be able to

CO1 Analyze the basic concepts involved in the PCB design

CO2 Design a circuit schematic using electronic components

CO3 Design a PCB layout and realize the manufacturing data

CO4 Design a PCB for High Speed Circuits

CO5 Develop a prototype model and understand the PCB manufacturing process and PCB assembly Process

Articulation Matrix

CO. No.	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	1	3	1	3	-	-	-	-	-	-	-	1	1	1
2	2	2	2	2	3	-	-	-	-	-	-	2	1	1	1
3	2	2	2	2	3	-	-	-	-	-	-	2	1	1	1
4	2	2	3	2	3	-	-	-	2	-	2	2	1	1	1
5	1	1	2	2	3	3	-	3	3	2	2	2	1	1	1

Unit I Basics of PCB **9 Hours**

PCB - Overview, History, Challenges, Market - Classification of PCB - Classes of PCB Design – PCB Laminates - Terminologies in PCB - VIAS - PCB Design Process CAD /CAM Operation – Industry Standard PCB Design Tools

Unit II Schematic Design and Footprint Creation **9 Hours**

Reading Drawings and Diagrams - Schematic symbols for common electronic components – Symbol Properties - Reference Designators - BoM - ERC - Symbol Creation - Mounting Technologies – Through Hole and SMD - Component Library Creation - PTH Components Footprint Designing – SMD Components Footprint Designing as per IPC 7351Standards

Unit III Layout Planning and Design **9 Hours**

General PCB Consideration - Mechanical Calculation - Holes and Solder PAD - Automatic routers for PCB design - Layout Verification - DRC, Net, LVS - Layout Design Check list - DRC - Gerber File - PCB Design Check List

Unit IV High Speed PCB Design **9 Hours**

High-Speed Design Considerations - Signal Integrity - Need for Signal Integrity - Causes of Signal Integrity Issues in a PCB - Electromagnetic Compatibility (EMC) - EMI - Sources of EMI - Best PCB Design Practices for EMC - Power Integrity - Component Placement Considerations in High-Speed PCBs -Separating Analog and Digital Circuits - Component Orientation - High-Speed Routing Strategy - Differential Pair Signals - Length Matching - High-Speed PCB Design Checklist

UNIT V PCB Fabrication **9 Hours**

PCB Safety Guidelines - CAM Editing - Single Layer, Double Layer and Multilayer PCB Board Manufacturing Process - PCB Defects - PCB Assembly Process - Through Hole and SMD - Quality Assurance - Acceptance Criteria

Total 45 Hours

References

1. R.S. Khadhapur, Printed Circuit Boards: Design, Fabrication and Assembly, McGraw Hill Companies, Electronic Engineering, 2006.
2. Earl Gates, Introduction to Basic Electricity and Electronics Technology, Delmar Cengage Learning, 2013.
3. Kraig Mitzner, Complete PCB Design using OrCAD Capture and Layout, Newnes, 2007.
4. Clyde F. Coombs, Printed Circuits Handbook, McGraw Hill, Sixth Edition, 2008.
5. Sd. Mehta, Electronic Product Design Vol. 1 Basics of PCB Design, S Chand & Company Pvt. Ltd, 2011.

Online Resources

1. https://archive.nptel.ac.in/courses/106/105/106105193/
2. https://github.com/erinjense/Learn-Embedded-Systems
3. https://www.arm.com/resources/education/online-courses/efficient-embedded-systems
4. https://www.khanacademy.org/math/differential-calculus
5. http://ocw.mit.edu/ans7870/18/18.013a/textbook/HTML/chapter31/

22BM046 **HEALTH CARE MANAGEMENT** **3 0 0 3**

Course Objectives

- To understand the general management principles and basic healthcare application
- To explore the International and national healthcare problems and issues.
- To learn Planning, budgeting and uses of computers and information technology.
- To have an understanding on International standards and protocol for hospital management

Programme Outcomes (POs)

PO6 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
PO7 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
PO8 Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice
PO12 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.
PSO1 Apply knowledge on foundation in Life Science, engineering, mathematics and current biomedical engineering practices with an ability to demonstrate advanced knowledge of a selected area within Biomedical Engineering.
PSO2 Critically analyse the current healthcare systems and develop innovative solutions effectively through problem specific design and development using modern hardware and software tools.

Course Outcomes (COs)
The students will be able to
CO1 Analyze the elements of healthcare management and the importance of Healthcare service providers.
CO2 Compare the Indian and global healthcare market and organization structure.
CO3 Assess the knowledge of various hierarchy of hospital system, Role of biomedical engineers.
CO4 Analyze the need for Communication within the hospital, Orientation and budgeting and Implementation of Computer and Information Management in Hospitals, software for billing, maintenance of patient record
CO5 Outline the International standards and protocol for hospital management

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	-	-	-	-	-	1	1	2	-	-	-	2	2	1	-
2	-	-	-	-	-	1	1	2	-	-	-	2	1	2	-
3	-	-	-	-	-	1	1	2	-	-	-	2	1	2	-
4	-	-	-	-	-	1	1	2	-	-	-	2	2	1	-
5	-	-	-	-	-	1	1	2	-	-	-	2	2	2	-

UNIT I Introduction to Management & Health Care Service Providers 9 Hours
Principles of Management – Origin of principles of Management, What is management? Henry Fayol's 14 principles of Management, elements of management, organizational hierarchy, Introduction to principles of management in Healthcare environment, health ergonomics. Role of the healthcare service providers Conventional hospital s tup, types of leadership in healthcare environment, Private clinics, Corporate hospitals

UNIT II Global and Indian Healthcare Scenario 9 Hours
Global Healthcare Scenario - Global spending on healthcare, WHO Statistics, Global Healthcare Care Market, Medicare, Medicaid, Indian Healthcare Scenario – Indian healthcare system, composition, organizational structure, Indian Healthcare Market, Key Stake Holders, Global players in Indian healthcare market Case studies – USA, India and Singapore.

UNIT III Classification of Hospital Systems And Planning 9 Hours
General Hospital –Specialist Hospital –Teaching – Research, Primary Health Centre –Their role, Functions. Role of Biomedical Engineers, Aspects of Hospital Services-Outpatient- Inpatient supportive emergency, drug and medical supply, Nursing Services, Dietary services, Transport services. Supply Chain Management, Hospital planning - Orientation, Budgeting, Communication within the hospital and outside the hospitals - Electric power supply for various theatres and rooms, Diesel generator, Standby power supply- conditioning of important theatres and equipment housings - Water supply requirements & management, Lifts and firefighting equipment's - Sanitation within the hospitals, Laundry services.

UNIT IV Computer and Information Management In Hospitals 9 Hours
Computer aided hospital management - Application, Administration/Discharge records of patients, Patient billing, Maintenance of patient records and their history - Maintenance of inventory of medicines and drugs – Purchase

UNIT V Hospital Standards and Maintenance 9 Hours
Introduction to ISO - WHO standards, FDA standards, Indian standards for biomedical equipment services, Their purchase, Servicing and maintenance- Keeping intact and throwing the condemned equipment, Training personal for medical equipment, Preventive and periodical maintenance procedures.

Total 45 Hours

References

1. Joan Gratto Liebler, Charles R. McConnell, "Management Principles for Health Professionals", 2011, 6th Edition, Jones and Bartlett Learning, Massachusetts.
2. Sharon Bell Buchbinder, Nancy H. Shanks, "Introduction to Health Care Management", 2011, 1 st Edition, Jones and Bartlett Learning, Massachusetts.
3. Walshe, Kieran, Smith, Judith, "Healthcare Management", 2011, 1st Edition, McGraw Hill, New York.

22BM047 EMBEDDED C PROGRAMMING 3 0 0 3

Course Objectives

- To expose the students to the fundamentals of C Programming
- To familiarize the students with data structures concepts
- To introduce the students basic Linux concepts
- To involve the students to familiarize with SHELL programming
- To implement the device drivers in LINUX environment

Program Outcomes (POs)

PO1 Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems

PO2 Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences

PO3 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.

PO4 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.

PO5 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.

PSO1. Apply knowledge on foundation in Life Science, engineering, mathematics and current biomedical engineering practices with an ability to demonstrate advanced knowledge of a selected area within Biomedical Engineering.

PSO2. Critically analyse the current healthcare systems and develop innovative solutions effectively through problem specific design and development using modern hardware and software tools.

Course Outcomes (COs)

1. Outline the fundamentals of C and Data Structures
2. Assess the basics of LINUX and SHELL programming
3. Analyze the basic knowledge of Embedded Linux
4. Apply the concepts of Kernel Module Programming
5. Implement Device Drivers programs and hands on experience in using state-of-art hardware and software tools

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	3	2	-	-	-	-	-	-	-	-	-	1	1	-

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

UNIT I **9 Hours**

C LANGUAGE AND DATA STRUCTURES OF KERNEL PROGRAMMING

Basic Concepts of C, Embedded C Vs C, Embedded Programming aspects with respect to firmware and OS Functions, Arrays, Pointers, Structures and Inputs/Outputs. Linked List, Singly Linked List, Doubly Linked List, Queues.

UNIT II **9 Hours**

LINUX AND SHELL PROGRAMMING

Command prompt, X windows basics, navigating file system, Finding Files, working with folders, Reading files, Text editing in Linux, Compression and archiving tools, Basic shell commands, File Management, I/OHandling, File Locking.Processes, Prioritizing and killing processes, Scheduling Commands, Pipes and redirection, Regular expression, Pattern Matching, Scripting using for, while, if and other commands.

UNIT III **9 Hours**

EMBEDDED LINUX

Linux Basics, Booting process, Make files using SD card reader to transfer program. Introduction to Linux system calls, API"s, device drivers, compiling and installing a device driver.

UNIT IV **9 Hours**

KERNEL MODULE PROGRAMMING

Compiling kernel, configuring kernel and compilation, Kernel code, Browsers, Static linking, Dynamic linking of modules, User space, Kernel space concepts, writing simple modules, Writing, Make files for modules.

UNIT V **9 Hours**

DEVICE DRIVER CONCEPTS

Driver concepts, Block and character driver distinction, Low level drivers, OS drivers etc, writing character drivers, Device major, minor number.

Total: 45 Hours

Reference(s)

1. Neil Mathew, Richard stones, Beginning Linux Programming, 2012 reprint, Wrox-Wiley Publishing, USA.
2. Eric Foster Johnson, John C. Welch, Micah Anderson, Beginning shell scripting, 2012, reprint, Wrox-Wiley Publishing, USA
3. Derek Molloy, Exploring BeagleBone: Tools and Techniques for Building with Embedded Linux, 2015, 1st Edition, Wiley Publications, USA.

22OCE01 ENERGY CONSERVATION AND MANAGEMENT

3 0 0 3

Course Objectives

- To develop an understanding and analyze the energy data of industries
- To carryout energy accounting and balancing
- To conduct energy audit and suggest methodologies for energy savings and
- To utilize the available resources in optimal ways

Program Outcomes (POs)

PO1. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. 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.
PO3. 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.
PO11. Project Management and Finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO12. 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. Differentiate and attribute the various energy utilization techniques.
2. Apply suitable technique to provide an energy efficient system.
3. Outline the need for thermal systems with latest technologies.
4. Implement suitable techniques for conserving energy with respect to emerging trends.
5. Assess the impact of economics on the conservation of energy.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	1	-	-	-	-	-	-	-	-	-	1	3	-	-	-
2	1	3	-	-	-	-	-	-	-	-	1	3	-	-	-
3	1	3	-	-	-	-	-	-	-	-	2	3	-	-	-
4	1	3	2	-	-	-	-	-	-	-	3	3	-	-	-
5	1	2	2	-	-	-	-	-	-	-	1	3	-	-	-

UNIT I **9 Hours**

INTRODUCTION

Energy - Power – Past & Present scenario of World; National Energy consumption Data – Environmental aspects associated with energy utilization – Energy Auditing: Need, Types, Methodology and Barriers. Role of Energy Managers. Instruments for energy auditing.

UNIT II **9 Hours**

ELECTRICAL SYSTEMS

Components of EB billing – HT and LT supply, Transformers, Cable Sizing, Concept of Capacitors, Power Factor Improvement, Harmonics, Electric Motors - Motor Efficiency Computation, Energy Efficient Motors, Illumination – Lux, Lumens, Types of lighting, Efficacy, LED Lighting and scope of Encon in Illumination.

UNIT III **9 Hours**

THERMAL SYSTEMS

Stoichiometry, Boilers, Furnaces and Thermic Fluid Heaters – Efficiency computation and Encon measures. Steam: Distribution &U sage: Steam Traps, Condensate Recovery, Flash Steam Utilization, Insulators & Refractories

UNIT IV **9 Hours**

ENERGY CONSERVATION IN MAJOR UTILITIES

Pumps, Fans, Blowers, Compressed Air Systems, Refrigeration and Air Conditioning Systems – Cooling Towers – D.G. sets

UNIT V **9 Hours**

ECONIMICS

Energy Economics – Discount Rate, Payback Period, Internal Rate of Return, Net Present Value, Life Cycle Costing –ESCO concept .

Total: 45 Hours

Reference(s)

1. Energy Manager Training Manual (4 Volumes) available at www.energymanager training.com,a website administered by Bureau of Energy Efficiency (BEE), a statutory body under Ministry of Power, Government of India, 2004.
2. Witte. L.C., P.S. Schmidt, D.R. Brown, "Industrial Energy Management and Utilisation" Hemisphere Publ, Washington, 1988.
3. Callaghn, P.W. "Design and Management for Energy Conservation", Pergamon Press, Oxford, 1981.
4. Dryden. I.G.C., "The Efficient Use of Energy" Butterworths, London, 1982
5. Turner. W.C., "Energy Management Hand book", Wiley, New York, 1982.
6. Murphy. W.R. and G. Mc KAY, "Energy Management", Butterworths, London 1987.

22OCS01 OBJECT ORIENTED PROGRAMMING

3 0 0 3

Course Objectives

- Understand the concepts of Object Oriented Programming
- Study the concepts of objects and classes.
- Familiarize in the types of constructors.

Program Outcomes (POs)

PO1. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. 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.
PO3. 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.
PO5. 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. Use the characteristics and data types of C++ language.
2. Construct programs using objects and classes for real-world applications.
3. Construct programs to implement operator overloading and inheritance techniques.
4. Implement Polymorphism and File streams concepts to develop C++ programs.
5. Design applications using templates and apply exception handling mechanisms.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	1	2	-	-	3	-	-	-	-	-	-	-	-	-	-
2	1	2	3	-	3	-	-	-	-	-	-	-	-	-	-
3	1	2	2	-	3	-	-	-	-	-	-	-	-	-	-
4	1	2	3	-	3	-	-	-	-	-	-	-	-	-	-
5	1	2	3	-	3	-	-	-	-	-	-	-	-	-	-

UNIT I **8 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.Function Prototyping-call by reference, return by reference- Inline function- Default arguments -Function overloading.(sona)

UNIT II **8 Hours**

OBJECTS AND CLASSES

Objects and Classes Simple Class - C++ Objects as Physical Objects - C++ Object as

Datatypes -CONSTRUCTORS:Parameterized Constructors –Multiple Constructors in a Class-Constructors with Default Arguments - Dynamic Initialization of Objects - Copy and Dynamic Constructors - Destructors(PSG)-Structures and Classes-Arrays and Strings

UNIT III **9 Hours**
OPERATOR OVERLOADING AND INHERITANCE
Operator Over loading 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
POLYMORPHISM AND FILE STREAMS **10 Hours**
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 **10 Hours**
TEMPLATES AND EXCEPTION HANDLING
Templates: Introduction – Function Templates – Overloading Function Templates -,user defined template arguments (sona) – Class Templates – Exception Handling-Syntax, multiple exceptions, exceptionswith arguments.

Total: 45 Hours

Reference(s)

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

22OCS02JAVA FUNDAMENTALS 3 0 0 3

Course Objectives

- Implement applications based on core Java Concepts with examples
- Construct application using inheritance, packages and exception handling for real time problems.
- Integrate the Java I/O concepts to handle input and output operations.
- Develop programs to perform string manipulation in java.
- Design GUI with Java for event handling and database applications.

Program Outcomes (POs)

PO1. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. 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.
PO3. 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.
PO5. 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 applications based on core Java concepts with examples.
2. Construct applications using inheritance, packages, and exception handling for real-time problems.
3. Implement the Java I/O concepts to handle input and output operations.
4. Construct programs to perform string manipulation in Java.
5. Design GUI with Java for event handling and database applications.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	3	2	-	2	-	-	-	-	-	-	-	-	-	-
2	2	3	2	-	2	-	-	-	-	-	-	-	-	-	-
3	3	3	3	-	3	-	-	-	-	-	-	-	-	-	-
4	2	2	2	-	2	-	-	-	-	-	-	-	-	-	-
5	2	2	2	-	2	-	-	-	-	-	-	-	-	-	-

UNIT I **9 Hours**
BASICS OF JAVA
The Genesis of Java - Overview of Java - Data Types, Variables, and Arrays - Operators – Control Statements - Introducing Classes - Methods and Classes.

UNIT II **9 Hours**
INHERITANCE, PACKAGES AND EXCEPTIONS
Inheritance: Basics - Using Super - Creating a Multilevel Hierarchy - Method overriding - Using Abstract Classes - Packages and Interfaces: Packages - Access Protection - Importing

Packages- Interfaces Definitions and Implementations - Exception Handling: Types - Try and Catch - Throw.

UNIT III **9 Hours**
EXPLORING JAVA I/O
I/O Basics - Reading Console Input -Writing Console output - Native Methods - I/ O Classes and Interfaces - File - The Byte Streams - The Character Streams - Using Stream I/ O - Serialization.

UNIT IV **9 Hours**
JAVA STRINGS
String Handling: Special String operations and Methods - String Buffer - Exploring java.lang: Simple type Wrappers - System - Math - Collections Framework: Collections Interfaces and Classes – Utility Classes: String Tokenizer - Date and Time.

UNIT V **9 Hours**
GUI WITH JAVA
Applet Basics - Applet Architecture - Applet Display Methods - Parameter Passing - Event Handling Mechanisms - Event Classes - Event Listener - Working with Windows, Graphics, Colors and Fonts - AWT Controls - Layout Managers and Menus – JDBC

Total: 45 Hours

Reference(s)

1. Herbert Schildt, Java 2-Complete Reference, Tata Mc Graw Hill, 2015.
2. Deitel & Deitel, Java How to Program, Prentice Hall of India, 2010.
3. Gary Cornell and Cay S.Horstmann, Core Java Vol.1 and Vol.2, Sun Microsystems Press, 2008.

22OCS03 KNOWLEDGE DISCOVERY IN DATABASES

3 0 0 3

Course Objectives

- Introduce the basic concepts of data warehousing.
- Impart knowledge about the data mining functionalities.
- Assess the strengths and weaknesses of association mining and cluster analysis.

Program Outcomes (POs)

PO1. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. 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.

PO3. 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.

PO4. Conduct Investigations of Complex Problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

Course Outcomes (COs)

1. Analyze the concepts of Data Warehousing architecture and business analysis process.
2. Implement the process of Data Mining and preprocessing techniques for data cleansing.
3. Implement the association rules for mining the various kinds of data.
4. Differentiate Classification and Clustering algorithms for various problems with high-dimensional data.
5. Apply the various data mining techniques on complex data objects.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2	2	3	2	-	-	-	-	-	-	-	-	-	-	-	-
3	2	2	2	-	-	-	-	-	-	-	-	-	-	-	-
4	3	2	2	2	-	-	-	-	-	-	-	-	-	-	-
5	2	2	2	2	-	-	-	-	-	-	-	-	-	-	-

UNIT I **9 Hours**

DATA WAREHOUSING AND BUSINESS ANALYSIS

Dataware housing Components- Building a Data warehouse –Data Warehouse and DBMS-Metadata-Multi dimensional data model- Data Extraction, Cleanup and Transformation Tools-Reporting, Query tools and Applications-OLAP vs OLTP- OLAP operations- Data Warehouse Schemas:Stars, Snowflakes and Fact constellations.

UNIT II

INTRODUCTION TO DATA MINING **8 Hours**

Introduction-Stepsinknowledgediscoveryfromdatabasesprocess-ArchitectureofaTypicalData MiningSystems-DataMiningFunctionalities-ClassificationofDataMiningSystems-

Dataminingon differentkindsofdata-Differentkindsofpattern-TaskPrimitives-Integration of a Data Mining System with a Data Warehouse – Major issues in Data mining.

UNIT III **9 Hours**

ASSOCIATION RULE MINING

Market Basket Analysis – Frequent Item Set Mining methods : A priori algorithm-Generating Association Rules- A Pattern Growth Approach- Pattern mining in multilevel and multidimensional space- Mining Various Kinds Of Association Rules-Association Analysis to Correlation Analysis- Constraint Based Association Mining.

UNIT IV **9 Hours**

CLASSIFICATION AND CLUSTERING

Decision Tree Induction – Bayesian Classification – Rule Based Classification-Classification by Back propagation – Support Vector Machines – Clustering :Types of data-Partitioning methods : k-means, k- medoid-Hierarchical Methods: distance based agglomerative and divisible clustering, BIRCH–Density Based Method: DBSCAN - Grid Based Method: STING.

UNIT V **10 Hours**

DATA MINING APPLICATIONS

Mining complex data objects-Text Mining-Graph mining-Web mining-Spatial Datamining-Application and trends in data mining –Social impacts of Data mining.

Total: 45 Hours

Reference(s)

1 JiaweiHan,MichelineKamberandJianPai,DataMining:ConceptsandTechniques,Morgan Kauffman, 3rd Edition, 2013.

2 AlexBersonandStephenJSmith,DataWarehousing,DataMining,andOLAP,TataMcgra w- Hill,1997.

3 David Hand, Heikki Manila, PadhraicSymth, PrinciplesofDataMining, MITPress, 2001.

4 MargaretH.Dunham, Data Mining:Introductoryand AdvancedTopics, Pearson Education2003.

22OCS04E-LEARNING TECHNIQUES **3 0 0 3**

Course Objectives

- Understand the technologies involved in e-learning.
- Gain the fundamentals of e-learning techniques
- Determine the characteristics of Teaching-Learning Process

Program Outcomes (POs)

PO1. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. 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.

PO3. 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 knowledge about the basic concepts of e-learning.
2. Execute the technology-mediated communication in e-learning.
3. Exemplify e-learning and content process management.
4. Analyze the teaching and learning processes in an e-learning environment.
5. Assess the various applications of e-learning.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	2	-	-	-	-	-	-	-	-	-	-	-	-	-
2	2	2	3	-	-	-	-	-	-	-	-	-	-	-	-
3	3	3	3	-	-	-	-	-	-	-	-	-	-	-	-
4	2	2	2	-	-	-	-	-	-	-	-	-	-	-	-
5	2	2	2	-	-	-	-	-	-	-	-	-	-	-	-

UNIT I **9 Hours**

INTRODUCTION

Evolution of Education - Generations of Distance Educational Technology - Role of E-Learning - Components of e-learning: CBT, WBT, Virtual Classroom - Barriers to e-Learning Roles and Responsibilities: Subject Matter Expert - Instructional Designer - Graphic Designer - Multimedia Author - Programmer - System Administrator - Web Master

UNIT II **9 Hours**

TECHNOLOGIES

Satellite Broadcasting - Interactive Television - Call Centers - Whiteboard Environment - Teleconferencing: Audio Conferencing - Video Conferencing -Computer Conferencing. Internet: E-mail, Instant Messaging, Chat, Discussion Forums, Bulletin Boards, Voice Mail, File Sharing, Streaming Audio and Video.

UNIT III **9 Hours**

MANAGEMENT

Content: E-Content, Dynamic Content, Trends - Technology: Authoring, Delivery, Collaboration - Services: Expert Service, Information Search Service, Knowledge Creation

Service - Learning Objects and E-Learning Standards. Process of E-Learning: Knowledge acquisition and creation, Sharing of knowledge, Utilization of knowledge - Knowledge Management in E-Learning.

UNIT IV **9 Hours**
TEACHING-LEARNING PROCESS
Interactions: Teacher-Student - Student-Student - Student-Content - Teacher- Content - Teacher-Teacher - Content-Content Role of Teachers in E-Learning - Blended Learning - Cooperative Learning - Collaborative Learning - Multi Channel learning -Virtual University – Virtual Library.

UNIT V **9 Hours**
APPLICATIONS
Customer service training - Sales training - Customer training - Safety training - IT training – Product training - Healthcare training.

Total: 45 Hours

Reference(s)

1. E-Learning: An Expression of the Knowledge Economy, Gaurav Chadha, S.M. Nafay Kumail, Tata McGraw-Hill Publication, 2002.
2. E-Learning: New Trends and Innovations, P.P. Singh, Sandhir Sharma, Deep & Deep Publications, 2005. 4. 4. Michael Allen's Guide to E-Learning, Michael W. Allen, Michael Allen, Wiley Publication, 2002
3. E-Learning: Concepts, Trends and Applications, Epignosis LLC, LLC publications, 2014.
4. Michael Allen's Guide to E-Learning, Michael W. Allen, Michael Allen, Wiley Publication, 2002.

3 0 0 3

22OCS05 SOCIAL TEXT AND MEDIA ANALYTICS

Course Objectives

- Understand the basic ideas of Text mining.
- Analyze the methods and approaches used in analytics.
- Gain knowledge on various types of analytics like web, social network, and social media

Program Outcomes (POs)

PO1. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. 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.
PO3. 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.
PO4. 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.
PO5. 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. Execute the concepts and applications of text mining.
2. Differentiate Content analysis and Sentiment analysis.
3. Assess web analytics with a suitable model.
4. Integrate social network analytics with a suitable example.
5. Analyze social media analytics with a suitable example.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	3	-	2	3	-	-	-	-	-	-	-	-	-	-
2	2	3	-	2	2	-	-	-	-	-	-	-	-	-	-
3	2	3	-	3	3	-	-	-	-	-	-	-	-	-	-
4	2	2	2	3	2	-	-	-	-	-	-	-	-	-	-
5	2	3	-	-	3	-	-	-	-	-	-	-	-	-	-

UNIT I **7 Hours**
TEXT MINING

Introduction, Core text mining operations, Preprocessing techniques, Categorization, Clustering, Information extraction, Probabilistic models for information extraction, Text mining applications.

UNIT II **9 Hours**
METHODS

Content Analysis-Natural Language Processing-Clustering & Topic Detection-Simple Predictive Modeling-Sentiment Analysis; Sentiment Prediction.

UNIT III **9 Hours**
WEB ANALYTICS
Web analytics tools-Clickstream analysis-A/B testing, online surveys-Web search and retrieval-Search engine optimization-Web crawling and Indexing-Ranking algorithms-Web traffic models.

UNIT IV **10 Hours**
SOCIAL NETWORK ANALYTICS
Social contexts: Affiliation and identity - Social network analysis - Social network and web data and methods. Graphs and Matrices - Basic measures for individuals and networks

UNIT V **10 Hours**
SOCIAL MEDIA ANALYTICS
Information visualization - Making connections: Link analysis - Random graphs and network evolution.

Total: 45 Hours

Reference(s)

1. Ronen Feldman and James Sanger, The Text Mining Handbook: Advanced Approaches in Analyzing Unstructured Data, Cambridge University Press, 2006.
2. Hansen, Derek, Ben Sheiderman, Marc Smith. Analyzing Social Media Networks with NodeXL: Insights from a Connected World, Morgan Kaufmann, 2011.
3. Avinash Kaushik. Web Analytics 2.0: The Art of Online Accountability, 2009.
4. Hanneman, Robert and Mark Riddle. Introduction to Social Network Method, 2005.
5. Wasserman, S. & Faust, K. Social network analysis: Methods and applications. New York: Cambridge University Press, 1994.
6. Monge, P. R. & Contractor, N. S. Theories of communication networks. New York: Oxford University, 2003

22OEC04 PRINCIPLES OF COMPUTER COMMUNICATION AND NETWORKS

3 0 0 3

Course Objectives

- To understand the concept of data communication and networking models.
- To study the various networking Components and Networks.
- To explore the routing, addressing and security and management aspects of computer networks.

Program Outcomes (POs)

PO1. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. 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.
PO3. 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.
PO4. 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. Classify the types of computer networks and analyze the seven layers of the OSI model.
2. Outline the basic operations of Routing Algorithms and Routing devices.
3. Assess the local and wide area networking technologies.
4. Implement the ISDN and ATM interface connections in broadband networks.
5. Design the security and management techniques related to networks.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	1	2	1	1	-	-	-	-	-	-	-	-	-	-	-
2	1	2	2	3	-	-	-	-	-	-	-	-	-	-	-
3	1	1	2	3	-	-	-	-	-	-	-	-	-	-	-
4	1	1	3	-	-	-	-	-	-	-	-	-	-	-	-
5	1	2	3	3	-	-	-	-	-	-	-	-	-	-	-

UNIT I **9 Hours**

NETWORK FUNDAMENTALS

Types of Computer Networks: by Area, by Topology; Communication Services: Serial and Parallel, Synchronous and Asynchrounous, Simplex and Duplex, Analog and Digital; Speed and Capacity; Multiplexing and Switching; Network Architecture: OSI Seven-Layer Network model.

UNIT II **9 Hours**

INTERNETWORKING AND COMPONENTS

Routing Concepts: Routing Algorithms, RIP, RIP-2, OSPF and other routing Protocols; Switches and Hubs: Store and Forward Switch, Cut-Through Switch, Hybrid Switch, Performance of Switches ; Repeaters; Repeater Vs Hubs; Bridges: Standards, Bridges Vs Repeaters; Routers and Gateways.

UNIT III **9 Hours**

LOCAL AND WIDE AREA NETWORKING TECHNOLOGIES

LAN Components and Topologies; Access Techniques; Transmission Protocols and Media; Ethernet and IEEE 802.3 Networks: History, 10-MBPS Ethernet, Switched Ethernet, 100-MBPS Ethernet, Gigabit Ethernet.

UNIT IV **9 Hours**

BROADBAND NETWORKS

ISDN: Evolution, ISDN Channel and Interface Structures; Broadband ISDN: Basics, Principles and General Architecture; Asynchronous Transfer Mode(ATM): Introduction, Concepts, Components, Connection Supported by ATM network and Concept of Virtual Channel and Virtual Path, Traffic control and Congestion Control, Operation and Maintenance aspects.

UNIT V **9 Hours**

NETWORK SECURITY AND MANAGEMENT

Security: Need of Security, Security Threats, Vulnerabilities, Methods, tools and Techniques for Attacks; Network Security: Levels of Security, Cryptosystems; Data Encryption Standard (DES), Public Key Cryptography, Firewalls; Network Management: Functions and Elements, Distribution of Management; Simple Network Management Protocol (SNMP), Remote Network Management Services.

Total: 45 Hours

Reference(s)

1. Michael A.Gallo, William M. Hancock, Computer Communications and Networking Technologies, 1 Ed, Thomson Learning, 2002.
2. Kenneth C. Mansfield, Jr.James L. Antonakos, An Introduction to Computer Networking, 1Ed, Prentice Hall of India, 2002
3. A Shanmugam, S Rajeev, Computer Communication Networks, 1Ed, ISTE Learning Materials Centre, 2001
4. Discrete-Time Signal Processing by Alan V. Oppenheim and Ronald W. Schafer, 3rd edition, 2010, Prentice Hall
5. Digital Signal Processing by Sanjit Mitra, 4th edition, 2011, McGraw-Hill, New York, NY

22OEI01 PROGRAMMABLE LOGIC CONTROLLER 3 0 0 3

Course Objectives

- To impart knowledge about automation and architecture of PLC
- To understand the PLC programming using timers, counters and advanced PLC functions
- To familiarize the student with PLC based applications

Program Outcomes (POs)

PO1. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. 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.
PO4. 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.
PO5. 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.
PO7. 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. Outline the fundamental Concepts of Automation
2. Conclude the architecture, interfacing and communication techniques of PLC
3. Implement the suitable PLC Programming languages
4. Attribute the various functions and instruction sets of PLC
5. Execute a suitable logical programming for given applications

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	1	-	2	2	-	3	-	-	-	-	-	-	-	-
2	2	1	-	2	2	-	3	-	-	-	-	-	-	-	-
3	2	1	-	2	2	-	3	-	-	-	-	-	-	-	-
4	2	1	-	2	2	-	3	-	-	-	-	-	-	-	-
5	2	1	-	2	2	-	3	-	-	-	-	-	-	-	-

UNIT I **10 Hours**

INTRODUCTION TO AUTOMATION

Evolution of automation -Types of automation - Fixed, flexible and programmable automation - Batch process and continuous process - open loop system and closed loop system - Function of sensors - Proximity sensors: Capacitive and Inductive - Infrared and Laser Push-buttons and toggle switches - Actuators: Solenoid valve - servo motor - electromagnetic relays.

UNIT II **9 Hours**

ARCHITECTURE OF PLC

Components of PLC - sink and source I/O cards - Processor - Memory: Types of memory, Input and Output modules: Discrete, Analog -Scan time of PLC -Interfacing computer and PLC: RS232, RS485, Ethernet - Selection criteria for PLC.

UNIT III **8 Hours**

PLC PROGRAMMING

Programming languages - Ladder logic components: User and bit Instructions, branch instructions, internal relay instruction Boolean logic using ladder logic programming, Latching -Timers: On Delay timer, OFF Delay timer and Retentive timer - Counters: Up Counter and Down Counter.

UNIT IV **10 Hours**

ADVANCED PLC FUNCTONS

Instructions in PLC: Program Control Instructions, Math Instructions, Data Manipulation Instructions: Data compare operations, Data transfer operations - Sequencer and Shift register instructions- Analog Instructions: PID Controller - Scaling Instructions.

UNIT V **8 Hours**

APPLICATIONS OF PLC

Case Studies: Bottle filling system - Pick and place robot - Car Parking - Traffic light control (4 ways with pedestrian signal) -Elevators - Pneumatic stamping system - alarm annunciator system.

Total: 45 Hours

Reference(s)

1. F.D. Petruzella, Programmable Logic Controllers, Tata Mc-Graw Hill, Third edition, 2015.
2. Benjamin C Kuo, Automatic Control Systems, Prentice Hall of India, New Delhi, 2014.
3. John Park, Steve Mackay, Edwin Wright, Practical data communications for instrumentation and control, Newnes, Elsevier, 2015.
4. K. L.S. Sharma, Overview of Industrial Process Automation, Elsevier, 2014.
5. John W Webb and Ronald A Resis, Programmable Logic Controller, Prentice Hall of India Pvt. Ltd., New Delhi, 2013.

22OME01 DIGITAL MANUFACTURING 3 0 0 3

Course Objectives

- To understand the process of generating 3D Computer Aided Design (CAD) model by different method.
- To explain the constructional features and develop simple program for CNC lathe and Milling machines.
- To provide an exhaustive knowledge on various generic process and benefits of Additive Manufacturing.
- To familiarize about materials and process parameters of liquid and solid based AM techniques.
- To educate powder based methodology and emerging trends with case studies, applications of AM techniques.

Program Outcomes (POs)

PO1. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. 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.
PO3. 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.
PO5. 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. Design a 3D model from the 2D data.
2. Develop a CNC program for simple components.
3. Generate stl file and manipulate parameters of AM machine
4. Implement appropriate liquid or solid materials based AM process to the respective application
5. Select appropriate process to fabricate a functional/prototype for aerospace, automotive, electronics, manufacturing and medical applications.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	2	2	-	2	-	-	-	-	-	-	-	-	-	-
2	2	2	2	-	2	-	-	-	-	-	-	-	-	-	-
3	2	2	2	-	2	-	-	-	-	-	-	-	-	-	-
4	2	2	2	-	2	-	-	-	-	-	-	-	-	-	-
5	2	2	2	-	2	-	-	-	-	-	-	-	-	-	-

UNIT I **9 Hours**

CAD MODELING

Introduction - Design process - Stages. CAD - Input and Output devices, Modeling methods - Wire frame modelling, Surface modelling, Solid modelling - Constructive Solid Geometry and Boundary Representation Techniques. CAD/CAM data exchange - IGES, STEP. Product Life cycle management (PLM).

UNIT II **10 Hours**

AUTOMATION AND CNC MACHINES

Introduction to Automation - Definition, types, reasons for automating. CNC Machines - Principles, types, features, advantages, applications. CNC Machine structure - Linear motion bearings, Recirculating ball bearings, drive system, and control system. CNC Lathe and Milling programming - Linear and circular interpolation, threading and drilling programs.

UNIT III **7 Hours**

ADDITIVE MANUFACTURING

Introduction - Impact of Additive Manufacturing (AM) and Tooling on Product Development - Distinction between AM and CNC Machining - The Generalized AM Process chain - CAD Model - Input file formats - Generation and Conversion of STL file - File Verification and Repair - Build File Creation - Part Construction - Part Cleaning and finishing - AM Benefits - Classification of AM process

UNIT IV **8 Hours**

LIQUID AND SOLID MATERIAL BASED SYSTEMS

Stereo lithography Apparatus (SLA), Digital Light Processing (DLP), Fused Deposition Modelling (FDM) and Laminated Object Manufacturing (LOM) - Working Principle, Construction, Process, Materials and Applications

UNIT V **11 Hours**

POWDER BASED PROCESSES AND APPLICATIONS OF ADDITIVE MANUFACTURING

Selective Laser Sintering (SLS), Color Jet Printing (CJP), Electron Beam Melting (EBM) and Laser Engineered Net Shaping (LENS) - Working Principle, Construction, Process Variables, Materials and Applications. Reverse Engineering using 3D scanner. Application of Additive Manufacturing in Medical field, Manufacturing, Automotive industries, Aerospace and Electronics and Retail industries.

Total: 45 Hours

Reference(s)

1. Ibrahim Zeid, R.Sivasubramania, CAD/CAM Theory and Practice, Tata McGraw Hill, 2010.
2. M. Aditan, B.S. Pabala, CNC Machines, New age International, 2012.
3. C. K. Chua, K. F. Leong and C. S. Lim, Rapid prototyping: Principles and applications, Cambridge University Press, 2010.
4. D. T.Pham, S. S.Dimov, Rapid manufacturing, Springer-Verlag, London, 2001.
5. I. Gibson, D. W. Rosen, and B. Stucker, Additive Manufacturing Technologies 3D Printing, Rapid Prototyping and Direct Digital Manufacturing, Springer, 2015 http://www.springer.com/978-1-4939-2112-6
6. www.grabcad.com, www.all3dp.com

22OME02 INDUSTRIAL PROCESS ENGINEERING 3 0 0 3

Course Objectives

- To impart the knowledge on production planning methodologies and layout design
- To learn about production planning and its control methods
- To provide the knowledge of work study, process charts and ergonomic condition
- To impart the knowledge on inventory control and material handling
- To learn about system analysis and different types of maintenance processes

Program Outcomes (POs)

PO1. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. 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.
PO3. 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.
PO5. 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 proper plant layout for the required production system
2. Use the resources required for the production and to perform the control methods
3. Implement work study method, prepare charts to outline the process and develop ergonomic condition suitable for the processes.
4. Compute the inventory required based on production needs and material handling
5. Perform system analysis and use different types of maintenance process for smooth operations.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	3	1	-	1	-	-	-	-	-	-	-	-	-	-
2	3	3	1	-	2	-	-	-	-	-	-	-	-	-	-
3	1	3	3	-	2	-	-	-	-	-	-	-	-	-	-
4	2	3	1	-	2	-	-	-	-	-	-	-	-	-	-
5	2	3	1	-	2	-	-	-	-	-	-	-	-	-	-

UNIT I **9 Hours**

INDUSTRIAL ENGINEERING AND PRODUCTION SYSTEM

Industrial engineering - Concept, History and development, Applications, Roles of Industrial engineer-Production management, Industrial engineering versus production management, operations management. Plant layout, Criteria for good layout, Types of layout - Process layout, Product layout, Combination layout and fixed position layout, Flow (material movement) pattern, Workstation Selection and design.

UNIT II **10 Hours**

PROCESS PLANNING AND PRODUCTION CONTROL

Introduction to Process planning-Definition, Procedure, Process selection, Machine capacity, Process sheet.Process analysis - Group technology, classification and coding system, formation of component family - Production planning, loading, scheduling. Production control -dispatching, routing - Progress control bar, curve, Gantt chart, route and schedule chart.

UNIT III **8 Hours**

WORK STUDY AND ERGONOMICS

Work study - Definition, Need, Advantages, objectives of method study and work measurement, method study procedure, Process chart - symbols, outline process chart, flow process chart, principles of motion economy, ergonomics- applications of ergonomic principles in the shop floor- work benches-seating arrangement, Industrial physiology.

UNIT IV **10 Hours**

INVENTORY MANAGEMENT

Inventory control, classification, management, objectives, functions. Economic order quantity, Economic batch quantity, inventory models,ABC analysis, Material Requirement Planning(MRPI), Manufacturing Resource Planning (MRPII), Operating cycle, lean manufacturing, Supply chain management - Material handling.

UNIT V **8 Hours**

SYSTEM ANALYSIS AND MAINTENANCE

System concept - system analysis, systems engineering, value engineering, value control, types of values. Plant maintenance - objectives, importance. Maintenance engineer - duties, functions and responsibilities. Types - breakdown, scheduled, preventive and predictive - Plant maintenance schedule, Condition monitoring.

Total: 45 Hours

Reference(s)

1. Khanna O.P., Industrial Engineering and management, Dhanpat Rai Publications.,2010
2. Martand T.Telsang, Industrial Engineering and Production Management, S Chand Publishers,2006
3. Panneerselvam R., Production and operations management, Heritage Publishers, 2006
4. Ravi Shankar, Industrial Engineering and Management, Golgotia Publications Pvt. Ltd., New Delhi, 2009

22OME03 MAINTENANCE ENGINEERING 3 0 0 3

Course Objectives

- To understand the principles, objectives and importance of maintenance adopted in industry for successful progress.
- To introduce different maintenance categories, its merits and types of lubrication.
- To expose the idea of condition monitoring, methods and instruments used for allied measurements.
- To learn about failure analysis and repair methods for few mechanical elements.
- To promote computerization in maintenance and inventory management.

Program Outcomes (POs)

PO1. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. 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.
PO3. 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.
PO5. 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.
PO6. 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.
PO7. 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. Outline the principles, objectives, and importance of maintenance adopted in the industry.
2. Select the suitable maintenance category and lubrication type.
3. Use appropriate methods and instruments for condition monitoring.
4. Integrate the failures of mechanical systems and select suitable repair methods.
5. Implement computers in maintenance and inventory management.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	2	-	-	-	-	-	-	-	-	-	-	-	-	-
2	2	2	-	-	-	-	-	-	-	-	-	-	-	-	-
3	-	-	-	-	2	2	1	-	-	-	-	-	-	-	-
4	1	2	1	-	2	2	2	-	-	-	-	-	-	-	-
5	2	2	2	-	1	1	1	-	-	-	-	-	-	-	-

UNIT I **9 Hours**

PRINCIPLES OF MAINTENANCE PLANNING

Basic principles of maintenance planning - Objectives and principles of planned maintenance activity - Importance and benefits of sound maintenance systems - Maintenance organization - Maintenance economics.

UNIT II **9 Hours**

MAINTENANCE CATEGORIES AND LUBRICATION

Maintenance categories - Comparative merits of each category - Preventive maintenance, Maintenance schedules, Repair cycle - Total Productive Maintenance - Principles and methods of lubrication.

UNIT III **9 Hours**

CONDITION MONITORING

Condition based maintenance - Cost comparison with and without Condition Monitoring - Methods and instruments for condition monitoring - Noise, vibration, wear and temperature measurement.

UNIT IV **9 Hours**

FAILURE ANALYSIS AND REPAIR METHODS

Failure analysis - Failures and their development - Role of Non Destructive Testing in failure analysis - Repair methods for bearings, cylinder block, fuel pump, shaft.

UNIT V **9 Hours**

COMPUTER AIDED MAINTENANCE MANAGEMENT

Approach towards Computerization in maintenance - computer-aided maintenance management system (CAMMS) - Advantages of CAMMS - spare parts and inventory centre performance reporting.

FURTHER READING

Retrofitting, objectives, classification of retrofitting, cost effectiveness through retrofitting (economical aspects), circumstances leading to retrofitting, features and selection for retrofitting.

Total: 45 Hours

Reference(s)

1. Srivastava S.K, Maintenance Engineering, S Chand and Company, 2010.
2. Mishra R.C, Pathak K, Maintenance Engineering and Management, Second edition, Prentice Hall India Learning Pvt. Ltd., 2012.
3. Keith Mobley R, Lindley R. Higgins and Darrin J. Wikoff, Maintenance Engineering Handbook, Seventh edition, McGraw-Hill Professional, 2008.
4. Davies A, Handbook of Condition Monitoring: Techniques and Methodology, Springer, 2012.
5. Otegui Jose Luis, Failure Analysis, Fundamentals and Applications in Mechanical Components, Nineteenth edition, Springer, 2014.

22OBT01 BIOFUELS 3 0 03

Course Objectives

- To understand and explore the scope of biofuels the most efficient renewable source of energy.
- To develop the expertise in the technology pertaining to their generation and employment inorder to surrogate the existing conventional fuels and hence strives towards sustainable development
- To give way to the bolster green technology and incline towards more eco-friendly options.

Program Outcomes (POs)

PO1. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO3. 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.
PO7. 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. Apply the bio resources that can be used for the production of bio fuels.
2. Utilize the physical and chemical properties of the biodiesel.
3. Outline the mechanisms of improvising the quality and performance of engines using biofuels
4. Design the bio-fuel conversion technologies and their environmental attributes
5. Assess the designing aspects of major unit processes/operations of an integrated bio-refinery

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	1	-	2	-	-	-	3	-	-	-	-	-	-	-	-
2	2	-	-	-	-	-	1	-	-	-	-	-	-	-	-
3	1	-	-	-	-	-	3	-	-	-	-	-	-	-	-
4	2	-	-	-	-	-	3	-	-	-	-	-	-	-	-
5	1	-	-	-	-	-	1	-	-	-	-	-	-	-	-

UNIT I **9 Hours**

CLASSIFICATION AND RESOURCES

Introduction, biofuel as a renewable energy, classification of biofuels - First, second, third and fourth generation biofuels, different plant sources as biofuel feed stocks, Biogases, physical and chemical characteristics of vegetable oils - iodine number, hydroxyl, acid values, rancidity, hydrogenolysis and hydrolysis, Food vs energy.

UNIT II **9 Hours**

BIODIESEL

Definition, basics and chemistry of biodiesel, vegetable oils in bio diesel production, Trans esterification: Chemical methods, enzymatic methods and types of catalysts, separation and purification, physical properties and characterization of biodiesel - Cloud point, pour point, cold filter plugging point, flash point, viscosity and cetane number.

UNIT III **9 Hours**

QUALITY BIODIESEL AND ENVIRONMENT

Producing Quality Biodiesel, quality control ,test methods, ASTM specifications. Oxidative and thermal stability, estimation of mono, di, triglycerides and free glycerol, engine performance test, blending of ethanol with biodiesel, blending of biodiesel with high speed diesel (HSD) and their combustion properties.

UNIT IV **9 Hours**

BIOETHANOL AND BIOGASES

Ethanol as a fuel, microbial and enzymatic production of ethanol from biomass - lignocellulose, sugarcane, sugar beet, corn, wheatstarch, purification-wet and dry milling processes, saccharification - chemical and enzymatic. Production of bio methane and bio hydrogen.

UNIT V **9 Hours**

BIOREFINERIES

Definition and types of bio-refineries, co-products of bio-refineries-oilcake and glycerol, purification of glycerol obtained in biodiesel plant; anaerobic and thermal gasification of biomass, economics of bio-refineries.

Total: 45 Hours

Reference(s)

1. Caye Drapcho, John Nghiem and Terry Walker, Biofuels Engineering process technology ,McGrawHill Professional,2008.
2. Mousdale, Biofuels,CRCPress,2008
3. Ahindra Nag,Biofuels Refining and Performance ,McGraw-HillProfessional,2007.
4. Lisbeth Olsson, Biofuels (Advances in Biochemical Engineering / Biotechnology), Springer, 2007

22OFD01 TRADITIONAL FOODS **3 0 0 3**

Course Objectives

- Understand the importance of traditional foods and food habits
- Know the traditional processing of snack, sweet and dairy food products
- Infer the wide diversity and common features of traditional Indian foods and meal patterns.

Program Outcomes (POs)

PO1. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. 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.
PO3. 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.
PO8. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

Course Outcomes (COs)

1. Justify the processing methods of traditional foods in terms of its health benefits
2. Assess the production methods of traditional sweets, snacks and dairy products
3. Differentiate Traditional fermented foods products based on its raw material
4. Implement a large scale production of tradition foods for its increased consumption
5. Compare the health aspects of traditional foods with modern foods

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-
3	2	1	1	-	-	-	-	-	-	-	-	-	-	-	-
4	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-
5	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-

UNIT I **9 Hours**

TRADITIONAL METHODS OF FOOD PROCESSING

Introduction - food culture -geographical features and food. Traditional methods of milling grains - rice, wheat and corn - equipment and processes as compared to modern methods. Equipment and processes for edible oil extraction- comparison of traditional and modern methods. Energy costs, efficiency, yield, shelf life and nutrient content comparisons. Traditional methods of food preservation - sun-drying, osmotic drying, brining, pickling and smoking.

UNIT II **9 Hours**

TRADITIONAL SWEETS, SNACKS AND DAIRY PRODUCTS

Production, formulation, preparation and processing of Indian traditional sweet and snack food products:-Rasgolla, Gulab jamun; formulation and preparation of namkeen, potato chips, banana chips. Acid coagulated and fermented dairy products- paneer, dahi, shrikhand, lassi - processing conditions, defects etc. Fat rich products- Butter, ghee and its processing.

UNIT III **9 Hours**

TRADITIONAL FERMENTED FOOD PRODUCTS

Idli, Soya sauce, fish pickle, dry fish, meat and vegetable fermented products. Various alcohol based products. Ways to increase nutritional quality of food such as enrichment, fortification, fermentation and mutual supplementation. Best cooking and processing methods to retain nutrients

UNIT IV **10 Hours**

COMMERCIAL PRODUCTION OF TRADITIONAL FOODS

Commercial production of traditional breads, snacks, ready-to-eat foods and instant mixes, frozen foods -types marketed, turnover; role of SHGs, SMES industries, national and multinational companies; commercial production and packaging of traditional beverages such as tender coconut water, neera, lassi, buttermilk, dahi. Commercial production of intermediate foods - ginger and garlic pastes, tamarind pastes, masalas (spice mixes), idli and dosa batters

UNIT V **8 Hours**

HEALTH ASPECTS OF TRADIONAL FOODS

Comparison of traditional foods with typical fast foods / junk foods - cost, food safety, nutrient composition, bioactive components; energy and environmental costs of traditional foods; traditional foods used for specific ailments /illnesses.

Total: 45 Hours

Reference(s)

1. Sen and Colleen Taylor, Food Culture in India, Greenwood Press, 2005.
2. Davidar, Ruth N. "Indian Food Science: A Health and Nutrition Guide to Traditional Recipes:" East West Books, 2001.
3. Steinkrus.K.H. Handbook of Indigenous Fermented Foods, CRC press, 1995.
4. Aneja. R.P, Mathur.BN, R.C. Chandan,and Banerjee.A.K. Technology of Indian Milk Products. Dairy India Year Book, 2009.

3 0 0 3

22OFD02 FOOD LAWS AND REGULATIONS

Course Objectives

- Introduce the concept of food hygiene, importance of safe food and laws governing it
- Learn common causes of food borne illness - viz. physical, chemical and biological and identification through food analysis
- Understand food inspection procedures employed in maintaining food quality

Program Outcomes (POs)

PO1. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. 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.

PO3. 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.

PO6. 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.

PO7. 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.

PO8. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

Course Outcomes (COs)

1. Outline the food safety strategies and nutritional quality of the food
2. Find the food regulatory mechanism and mandatory laws for food products
3. Determine the national and international regulatory agencies
4. Interpret and apply the voluntary regulatory standards
5. Assess the implementation of food safety for a food processing industry

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	1	2	1	-	-	-	-	-	-	-	-	-	-	-	-
2	-	1	-	-	-	1	2	1	-	-	-	-	-	-	-
3	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-
4	1	2	-	-	-	-	-	-	-	-	-	-	-	-	-
5	1	2	-	-	-	-	-	-	-	-	-	-	-	-	-

UNIT I **10 Hours**

INTRODUCTION

Introduction, concept of food safety and standards, food safety strategies. Food hazards and contaminations - biological (bacteria, viruses and parasites), chemical (toxic constituents / hazardous materials) pesticides residues / environmental pollution / chemicals) and physical hazards. Preventive food safety systems - monitoring of safety, wholesomeness and nutritional quality of food. Prevention and control of physical, chemical and microbiological hazards. Principles of food safety - Establishment: design and facilities - emergency preparedness - Maintenance cleaning and sanitation - personal hygiene - packaging and labelling - transportation - traceability - recall procedure - visitor policy. Adulteration: Intentional and unintentional - Preservatives - antioxidants, sweeteners, flavours, colours, vitamins, stabilizers - indirect additives - organic resides - inorganic residues and contaminants.

UNIT II **10 Hours**

FOOD LAWS

Indian and Food Regulatory Regime (Existing and new), PFA Act and Rules, Food Safety and Quality Requirements, Additives, Contaminants and Pesticide Residue. Food Safety and Standards Act, 2006, FSSAI roles and responsibilities, Essential Commodities Act, 1955, Global Scenario, Codex Alimentarius, WHO/FAO Expert Bodies (JECFA/ JEMRA/JMPR) WHO/FAO Expert Bodies (JECFA/ JEMRA/JMPR). Food safety inspection services (FSIS) and their utilization.

UNIT III **10 Hours**

REGULATIONS

Introduction to OIE & IPPC, Other International Food Standards (e.g. European Commission, USFDA etc). WTO: Introduction to WTO Agreements: SPS and TBT Agreement, Export & Import Laws and Regulations, Export (Quality Control and Inspection) Act, 1963. Role of Agricultural and Processed Food Products Export Development Authority (APEDA), Customs Act and Import Control Regulations, Other Voluntary and mandatory product specific regulations, Other Voluntary National Food Standards: BIS Other product specific standards; AGMARK. Nutritional Labelling, Health claims.

UNIT IV **10 Hours**

STANDARDS

Voluntary Quality Standards and Certification GMP, GHP, HACCP, GAP, Good Animal Husbandry Practices, Good Aquaculture Practices ISO 9000, ISO 22000, ISO 14000, ISO 17025, PAS 22000, FSSC 22000, BRC, BRCIOP, IFS, SQF 1000, SQF 2000. Role of NABL, CFLS.

UNIT V **5 Hours**

IMPLEMENTATION AND RISK ASSESSMENT

Implementation of food safety for a desired food processing industry. Risk assessment studies: Risk management, risk characterization and communication.

Total: 45 Hours

Reference(s)

1. Singal RS (1997). Handbook of indices of food quality and authenticity. Woodhead Publ. Cambridge, UK.
2. Shapton DA (1994). Principles and practices of safe processing of foods. Butterworth Publication, London. Winton AL (1999) Techniques of food analysis, Allied Science Publications New Delhi.
3. Pomeranze Y (2004). Food analysis - Theory and Practice CBS Publications, New Delhi.
4. Jacob MB (1999). The chemical analysis of foods and food products. CBS Publ. New Delhi

22OFD03 POST HARVEST TECHNOLOGY OF FRUITS AND VEGETABLES 3 0 0 3

Course Objectives

- To understand the importance and different methods of post harvest handling and storage of fruits and vegetables.
- To gain knowledge on different preservation methods of fruits and vegetables
- To familiarize with the value added products from fruits and vegetables

Program Outcomes (POs)

PO1. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. 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.
PO3. 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.
PO4. 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.
PO7. 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. Implement the different post harvest handling practices for the storage of fruits and vegetables
2. Integrate the suitable preservation method (sugar, salt or dehydration) to produce value added products from fruits and vegetables
3. Interpret the requirement of low temperature and irradiation methods to preserve specific fruits and vegetables
4. Apply the concentration and fermentation methods to preserve fruits and vegetables
5. Implement the canning method to preserve fruits and vegetables

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	1	1	2	1	-	-	1	-	-	-	-	-	-	-	-
2	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-
3	1	2	-	-	-	-	-	-	-	-	-	-	-	-	-
4	1		1	-	-	-	-	-	-	-	-	-	-	-	-
5	2	1	1	-	-	-	-	-	-	-	-	-	-	-	-

UNIT I **9 Hours**

POST-HARVEST PRACTICES AND PROCESSING

Maturity indices for harvesting; pathological spoilage's during storage, ripening and control measures, Post-harvest handling, sorting & grading, packaging, storage, transportation, Methods of pre-cooling, post-harvest treatments to hasten and delay ripening; Methods of storage at farm level - cold storage, controlled/modified atmosphere storage, Quality management, export requirements, Nutritive value, nutraceutical properties

UNIT II **9 Hours**

PRESERVATION AND VALUE ADDITION

General principles and methods of fruit and vegetable preservation. Preservation using sugar: Principle and Preparation of jam, jelly, marmalade, squash, RTS, carbonated beverages, crush, nectar, cordial, fruit bar, preserves, candies and carbonated fruit beverages. Processing using salt: Principle - Brining - Preparation of pickles, chutney and sauces, ketchup.

UNIT III **9 Hours**

PRESERVATION BY LOW TEMPERATURE AND IRRADIATION

Preservation by low temperature: definition, principle, methods - Refrigeration, freezing. Methods of freezing- changes during freezing. Preparation of frozen foods. Minimal Processing of Fruits and Vegetables - techniques involved - Preservation by irradiation: definition- principle, application, irradiation unit.

UNIT IV **9 Hours**

PRESERVATION BY DRYING

Machineries involved in processing of fruits and vegetables products. Drying and dehydration: definition, principle, Types of driers: Solar, cabinet, spray drier, drum drier, fluidized bed drier. Preparation of product for dehydration. Dehydration principles and equipment. Preparation of fruits - powder production. Problems related to storage of dehydrated products.

UNIT V **9 Hours**

PRESERVATION BY CANNING

Canning: principles, Types of cans, packing of canned products-preparation of canned products - general considerations in establishing a commercial fruit and vegetable cannery, machineries involved in canning and bottling unit- spoilage of canned foods. Bottling of fruit and vegetable. Precautions in canning operations.

Total: 45 Hours

Reference(s)

1. S.Ranganna, HandBook of Analysis and Quality Control for Fruit and Vegetable Products, McGraw Hill Education (India) Private Limited, Chennai, 2017
2. N.W. Desrosier, the Technology of Food Preservation, CBS Publisher & Distributions, New Delhi, 1987.
3. R.P. Srivastava and S. Kumar, Fruit and Vegetable Preservation: Principles and Practices, Second Edition, International Book Distribution Co., Lucknow, 1998.
4. G. Lal, G. Siddappa and G.L. Tondon, Preservation of Fruits and Vegetables, Indian Council of Agricultural Research, New Delhi, 1986.
5. Chakraverty, A.S. Mujumdar, G.S.V. Raghavan and H.S. Ramaswamy, Handbook of Post-harvest Technology, Marcel Dekker Press, USA, 2001.
6. D.K. Salunkhe, and S.S. Kadam, Handbook of Fruit Science and Technology: Production, Composition and Processing, Marcel Dekker, New York, 1995.

22OFD04 CEREAL, PULSES AND OILSEED TECHNOLOGY

3 0 0 3

Course Objectives

- Understand the application of scientific principles in the processing technologies specific to the materials
- Understand the storage methods and handling techniques followed for cereals, pulses and oil seeds
- Develop the knowledge in the area of Cereals, pulses and oil seed processing and technology

Program Outcomes (POs)

PO1. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. 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.
PO4. 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.
PO6. 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. Implement the specific processing technologies employed for cereals
2. Analyze the composition of millets and their nutritional importance
3. Integrate the compositional changes and processing methods of pulses and legumes
4. Contrast the competence in processing of oilseeds technology
5. Assess the storage processing of food grains with quality aspects

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	2	-	2	-	2	-	-	-	-	-	-	-	-	-
2	1	2	-	2	-	1	-	-	-	-	-	-	-	-	-
3	2	2	-	1	-	2	-	-	-	-	-	-	-	-	-
4	2	3	-	2	-	2	-	-	-	-	-	-	-	-	-
5	2	2	-	2	-	3	-	-	-	-	-	-	-	-	-

UNIT I **9 Hours**

CEREALS

Cereal Grains- Basic agricultural aspects, structure and composition; Storage, Insect control; Processing: Wheat- milling, (Atta and maida), quality aspects of flour, wheat proteins and their function, rheology of flour; wheat based baked products - Bread, Biscuit, Cakes, Extruded products, Pizza, Chapatis, malting and malt products; Rice-Milling, Parboiling, Quick cooking rice, Traditional Indian Products- Puffed Rice, flaked rice, Idli/Dosa/vada mixes and other savouries; Corn- Wet and dry milling, Corn Products - Corn flakes, Corn starch, canned corn products, puffed product; Oats-Milling, Oat Products - Steel cut,rolled oats, quick cooking; Traditional and Fermented cereal products.

UNIT II **9 Hours**

OTHER CEREALS AND MILLETS

Sorghum, Pearl Millet, Finger millet, Foxtail Kodo Millet - Basic agricultural millet, aspects, structure and composition; storage, insect control; processing - pearling, Milling, Malting, Malt based foods, flaked and fermented products; Traditional and Nutritional products based on finger millet.

UNIT III **9 Hours**

PULSES AND LEGUMES

Basic agricultural aspects, structure, composition, storage, insect control, processing Milling/splitting, dhal milling, products - puffed, flakes, flour, legume-based traditional products, flour based Indian sweets and savouries, soya milk, soy protein Isolate, soya paneer

UNIT IV **9 Hours**

OIL SEEDS AND NUTS

Basic agricultural aspects structure, composition, Storage, Insect control; processing: traditional and modern methods of oil extraction, refining, bleaching, deodorizing, hydrogenation; oil blends; applications of different oils and fats in food processing & products.

UNIT V **9 Hours**

STORAGE AND HANDLING

Bag Storage - Advantages and Disadvantages, Cover Plinth Storage Structures, CAP storage (Cover and Plinth Storage). Protection against Rodents, Fungi, Pests and Mites. Fumigation Processes for bag storage piles. Bulk Storage in silos and large Bins. Conveyors and Elevators for feeding and discharging.

Total: 45 Hours

Reference(s)

1. Chakraverty, A.: Post Harvest Technology of Cereals, Pulses and Oilseeds. Oxford and IBH Publishing Co, Calcutta, 1995.
2. Delcour, Jan A. and R. Carl Hoseney., Principles of Cereal Science and Technology, 3rd Edition, American Association of Cereal Chemists, 2010.
3. Karl Kulp, Handbook of Cereal Science and Technology, 2nd Rev. Edition, CRC Press, 2000.
4. N.L.Kent and A.D.Evans, Technology of Cereals (4th Edition) Elsevier Science (Pergaman),Oxford, UK, 1994.
5. Matz, Samuel A., The Chemistry and Technology of Cereals as Food and Feed, 2nd Edition,CBS, 1996.
6. Morris, Peter C. and J.H. Bryce., Cereal Biotechnology, CRC/Wood head publishing, 2004.

22OFT01 FASHION CRAFTSMANSHIP 3 0 0 3

Course Objectives

- To impart theoretical and practical knowledge about various handicraft techniques
- To enhance innovative skills on hand crafts.
- To build confidence on doing handicrafts.

Program Outcomes (POs)

PO1. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. 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.

PO3. 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.

PO7. 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.

PO9. Individual and Team Work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10. 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.

PO12. 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. Outline the classification, techniques and criteria for selecting raw materials for making various handicraft materials and produce textile based handicrafts. Produce various decorative and appealing products
2. Design and construct various wall hangings and fashion accessories.
3. Design and construct toys and accessories
4. Interpret and develop head accessories, home furnishings and paintings
5. Outline and build various decorative and appealing products for interiors

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	1	3	-	-	-	2	-	2	2	-	2	-	-	-
2	3	2	3	-	-	-	1	-	2	3	-	2	-	-	-
3	3	2	3	-	-	-	2	-	2	3	-	2	-	-	-
4	3	2	3	-	-	-	2	-	2	3	-	2	-	-	-
5	3	2	3	-	-	-	2	-	2	3	-	2	-	-	-

UNIT I **9 Hours**

TECHNIQUES OF HANDICRAFT MATERIALS

Definition of Handicraft, Classification: Reusable, Non reusable, Raw materials used in various craft materials: printed, embroidered, stitched and handmade, Criteria for selection of raw materials: material types and end uses.

UNIT II **9 Hours**

DECORATIVE AND APPEALING PRODUCTS - INTERIORS

Designing and Construction procedures for following various decorative and appealing products: Wall hangings - String Art on plywood, Pressed Flower Art frames.

UNIT III **9 Hours**

DECORATIVE AND APPEALING PRODUCTS - ACCESSORIES

Designing and Construction procedures for following various decorative and appealing products: Handbags, Hats, footwear.

UNIT IV **9 Hours**

DECORATIVE AND APPEALING PRODUCTS - ORNAMENTS

Designing and Construction procedures for following various decorative and appealing products: Stone necklace using Macrame Technique, Tribal Jewellery using woollen threads, Floral Jewellery using Resin Technique, Fabric Jewellery using Tie and Dye Technique.

UNIT V **9 Hours**

DECORATIVE AND APPEALING PRODUCTS - FANCY ITEMS

Designing and Construction procedures for following various decorative and appealing products: Jewellery Box, Utility Holder, Gift items. Lampshade decors from cardboard, Driftwood Frames for pictures and Mirrors.

Total: 45 Hours

Reference(s)

1. Handmade in India: A Geographic Encyclopaedia of India Handicrafts. Abbeville press; 1 edition (October 20,2009)
2. Encyclopaedia of Card making Techniques (Crafts), Search Press Ltd, illustrated edition, 2007
3. All about Techniques in Illustration, Barron Educational Series, 2001
4. Printing by Hand: A Modern Guide to printing with Handmade stamps, Stencils and Silk Screens, STC Craft/A Melanie Falick Book, 2008
5. Materials & Techniques in the Decorative Arts: An Illustrated Dictionary, University of Chicago Press, 2000
6. https://www.marthastewart.com/274411/fashion-crafts

22OFT02 INTERIOR DESIGN IN FASHION 3 0 0 3

Course Objectives

- To impart knowledge on interior design.
- To improve the design skills, sustainable with socially-conscious designs

Program Outcomes (POs)

PO1. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. 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.
PO3. 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.
PO5. 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.
PO6. 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.
PO8. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

Course Outcomes (COs)

1. Interpret the elements of interior design concepts and resolve the personality requirements
2. Develop graphical representations of interior design concepts
3. Resolve the space planning requirements of residential home as per CPWD guidelines
4. Determine the aesthetic requirements of interior design components.
5. Appraise the roles and responsibilities of interior designer.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	2	3	-	-	-	-	-	-	-	-	-	-	-	-
2	3	2	3	-	2	3	-	2	-	-	-	-	-	-	-
3	3	3	3	-	2	2	-	2	-	-	-	-	-	-	-
4	3	3	3	-	2	3	-	2	-	-	-	-	-	-	-
5	3	2	-	-	2	-	-	3	-	-	-	-	-	-	-

UNIT I **9 Hours**

INTRODUCTION

Interior designing - definition, importance, requirements and types - Structural design, Decorative Design -Designing interiors, Good taste; Design themes, types and application. Personality of the Home - Art elements - Line: types, characteristics and importance; form: size and shape, characteristics; Colour - sources, qualities, emotional effects, colour wheel and schemes.

UNIT II **9 Hours**

GRAPHICAL PRESENTATIONS

3D composition; Isometric and Axonometric- Still life- Furniture Sketching- Object Drawing with color rendering - Interior elements, Lighting, plants. Perspective, Axonometric Isometric drawing. Orthographic Projection - Lifts and escalators.

UNIT III **9 Hours**

SPACE PLANNING

Space planning concepts- interiors, circulation. Definition, application of ergonomic principals in interiors. Residential house space planning case study- CPWD guidelines. Lighting for different locations and activities, measurement, ventilation and indoor air quality, noise control methods.

UNIT IV **9 Hours**

INTERIOR COMPONENTS

Application of colour in interiors; Texture - types and significance; Pattern: types and effects; Light - importance. Importance of Furniture Design for Interiors- Ancient Age / Middle Age / Contemporary. Doors, Windows, Staircase designs, False Ceiling, Partitions, Wall Panelling, Comics, Mosaic, Cladding- Flooring and Wall Cladding

UNIT V **9 Hours**

ROLES AND RESPONSIBILITIES OF INTERIOR DESIGNER

Role of an Interior Designer- Responsibility towards society and need of an Interior Designer to better the environment- Ethics and Code of Conduct- Responsibility towards client, contractor and supplier, Estimation. Professional Fees- Work of an Interior Designer- Making of portfolio, JD Annual Design Awards.

Total: 45 Hours

Reference(s)

1. Joanna Gaines, Homebody: A guide to creating spaces you never want to leave, Harper design, 2018.
2. Erin gates, Elements of Style: Designing a Home and a life, Simon and Schuster, 2014.
3. Simon Dodsworth, The Fundamentals of Interior Design, AVA publishing, 2009.
4. V. Mary. Knackstedt, The Interior Design Business Handbook: A Complete Guide to Profitability, Wiley, New Jersey; 2006.
5. M. G. Shah, C. M. Kale, and S.Y. Patki, Building Drawing with an Integrated Approach to Build Environment, Tata McGraw Hill, 2002.
6. Https://eclectictrends.com

22OFT03 SURFACE ORNAMENTATION 3 0 0 3

Course Objectives

- To familiarize the students about the various techniques of surface embellishment with relevance to garment embellishments.
- To aware of various types of embroidery and methods of producing it.
- To make the students confident about doing surface embellishment work

Program Outcomes (POs)

PO1. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. 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.
PO3. 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.
PO5. 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.
PO8. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO9. 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. Outline the raw material requirements for surface ornamentation and its application
2. Implement hand embroidery stitches on fabric and show the stitch development procedure in diagrammatic representations
3. Assess the machine and computerized embroidery stitches
4. Interpret the surface embellishment techniques and its application
5. Assess the quality maintenance parameters of all embroidered products and analyze the 6 traditional embroidery techniques

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	3	2	-	-	-	-	1	-	-	-	-	-	-	-
2	2	3	2	-	-	-	-	-	-	-	-	-	-	-	-
3	2	3	2	-	3	-	-	-	-	-	-	-	-	-	-
4	2	2	2	-	-	-	-	-	2	-	-	-	-	-	-
5	2	2	2	-	-	-	-	-	2	-	-	-	-	-	-

UNIT I **9 Hours**

INTRODUCTION TO SURFACE ORNAMENTATION

Introduction, Definition, Need, Types, Raw materials, Importance of surface ornamentation, Selection of needle, thread and fabric for hand embroidery and machine embroidery. various methods of surface embellishment- embroidery and surface ornamentation.

UNIT II **9 Hours**

HAND EMBROIDERY

General rules for hand embroidery. Types of hand embroidery stitches-Running, Couching, Button hole, Satin, Long & Short, Wheat, Chain, Stem, Herringbone, Cross stitch, Knotted stitches, Fish bone, Fly stitch, Braids, Back, Hem, Seed, Needle weaving, Whip stitches.

UNIT III **9 Hours**

MACHINE EMBROIDERY

General rules for machine embroidery. Types of frames and methods of transferring the designs. Attachments to sewing machines for embroidery, Types of machine embroidery stitches- Eyelet work, Cut work, patch work, Mirror work, Applique, Shaded embroidery, Shadow work, Bead and Sequins work, Vermicelli, Zigzag, Granite stitch. Computerized embroidery machine- Concept of design and development, software used in embroidery machines, process of designing, method and types of stitch application, punching and digitizing.

UNIT IV **9 Hours**

EMBELLISHMENT TECHNIQUES

Materials used and Applications. Types of embellishment techniques- fabric painting-hand, Stencil-dabbing and Spraying. Dyeing and printing-advanced tie and dye techniques, batik and block printing. Trimmings and decorations-Laces, Pompons, Fringes, Tassels, Tucks, Show buttons, Crocheting.

UNIT V **9 Hours**

TRADITIONAL EMBROIDERIES OF INDIA AND CARE

Care and maintenance of embroidered articles-care and maintenance methods for embroidered apparel, pressing. Traditional Embroideries of India-Phulkari, Kasuti, Kashmiri embroidery, Kutch work, Chikkankari, Kantha.

Total: 45 Hours

Reference(s)

1. Ruth Chandler, Modern Hand Stitching-Dozens of stitches with creative free-form variations,2014
2. Sophie Long, Mastering the Art of Embroidery: Traditional Techniques and Contemporary Applications for Hand and Machine Embroidery, Heritage Publishers, London, 2013
3. Christen Brown ,Embroidered & Embellished, C&T Publishing, 2013
4. Sheila Paine, Embroidered Textiles, Thames and Hudson Publisher, UK, 1990.
5. Gail Lawther, Inspirational Ideas for Embroidery on Clothes & Accessories, Search Press Ltd, UK, 1993.
6. http://www.needlenthread.com/tag/hand-embroidery-stitches

22OPH05 PHYSICS OF SOFT MATTER 3 0 0 3

Course Objectives

- To recognize the properties of soft matter and hard matter
- To understand the fundamental interactions of colloids and gels
- To explain the structure and phase behavior of liquid crystals and supramolecules
- To summarize the soft matter proprties of structures and components of life

Program Outcomes (POs)

PO1. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

Course Outcomes (COs)

1. Analyze the structural and mechanical differences between soft matter and hard matter
2. Exemplify the fundamental interactions and stability of colloids and gels
3. Analyze the optical and electro-optical properties of liquid crystals used in display technologies
4. Outline the aggregation and phase behavior of surfactants, polymers, copolymers and block copolymers
5. Analyze the soft matter behavior of nucleic acids, proteins, polysaccharides and membranes

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	1	-	-	-	-	-	-	-	-	-	-	-	-	-
2	2	1	-	-	-	-	-	-	-	-	-	-	-	-	-
3	2	2	-	-	-	-	-	-	-	-	-	-	-	-	-
4	2	2	-	-	-	-	-	-	-	-	-	-	-	-	-
5	2	2	-	-	-	-	-	-	-	-	-	-	-	-	-

UNIT I **9 Hours**

CONDENSED MATTER

Intermolecular forces-Condensation and freezing-mechanical response: Hookean solid-Newtonian liquid-viscoelasticity. Glasses: relaxation time-viscosity- glass forming liquids. Soft matter: length scales-fluctuations and Brownian motion

UNIT II **9 Hours**

COLLOIDAL DISPERSIONS & GELS

Forces between colloidal particles: vander Waals forces-electrostatic double layer forces-steric hindrance-depletion interactions. Stability and phase behaviour: Crystallisation-strong colloids-weak colloids.Physical and chemical gels-classical theory of gelation-elasticity of gels

UNIT III **9 Hours**

LIQUID CRYSTALS

Liquid crystal phases-distortions and topological defects-electrical and magnetic properties-polymer liquid crystals-Fredricks transition and liquid crystal displays

9 Hours

UNIT IV

SUPRAMOLECULAR SELF ASSEMBLY

Aggregation and phase separation-types of micelles- bilayers and vesicles. Phase behaviour of concentrated surfactant solutions-phase separation in polymers, copolymers and block copolymers

9 Hours

UNIT V

SOFT MATTER IN NATURE

Components and structures of life-Nucleic acids-proteins-interaction between proteins-polysaccharides-membranes

Total: 45 Hours

REFERENCES

1. Richard A L Jones, Soft Condensd Matter, Oxford University Press, UK, 2002
2. Masao Doi, Soft Matter Physics,Oxford University Press, UK, 2013.
3. Ian W. Hamley, Introduction to Soft Matter, John Wiley & Sons, 2007
4. A. Fernandez-Nieves, A M Puertas, Fluids, Colloids and Soft materials: An Introduction to Soft Matter Physics, John Wiley & Sons, 2016
5. Maurice Kleman, Oleg D. Lavrentovich, Soft Matter Physics: An Introduction, Springer-Verlag, New York, 2003.

22OCH01 CORROSION SCIENCE AND ENGINEERING **3 0 0 3**

Course Objectives

- Analyse the loss incurred due to corrosion in different sectors and terminologies related to corrosion
- Identify forms and types of corrosion with suitable mechanism
- Apply various methods of corrosion control, corrosion testing and monitoring

Program Outcomes (POs)

PO1. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. 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.
PO7. 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. Apply fundamental principles of corrosion science to calculate corrosion rates, analyze metal degradation and interpret Pourbaix diagrams to predict corrosion behavior in various industrial environments.
2. Compare different corrosion types on metals when exposed to air, water and at high temperatures (> 100 C)
3. Analyze the mechanism of corrosion on steel, iron, zinc and copper metal surfaces
4. Analyze the rate of corrosion on metals using electrochemical methods of testing
5. Analyze the correct materials, design and operation conditions to reduce the likelihood of corrosion in new equipment and constructions

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	1	-	-	-	-	-	-	-	-	-	-	-	-	-
2	2	-	-	-	-	-	1	-	-	-	-	-	-	-	-
3	1	3	-	-	-	-	-	-	-	-	-	-	-	-	-
4	2	2	-	-	-	-	-	-	-	-	-	-	-	-	-
5	3	3	-	-	-	-	1	-	-	-	-	-	-	-	-

UNIT I **9 Hours**

CORROSION

Importance of corrosion - spontaneity of corrosion - units of corrosion rate (mdd and mpy) - direct and indirect damage by corrosion - importance of corrosion prevention in industries - Pilling Bedworth ratio and its significance - passivation - area relationship in both active and passive states of metals - Pourbaix diagrams of Mg, Al and Fe and their advantages and disadvantages

UNIT II **7 Hours**

TYPES OF CORROSION

Eight forms of corrosion: uniform, galvanic, crevice corrosion, pitting, intergranular corrosion, selective leaching, erosion corrosion and stress corrosion-Catastrophic oxidation corrosion

UNIT III **9 Hours**

MECHANISM OF CORROSION

Hydrogen embrittlement - corrosion fatigue - filiform corrosion - fretting damage and microbes induced corrosion. Corrosion mechanism on steel, iron, zinc and copper metal surfaces

UNIT IV **10 Hours**

CORROSION RATE AND ITS ESTIMATION

Rate of corrosion: Factors affecting corrosion. Electrochemical methods of polarization: Tafel extrapolation polarization and linear polarization. Weight loss method - testing for intergranular susceptibility and stress corrosion. Non destructive testing methods: Visual testing - liquid penetrant testing - magnetic particle testing - Ultrasonic monitoring, and eddy current testing

UNIT V **10 Hours**

CORROSION CONTROL METHODS

Fundamentals of cathodic protection - types of cathodic protection(sacrificial anodic and impressed current cathodic protection). Stray current corrosion, problems and its prevention. Protective coatings: Metal coatings: Hot dipping (galvanizing, tinning and metal cladding) - natural inhibitors. Selection of suitable design for corrosion control

Total: 45 Hours

Reference(s)

1. Mouafak A. Zaher, Introduction to Corrosion Engineering, Create Space Independent Publishing Platform, 1st Edition, 2016.
2. E. McCafferty, Introduction to Corrosion Science, Springer, 1st Edition, January 2010.
3. R. Winstone Revie and Herbert H. Uhlig, Corrosion and Corrosion Control: An Introduction to Corrosion Science and Engineering, 4th Edition, John Wiley & Science, 2008.
4. Mars G. Fontana, Corrosion Engineering, Tata McGraw Hill, Singapore, 2nd Edition, 2008.
5. David E.J. Talbot and James D.R. Talbot, Corrosion Science and Technology, Second Edition (Materials Science & Technology), CRC Press, 2nd Edition, 2007.

22OCH02 POLYMER SCIENCE 3 0 0 3

Course Objectives

- Explain the properties of different polymers with its mechanism
- Select the appropriate polymerization techniques to synthesize the polymers
- Identify suitable polymers for various industrial applications

Program Outcomes (POs)

PO1. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. 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.
PO3. 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. Apply knowledge of polymerization mechanisms to predict the formation of different polymer products under various reaction conditions and catalysts
2. Apply suitable polymerization techniques to synthesize the high quality polymers
3. Apply the structural, thermal, and mechanical properties of polymers for different industrial applications
4. Apply the polymer processing methods to design polymer products
5. Analyze the polymers used in electronic and biomedical applications

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	1	-	-	-	-	-	-	-	-	-	-	-	-	-
2	1	2	-	-	-	-	-	-	-	-	-	-	-	-	-
3	2	2	-	-	-	-	-	-	-	-	-	-	-	-	-
4	1	1	2	-	-	-	-	-	-	-	-	-	-	-	-
5	1	3	2	-	-	-	-	-	-	-	-	-	-	-	-

UNIT I **10 Hours**

POLYMERS AND ELASTOMERS

Classification of polymers - Mechanism: Addition polymerization - free radical, cationic, anionic and co-ordination (Ziegler-Natta) polymerization - copolymerization - condensation polymerization (nylon-6,6) -ring opening polymerization (nylon-6). Elastomers: Natural rubber and synthetic rubber: styrene -butadiene rubber (SBR), butyl, neoprene, thiocol rubbers. High performance polymers: polyethers, polyether ether ketone (PEEK), polysulphones and polyimides

UNIT II **8 Hours**

POLYMERIZATION TECHNIQUES

Homogeneous and heterogeneous polymerization - bulk polymerization (PMMA, PVC) - solution polymerization - polyacrylic acid, suspension polymerization (ion-exchange resins) - emulsion polymerization (SBR) - advantages and disadvantages of bulk and emulsion polymerization. Melt solution and interfacial poly-condensation

UNIT III **8 Hours**

CHARACTERIZATION AND TESTING

Characterization of polymers by Infrared Spectroscopy (IR) and Nuclear Magnetic Spectroscopy (NMR) - Thermal properties: TGA and DSC - Testing tensile strength - Izod impact - Compressive strength - Rockwell hardness - Vicot softening point - water absorption

UNIT IV **9 Hours**

POLYMER PROCESSING

Moulding: Compression - injection - extrusion and blow mouldings. Film casting - calendering. Thermoforming and vacuum formed polystyrene - foamed polyurethanes. Fibre spinning: melt, dry and wet spinning. Fibre reinforced plastics fabrication: hand-layup - filament winding and pultrusion

UNIT V **10 Hours**

SPECIALITY POLYMERS

Preparation and properties of heat resistant and flame retardant polymers. Polymers for electronic applications: liquid crystalline, conducting and photosensitive polymers – E waste management. Polymer for biomedical applications: artificial organs, controlled drug delivery, Scaffolds in tissue Engineering –waste management.

Total: 45 Hours

Reference(s)

1. V. R. Gowarikar, N. V. Viswanathan and Jayadev Sreedhar, Polymer Science, New Age International (P) Ltd, New Delhi, 2021.
2. Joel R. Fried, Polymer Science and Technology, Prentice Hall of India (P). Ltd., 2014.
3. R. J. Young and P. A. Lovell, Introduction to Polymers, CRC Press, New York, 2011.
4. F. W. Billmeyer, Text Book of Polymer Science, John Wiley & Sons, New York, 2008.
5. Barbara H. Stuart, Polymer Analysis, John Wiley & Sons, New York, 2008.
6. George Odian, Principles of Polymerization, John Wiley & Sons, New York, 2004.

22OCH03 ENERGY STORING DEVICES 3 0 0 3

Course Objectives

- Compare the energy density of commercialized primary and secondary batteries.
- Classify the fuel cells and compare their efficiency in different environmental conditions.
- Demonstrate the various energy storage devices and fuel cells.

Program Outcomes (POs)

PO1. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. 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.
PO7. 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. Apply the parameters required for operation of a cell to evaluate the capacity of energy storage devices.
2. Compare the electrodes, electrolyte and cell reactions of different types of primary, secondary batteries and infer the selection criteria for commercial battery systems with respect to commercial applications.
3. Analyze fuel cells based on its construction, production of current and applications.
4. Analyze the methods of storing hydrogen fuel with its environmental applications.
5. Analyze the future prospects of renewable energy, hydrogen economy, and the efficiency of various generations of solar cells in energy production

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	1	-	-	-	-	-	-	-	-	-	-	-	-	-
2	2	3	-	-	-	-	1	-	-	-	-	-	-	-	-
3	3	1	-	-	-	-	-	-	-	-	-	-	-	-	-
4	2	2	-	-	-	-	1	-	-	-	-	-	-	-	-
5	3	3	-	-	-	-	1	-	-	-	-	-	-	-	-

UNIT I **6 Hours**

BASICS OF CELLS AND BATTERIES

Components - classification - operation of a cell - theoretical cell voltage - capacity - specific energy - energy density of lithium and lead acid battery - charge efficiency- charge rate - charge retention - closed circuit voltage - open circuit voltage current density - cycle life - discharge rate-over charge-over discharge

UNIT II **10 Hours**

BATTERIES FOR PORTABLE DEVICES AND ELECTRIC VEHICLES

Primary batteries: zinc-carbon - magnesium,and mercuric oxide - recycling/safe disposal of used cells. Secondary batteries: lead acid - nickel-cadmium - lithium ion batteries - rechargeable zinc alkaline battery. Reserve batteries: Zinc-silver oxide - lithium anode cell - photogalvanic cells. Battery specifications for cars and automobiles. Extraction of metals from battery materials.

UNIT III **10 Hours**

TYPES OF FUEL CELLS

Importance and classification of fuel cells: Description, working principle, components, applications and environmental aspects of the following types of fuel cells: alkaline fuel cells - phosphoric acid - solid oxide - molten carbonate and direct methanol fuel cells

UNIT IV **10 Hours**

HYDROGEN AS A FUEL

Sources and production of hydrogen: Electrolysis and photocatalytic water splitting. Methods of hydrogen storage: High pressurized gas - liquid hydrogen type - metal hydride. Hydrogen as engine fuel - features, application of hydrogen technologies in the future – limitations.

UNIT V **9 Hours**

ENERGY AND ENVIRONMENT

Future prospects of renewable energy and efficiency of renewable fuels - economy of hydrogen energy. Solar Cells: First, second, third and fourth generation solar cell - photobiochemical conversion cell.

Total: 45 Hours

Reference(s)

1. S.P. Jiang and Q. Li, Introduction to fuel cells, Springer, 2021.
2. M.M. Eboch, The Future of Energy: From solar cells to flying wind farms, Capstone publishers, 2020.
3. N. Eliaz and E. Gileadi, Physical electrochemistry, fundamentals, techniques and applications, Wiley, 2019.
4. J. Garche and K. Brandt, Electrochemical power sources: Fundamentals systems and applications, Elsevier, 2018.
5. A. Iulianelli and A. Basile, Advances in hydrogen production, storage and distribution, Elsevier, 2016.

22OMA01 GRAPH THEORY AND COMBINATORICS

3 0 0 3

Course Objectives

- This course comprehends the graphs as a modeling and analysis tool in computer science & Engineering
- It introduces the structures such as graphs & trees and techniques of counting and combinations, which are needed in number theory based computing and network security studies in Computer Science.

Program Outcomes (POs)

PO1. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. 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. Outline the basic ideas of Graph and its characteristics.
2. Assess the characteristics of trees and its properties.
3. Develop the coloring of graphs and its applications in the respective areas of engineering.
4. Compute the permutations and combinations in the engineering field.
5. Demonstrate the types of generating functions and their applications in engineering.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	1	2	-	-	-	-	-	-	-	-	-	-	-	-	-
2	1	3	-	-	-	-	-	-	-	-	-	-	-	-	-
3	2	3	-	-	-	-	-	-	-	-	-	-	-	-	-
4	2	3	-	-	-	-	-	-	-	-	-	-	-	-	-
5	3	3	-	-	-	-	-	-	-	-	-	-	-	-	-

UNIT I **9 Hours**

INTRODUCTION

Graphs - Introduction - Isomorphism - Sub graphs - Walks, Paths, Circuits - Connectedness - Components - Euler graphs - Hamiltonian paths and circuits - Trees - Properties of trees - Distance and centers in tree - Rooted and binary trees.

UNIT II **9 Hours**

TREES, CONNECTIVITY

Spanning trees - Fundamental circuits - Spanning trees in a weighted graph - cut sets - Properties of cut set - All cut sets - Fundamental circuits and cut sets - Connectivity and separability - Network flows - 1-Isomorphism - 2-Isomorphism - Combinational and geometric graphs - Planer graphs - Different representation of a planer graph.

UNIT III **9 Hours**

MATRICES, COLOURING AND DIRECTED GRAPH

Chromatic number - Chromatic partitioning - Chromatic polynomial - Matching - Covering - Four color problem - Directed graphs - Types of directed graphs - Digraphs and binary relations - Directed paths and connectedness - Euler graphs.

UNIT IV **9 Hours**

PERMUTATIONS

Fundamental principles of counting - Permutations and combinations - Binomial theorem - combinations with repetition - Combinatorial numbers - Principle of inclusion and exclusion - Derangements - Arrangements with forbidden positions.

UNIT V **9 Hours**

GENERATING FUNCTIONS

Generating functions - Partitions of integers - Exponential generating function - Summation operator - Recurrence relations - First order and second order - Non-homogeneous recurrence relations - Method of generating functions.

Total: 45 Hours

Reference(s)

1. Narsingh Deo, Graph Theory: With Application to Engineering and Computer Science, Prentice Hall of India, 2003
2. Grimaldi R.P., Discrete and Combinatorial Mathematics: An Applied Introduction, Addison Wesley, 1994.
3. Rosen K.H., Discrete Mathematics And Its Applications, McGraw Hil, 2007
4. Clark J. & Holton D.A., A First Look at Graph Theory, Allied Publishers, 1995.
5. Mott J.L., Kandel A. & Baker T.P., Discrete Mathematics for Computer Scientists and Mathematicians, Prentice Hall of India, 1996.
6. Liu C.L., Elements of Discrete Mathematics, McGraw Hill, 1985.

22OGE01 PRINCIPLES OF MANAGEMENT 3 0 0 3

Course Objectives

- To develop cognizance about importance of management principles.
- Extract the functions and responsibilities of managers.
- To Study and understand the various HR related activities.
- Learn the application of the theories in an organization.
- Analyze the position of self and company goals towards business.

Program Outcomes (POs)

PO9. Individual and Team Work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO11. Project Management and Finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

Course Outcomes (COs)

1. Implement the basic concepts of Management.
2. Implement the basic knowledge on planning process and its Tools & Techniques.
3. Outline the management concept of organizing and staffing.
4. Analyze the management concept of directing.
5. Outline the management concept of controlling.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	-	-	-	-	-	-	-	-	2	-	3	-	-	-	-
2	-	-	-	-	-	-	-	-	2	-	2	-	-	-	-
3	-	-	-	-	-	-	-	-	2	-	2	-	-	-	-
4	-	-	-	-	-	-	-	-	3	-	2	-	-	-	-
5	-	-	-	-	-	-	-	-	2	-	2	-	-	-	-

UNIT I **9 Hours**

INTRODUCTION TO MANAGEMENT AND ORGANIZATIONS

Definition of Management Science or Art Manager Vs Entrepreneur-types of managers - Managerial roles and skills Evolution of Management Scientific, Human Relations, System and Contingency approaches Types of Business organization - Sole proprietorship, partnership, Company - public and private sector enterprises - Organization culture and Environment Current Trends and issues in Management.

UNIT II **9 Hours**

PLANNING

Nature and purpose of planning - Planning process - Types of planning – Objectives - Setting objectives - Policies - Planning premises - Strategic Management - Planning Tools and Techniques - Decision making steps and process.

UNIT III **9 Hours**

ORGANISING

Nature and purpose – Formal and informal organization - Organization chart - Organization Structure Types - Line and staff authority - Departmentalization - Delegation of authority - Centralization and decentralization - Job Design - Human Resource - Management - HR Planning, Recruitment, Selection, Training and Development, Performance Management, Career planning and management

UNIT IV **9 Hours**

DIRECTING

Foundations of individual and group behaviour - Motivation-Motivation theories - Motivational techniques - Job satisfaction - Job enrichment - Leadership-types and theories of leadership - Communication-Process of communication - Barrier in communication Effective communication-Communication and IT.

UNIT V **9 Hours**

CONTROLLING

System and process of controlling - Budgetary and non-Budgetary control techniques - Use of Computers and IT in Management control - Productivity problems and management - Control and Performance-Direct and preventive control - Reporting.

Total: 45 Hours

Reference(s)

1. Robbins S, Management, (13th ed.), Pearson Education, New Delhi, 2017.
2. Stephen A. Robbins and David A. Decenzo and Mary Coulter, Fundamentals of Management, Pearson Education, 7th Edition, 2011.
3. Robert Kreitner and Mamata Mohapatra, Management, Biztantra, 2008.
4. L. M. Prasad, Principles and Practice of Management. 7th Edition, Sultan Chand & Sons, 2007.
5. P. C. Tripathi and P. N. Reddy, Principles of Management, Fourth Edition, Tata McGraw Hill, 2008.

22OGE02 ENTREPRENEURSHIP DEVELOPMENT I 3 0 0 3

Course Objectives

- Learn the basics and scope of the Entrepreneurship
- Understand the generation of ideas of the Entrepreneurship
- Evolve the legal aspects of the business
- Learn to analyze the various business finance
- Learn the basics of the Operations Management

Program Outcomes (POs)

PO6. 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.
PO7. 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.
PO9. 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. Assess the role of entrepreneurship in economic development.
2. Select the types of ideas that to be used for entrepreneurship development.
3. Find the legal aspects of business and its association.
4. Examine the sources of business and its analysis.
5. Implement the concepts of the different modes in operation management.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	-	-	-	-	-	1	2	-	2	-	-	-	-	-	-
2	-	-	-	-	-	1	2	-	2	-	-	-	-	-	-
3	-	-	-	-	-	1	2	-	2	-	-	-	-	-	-
4	-	-	-	-	-	1	2	-	2	-	-	-	-	-	-
5	-	-	-	-	-	1	2	-	2	-	-	-	-	-	-

UNIT I 9 Hours

BASICS OF ENTREPRENEURSHIP

Nature, scope and types of Entrepreneurship, Entrepreneur Personality Characteristics, Entrepreneurship process. Role of entrepreneurship in economic development

UNIT II 9 Hours

GENERATION OF IDEAS

Creativity and Innovation, Lateral Thinking, Generation of Alternatives, Fractional, Reversal Method, Brain Storming, Analogies

UNIT III **9 Hours**

LEGAL ASPECTS OF BUSINESS

Contract act-Indian contract act, Essential elements of valid contract, classification of contracts, sale of goods act- Formation of contract of sale, negotiable instruments- promissory note, bills and cheques, partnership, limited liability partnership (LLP), companies act-kinds, formation, memorandum of association, articles of association.

UNIT IV **9 Hours**

BUSINESS FINANCE

Project evaluation and investment criteria (cases), sources of finance, financial statements, break even analysis, cash flow analysis.

UNIT V **9 Hours**

OPERATIONS MANAGEMENT

Importance – functions - deciding on the production system - facility decisions: plant location, plant layout (cases), capacity requirement planning - inventory management (cases) - lean manufacturing, Six sigma.

Total: 45 Hours

Reference(s)

1. Hisrich, Entrepreneurship, Tata McGraw Hill, New Delhi: 2005
2. Prasanna Chandra, Projects Planning, Analysis, Selection, Implementation and Reviews, Tata McGraw-Hill Publishing Company Limited, New Delhi: 2000.
3. Akhileshwar Pathak, Legal Aspects of Business, Tata McGraw Hill: 2006

22OGE03 ENTREPRENEURSHIP DEVELOPMENT II 3 0 0 3

Course Objectives

- Evolve the marketing mix for promotion the product / services
- Handle the human resources and taxation
- Learn to analyze the taxation
- Understand the Government industrial policies and supports
- Preparation of a business plan

Program Outcomes (POs)

PO6. 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.

PO7. 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.

PO9. 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. Integrate the strategies and plans in marketing management.
2. Outline the cases involved in human resource management.
3. Differentiate the direct and indirect taxes in business.
4. Outline the supports given by government for improving the business.
5. Implement the various steps involved in preparing the business plan.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	-	-	-	-	-	1	2	-	2	-	-	-	-	-	-
2	-	-	-	-	-	1	2	-	2	-	-	-	-	-	-
3	-	-	-	-	-	1	2	-	2	-	-	-	-	-	-
4	-	-	-	-	-	1	2	-	2	-	-	-	-	-	-
5	-	-	-	-	-	1	2	-	2	-	-	-	-	-	-

UNIT I 9 Hours

MARKETING MANAGEMENT

Marketing environment, Segmentation, Targeting and positioning, Formulating marketing strategies, Marketing research, marketing plan, marketing mix (cases)

UNIT II 9 Hours

HUMAN RESOURCE MANAGEMENT

Human Resource Planning (Cases), Recruitment, Selection, Training and Development, HRIS, Factories Act 1948 (an over view)

UNIT III **9 Hours**

BUSINESS TAXATION

Direct taxation, Income tax, Corporate tax, MAT, Tax holidays, Wealth tax, Professional tax (Cases). Indirect taxation, Excise duty, Customs, Sales and Service tax, VAT, Octroi, GST (Cases

UNIT IV **9 Hours**

GOVERNMENT SUPPORT

Industrial policy of Central and State Government, National Institute - NIESBUD, IIE, EDI. State Level Institutions - TIIC, CED, MSME, Financial Institutions

UNIT V **9 Hours**

BUSINESS PLAN PREPARATION

Purpose of writing a business plan, Capital outlay, Technical feasibility, Production plan, HR plan, Market survey and Marketing plan, Financial plan and Viability, Government approvals, SWOT analysis.

Total: 45 Hours

Reference(s)

1. Hisrich, Entrepreneurship, Tata McGraw Hill, New Delhi: 2005
2. Philip Kotler., Marketing Management, Prentice Hall of India, New Delhi: 2003
3. Aswathappa K, Human Resource and Personnel Management - Text and Cases, Tata McGraw Hill: 2007.
4. Jain P C., Handbook for New Entrepreneurs, EDII, Oxford University Press, New Delhi: 2002.
5. Akhileshwar Pathak, Legal Aspects of Business, Tata McGraw Hill: 2006.
6. http://niesbud.nic.in/agencies.html

22OGE04 NATION BUILDING, LEADERSHIP AND SOCIAL RESPONSIBILITY **3 0 0 3**

Course Objectives

- To understand the importance of National Integration, Patriotism and Communal Harmony
- To outline the basic awareness about the significance of soft skills in professional and inter-personal communications and facilitate an all-round development of personality
- To analyze the different types of responsibility role of play for the improvement of society

Program Outcomes (POs)

PO1. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO3. 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.
PO7. 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.
PO12. 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. Assess religo-cultural diversity of the country and its impact on the lives of the people and their beliefs
2. Carry out a sense of responsibility, smartness in appearance and improve self confidence
3. Develop the sense of self-less social service for better social & community life
4. Assess the importance of Physical and Mental health and structure of communication organization and various mode of communication
5. Attribute the awareness about various types of weapon systems in the Armed Forces.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	-	1	-	-	-	1	-	-	-	-	3	-	-	-
2	2	-	2	-	-	-	2	-	-	-	-	2	-	-	-
3	2	-	1	-	-	-	1	-	-	-	-	2	-	-	-
4	2	-	3	-	-	-	3	-	-	-	-	3	-	-	-
5	2	-	1	-	-	-	1	-	-	-	-	2	-	-	-

UNIT I **9 Hours**

NATIONAL INTEGRATION

Importance & Necessity, Factors Affecting National Integration, Unity in Diversity. Threats to National Security. Water Conservation and Rain Harvesting, Waste Management and Energy Conservation. Leadership Capsule-Traits-Indicators-Motivation-Moral Values-Honor Code-Case Studies: Shivaji, Jhansiki Rani, Case Studies–APJ Abdul kalam, Deepa Malik, Maharana Pratap, N Narayan Murthy Ratan Tata Rabindra Nath Tagore, role of NCC cadets in 1965 war.

UNIT II **9 Hours**

PERSONALITY DEVELOPMENT AND LEADERSHIP

Intra & Interpersonal skills - Self-Awareness- &Analysis, Empathy, Critical & creative thinking, Decision making and problem solving, Communication skills, Group Discussion – copping with stress and emotions, changing mindset, Public Speaking, Time Management, Social skills, Career counseling, SSB procedure and Interview skills.

UNIT III **9 Hours**

SOCIAL SERVICE, COMMUNITY DEVELOPMENT AND ENVIRONMENTAL AWARENESS

Basics of social service and its need, Types of social service activities, Objectives of rural development programs and its importance, NGO's and their contribution in social welfare, contribution of youth and NCC in Social welfare. Protection of children & women safety, Road/ Rail Travel Safety, New initiatives, Cyber and mobile security awareness.

Disaster management Capsule-Organization-Types of Disasters-Essential Services-Assistance-Civil Defence Organization

UNIT IV **9 Hours**

HEALTH, HYGIENE AND COMMUNICATION

Sanitation, First Aid in Common Medical Emergencies. Health, Treatment and Care of Wounds. Yoga-Introduction, Definition, Purpose, Benefits. Asanas-Padamsana, Siddhasana, Gyan Mudra, Surya Namaskar, Shavasana, Vajrasana, Dhanurasana, Chakrasana, Sarvaangasana, Halasanaetc.

Obstacle Training Contact: Obstacle training - Intro, Safety measures, Benefits, Straight balance, Clear Jump, Gate Vault, ZigZagBalance, High Wall etc.

COMMUNICATION: Basic Radio Telephony (RT) Procedure-Introduction, Advantages, Disadvantages, Need for standard- Procedures-Types of Radio Telephony Communication-Radio telephony procedure, Documentation.

UNIT V **9 Hours**

ARMED FORCES AND NCC GENERAL

Introduction to Digital Signal Processors- Basic Classification-Features TMS320C6713 Architecture-Functional Unit-Pipelining- Addressing Modes -Instruction set Simple Assembly Language Program.

Total: 45 Hours

Reference(s)

1. Director General NCC Website: https://indiancc.nic.in/ncc-general-elective-subject-course-design/
2. Grooming Tomorrow's Leaders, published by DG, NCC. https://indiancc.nic.in/
3. Youth in Action, published by DG, NCC. https://indiancc.nic.in/
4. The Cadet, Annual Journal of the NCC. https://indiancc.nic.in/
5. Précis Issued by respective Service Headquarters on specialized subject available to PI Staff as reference material. https://indiancc.nic.in/

22OAI01 FUNDAMENTALS OF DATA SCIENCE 3 0 0 3

Course Objectives

- To learn the basics of data science and statistical inference.
- To understand the concept of data pre-processing.
- To visualize the processed data using visualization techniques

Program Outcomes (POs)

PO1. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering, fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. Problem Analysis: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3. 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.
PO4. 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.
PO5. Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

Course Outcomes (COs)

1. Outline the basics of data science and exploratory data analysis.
2. Represent the useful information using mathematical skills.
3. Demonstrate the usage of statistical inference and regression models.
4. Perform various data operations for cleaning and grouping of data.
5. Implement the visualization of data using visualization tools.

Articulation Matrix

CO No	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	P O9	PO 10	PO 11	PO 12	PS O1	PS O2	PSO 3
1	2	2	2	2	2	-	-	-	-	-	-	-	-	-	-
2	3	3	3	3	3	-	-	-	-	-	-	-	-	-	-
3	3	3	3	3	3	-	-	-	-	-	-	-	-	-	-
4	3	3	3	3	3	-	-	-	-	-	-	-	-	-	-
5	3	3	3	3	3	-	-	-	-	-	-	-	-	-	-

UNIT I **9 Hours**
INTRODUCTION
Need for data science – benefits and uses – facets of data – data science process – setting the research goal – retrieving data – cleaning, integrating, and transforming data – exploratory data analysis – build the models – presenting and building applications.

UNIT II **9 Hours**

DESCRIPTIVE STATISTICS I

Frequency distributions – Outliers – relative frequency distributions – cumulative frequency distributions – frequency distributions for nominal data – interpreting distributions – graphs – averages – mode – median – mean – averages for qualitative and ranked data – describing variability– range – variance – standard deviation – degrees of freedom – interquartile range.

UNIT III **9 Hours**

DESCRIPTIVE STATISTICS II

Normal distributions – z scores – normal curve problems – finding proportions – finding scores – more about z scores – correlation – correlation coefficient for quantitative data – computational formula for correlation coefficient – regression – regression line – least squares regression line – standard error of estimate – interpretation of r2.

UNIT IV **9 Hours**

PYTHON FOR DATA HANDLING

Basics of Numpy arrays – aggregations – computations on arrays – comparisons, masks, boolean logic – fancy indexing – structured arrays – Data manipulation with Pandas – data indexing and selection – operating on data – missing data – hierarchical indexing – combining datasets – aggregation and grouping.

UNIT V **9 Hours**

DATA VISUALIZATION

Types of data visualization: Exploratory, Explanatory, visualization with matplotlib – line plots – scatter plots – visualizing errors – density and contour plots – histograms, binnings, and density – threedimensional plotting– geographic data – data analysis using statmodels and seaborn – graph plotting using Plotly - Visualization Tools: Tableau

Total: 45 Hours

Reference(s)

1. David Cielen, Arno D. B. Meysman, and Mohamed Ali, “Introducing Data Science”, Manning Publications, 2016. (Unit I)
2. Robert S. Witte and John S. Witte, “Statistics”, Eleventh Edition, Wiley Publications, 2017. (Units II and III)
3. Jake VanderPlas, “Python Data Science Handbook”, O’Reilly, 2016. (Units IV and V)
4. Allen B. Downey, “Think Stats: Exploratory Data Analysis in Python”, Green TeaPress, 2014

22OIT01 DATA STRUCTURES 3 0 0 3

Course Objectives

- To understand the basic concepts such as Abstract Data Types, Linear and Non-Linear Data structures
- To analyze the performance of algorithms using time and space complexity.
- To understand the behavior of Linear and Non-Linear data structures
- To choose the appropriate data structures for a specified application
- To write programs in C++ to solve problems using various data structures.

Programme Outcomes (POs)

PO1 Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2 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.
PO3 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.
PO5 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.
PO7 Environment and Sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

Course Outcomes (COs)

1. Analyze the performances of the sorting and searching algorithms
2. Apply linked list linear data structures operations using dynamic memory allocation
3. Apply stack and Queue data structure operations to solve computational problems
4. Design tree data structures and hashing techniques for effective searching of data
5. Build algorithms for solving real world problems using Graph data structure

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	3	2	-	2	-	-	-	-	-	-	-	-	-	-
2	3	3	2	-	2	-	2	-	-	-	-	-	-	-	-
3	3	3	2	-	2	-	2	-	-	-	-	-	-	-	-
4	3	3	2	-	2	-	2	-	-	-	-	-	-	-	-
5	3	3	2	-	2	-	2	-	-	-	-	-	-	-	-

UNIT I **8 Hours**

INTRODUCTION

Introduction to data structures-types of data structures- Pseudo code - Abstract data types - ADT Implementations performance analysis- time complexity and space complexity- basics of OOPS concepts.

UNIT II **9 Hours**

SORTING AND SEARCHING TECHNIQUES

Searching methods: Linear and binary search methods, Sorting techniques: Insertion Sort - Selection Sort - Bubble Sort - Merge sort - Quick sort.

UNIT III **11 Hours**

LINEAR DATA STRUCTURES

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

UNIT IV **11 Hours**

TREE

Basic Tree concepts - Binary Trees - Tree Traversals - Binary Search Trees – B Tree - Heap concepts - Heap ADT

UNIT V **6 Hours**

GRAPHS

Introduction – types of graph- Shortest Path Algorithms: Unweighted Shortest Paths - Dijkstra's Algorithm. Minimum Spanning Tree: Prim's Algorithm - Kruskal's Algorithm- graph search methods DFS, BFS

Total: 45 Hours

Reference(s)

1. A Abirami, Priya R L , Advanced Data Structures and Algorithms , BPB publisher, 2023 March.
2. Data Structures using C++, Special Edition-MRCET, Tata McGraw-Hill Publishers 2017.
3. Data structures and Algorithms in C++, Michael T.Goodrich, R.Tamassia and Mount, Wiley student edition, John Wiley and Sons, 2011.
4. Data structures and Algorithm Analysis in C++, Mark Allen Weiss, Pearson Education. Ltd., Second Edition, 2013.
5. D.S. Malik, Data Structures Using C++, Second Edition 2010

22OIT02 C++ PROGRAMMING 2 0 2 3

Course Objectives

- To understand the concept of Object-Oriented Programming
- To apply the Object-Oriented concepts to solve problems using C++

Programme Outcomes (POs)

PO1 Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2 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.
PO3 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.
PO5 Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

Course Outcomes (COs)

1. Implement C++ programs using classes and objects.
2. Develop C++ programs using the concept of Inheritance.
3. Design applications using virtual functions.
4. Understand the concept of Operator overloading.
5. Develop GUI applications using C++ library classes

Articulation Matrix

CO No	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO 3
1	1	2	-	-	2	-	-	-	-	-	-	-	-	-	-
2	1	2	-	-	2	-	-	-	-	-	-	-	-	-	-
3	1	3	2	-	2	-	-	-	-	-	-	-	-	-	-
4	1	3	1	-	2	-	-	-	-	-	-	-	-	-	-
5	1	3	3	-	2	-	-	-	-	-	-	-	-	-	-

UNIT I **5 Hours**

BASICS OF C++ PROGRAMMING

C++ Program Structure, Character Set and Tokens, Data Type, Type Conversion, Preprocessor Directives, Namespace, Input/output Streams and Manipulators, Dynamic Memory Allocation with new and delete, Control Statements. Functions: Function Overloading, Inline Functions, Default Argument, Pass by Reference, Return by Reference, Scope and Storage Class. Pointers: Pointer variables declaration & initialization, Operators in pointers, Pointers and Arrays, Pointer and Function.

UNIT II **6 Hours**

CLASSES & OBJECTS

A Simple Class and Object, accessing members of class, Initialization of class objects: (Constructor, Destructor), Default Constructor, Parameterized Constructor, Copy Constructor, The Default Copy Constructor, Objects as Function Arguments, Returning Objects from Functions, Structures and Classes, Memory allocation for Objects, Static members, Member functions defined outside the class.

UNIT III **7 Hours**

OPERATOR OVERLOADING & INHERITANCE

Fundamental of operator overloading, Restriction on operator overloading, Operator functions as a class member, Overloading unary and binary operator, Introduction to inheritance, Derived Class and Base Class, Access Specifiers (private, protected, and public), Types of inheritance.

UNIT IV **6 Hours**

VIRTUAL FUNCTION & POLYMORPHISM

Concept of Virtual functions, Late Binding, Abstract class and pure virtual functions, Virtual Destructors, Virtual base class, Friend function and Static function, Assignment and copy initialization, Copy constructor, This pointer, Concrete classes, Polymorphism and its roles.

UNIT V **6 Hours**

FUNCTION TEMPLATES AND EXCEPTION HANDLING

Function templates, Function templates with multiple arguments, Class templates, templates and inheritance, Exceptional Handling (Try, throw and catch), Use of exceptional handling.

List of Laboratory Experiments

Experiment 1 **3 Hours**

Introduction to Object Oriented Programming- Classes and Objects.

Experiment 2 **5 Hours**

Programs using Constructor, Destructor

Experiment 3 **4 Hours**

Programs on operator overloading.

Experiment 4 **5 Hours**

Programs on Inheritance

Experiment 5 **3 Hours**

Programs on Virtual Function

Experiment 6 **3 Hours**

Programs on Friend Function

Experiment 7 **3 Hours**

Programs on exception handling

Experiment 8 **4 Hours**

Programs on Function and Class Templates

Total: 60 Hours

Reference(s)

1. Kumar Mukhopadhyaya, Value Engineering Mastermind - From Concepts to Certification, Response. Business Books from SAGE, Los Angeles / London / New Delhi / Singapore / Washington DC, 2014.
2. Anil Kumar Mukhopadhyaya, Value Engineering -Concepts, Techniques and Applications, Response Books, A Division of SAGE Publications, New Delhi / Thousand Oaks / London, 2003
3. R. D. Miles, Techniques of Value analysis & Engineering, McGraw Hill, 2000.
4. E. Midge Arthur, Value Engineering -A Systematic Approach, McGraw Hill Book Co., New York, 2000.
5. Zimmerman, Value Engineering - A Practical Approach, CBS Publishers & Distributors, New Delhi, 2000.

22OIT03 PROGRAMMING IN JAVA 2 0 2 3

Course Objectives

- To understand the concept of Object-Oriented Programming
- To develop console applications using Java.
- To develop GUI applications using Java library classes.

Programme Outcomes (POs)

PO1 Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2 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.
PO3 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.
PO5 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 Java programs using classes and objects.
2. Develop Java programs using the concept of Inheritance.
3. Design applications using functions, files and exceptions.
4. Develop console applications using Java OOPS.
5. Develop GUI applications using Java library classes

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	1	2	-	-	2	-	-	-	-	-	-	-	-	-	-
2	1	2	-	-	2	-	-	-	-	-	-	-	-	-	-
3	1	3	2	-	2	-	-	-	-	-	-	-	-	-	-
4	1	3	1	-	2	-	-	-	-	-	-	-	-	-	-
5	1	3	3	-	2	-	-	-	-	-	-	-	-	-	-

UNIT I **6 Hours**

INTRODUCTION TO OOP AND JAVA FUNDAMENTALS

Object Oriented Programming — Abstraction — objects and classes — Encapsulation- Inheritance — Polymorphism- OOP in Java — Characteristics of Java — The Java Environment — Java Source File - Structure — Compilation. Fundamental Programming Structures in Java — Defining classes in Java — constructors, methods -access specifiers — static members -Comments, Data Types, Variables, Operators, Control Flow, Arrays , Packages — JavaDoc comments.

UNIT II **6 Hours**

INHERITANCE AND INTERFACES

Inheritance — Super classes- sub classes –Protected members — constructors in sub classes- the Object class — abstract classes and methods- final methods and classes — Interfaces — defining an interface, implementing interface, differences between classes and interfaces and extending interfaces — Object cloning -inner classes, Array Lists — Strings.

UNIT III **6 Hours**

EXCEPTION HANDLING AND I/O

Exceptions — exception hierarchy — throwing and catching exceptions — built-in exceptions, creating own exceptions, Stack Trace Elements. Input / Output Basics — Streams — Byte streams and Character streams — Reading and Writing Console — Reading and Writing Files.

UNIT IV **6 Hours**

MULTITHREADING AND GENERIC PROGRAMMING

Differences between multi-threading and multitasking, thread life cycle, creating threads, synchronizing threads, Inter-thread communication, daemon threads, thread groups. Generic Programming — Generic classes — generic methods — Bounded Types — Restrictions and Limitations.

UNIT V

EVENT DRIVEN PROGRAMMING

Graphics programming — Frame — Components — working with 2D shapes — Using color, fonts, and images — Basics of event handling — event handlers — adapter classes — actions — mouse events — AWT event hierarchy — Introduction to Swing — layout management — Swing Components — Text Fields, Text Areas — Buttons- Check Boxes — Radio Buttons — Lists- choices- Scrollbars — Windows –Menus — Dialog Boxes.

List of Laboratory Experiments

Experiment 1 **4 Hours**

Introduction to Object Oriented Programming- Classes and Objects.

Experiment 2 **5 Hours**

Programs using inheritance and polymorphism

Experiment 3 **5 Hours**

Programs on operator overloading.

Experiment 4 **5 Hours**

Programs on exception handling

Experiment 5 **5 Hours**

Programs on multi-threading in java

Experiment 6 **6 Hours**

Programs on java swing

Total: 60 Hours

Reference(s)

1. Herbert Schildt, Java: The Complete Reference, Eleventh Edition, McGraw-Hill Education, 2018.

2. D.T. Editorial Services, Java 8 Programming Black Book, second edition, Dreamtech Press,2015.
3. Vaskaran Sarcar, Interactive Object-Oriented Programming in Java, Second edition, Apress, 2019

22OIT04 FUNDAMENTALS OF DATABASE MANAGEMENT SYSTEMS 2 0 2 3

Course Objectives

- Understand functional components of the Database Management System
- Understand need for concurrency and transaction property
- Compare and contrast various indexing strategies in different database systems

Programme Outcomes (POs)

PO1 Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2 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.
PO3 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.
PO5 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.
PO8 Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

Course Outcomes (COs)

1. Identify and analyze the essential concepts and key issues involved in the design of a relational database
2. Apply the concepts of normalization and ER model to guarantee an efficient database
3. Analyze the concurrent execution of transaction process and various recoveries from failures
4. Apply indexing and query optimization techniques for a database design
5. Analyze the various advanced database systems for efficient data storage & NOSQL concepts.

Articulation Matrix

CO No	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO1**	**PSO2**	**PSO 3**
1	3	-	2	-	2	-	-	3	-	-	-	-	-	-	-
2	2	3	3	-	2	-	-	-	-	-	-	-	-	-	-
3	3	-	2	-	3	-	-	-	-	-	-	-	-	-	-
4	3	-	3	-	3	-	-	-	-	-	-	-	-	-	-
5	3	2	3	-	-	-	-	-	-	-	-	-	-	-	-

UNIT I **6 Hours**
RELATIONAL DATABASES
Purpose of Database System - Views of data - Data Models - Database System Architecture - Introduction to relational databases - Relational Model - Keys - Relational Algebra - SQL fundamentals - Advanced SQL features.

UNIT II **6 Hours**
DATABASE DESIGN
Entity-Relationship model - E-R Diagrams - Enhanced-ER Model - ER-to-Relational Mapping - Functional Dependencies - First, Second, Third Normal Forms, - Boyce/Codd Normal Form- Multivalued Dependencies and Fourth Normal Form

UNIT III **6 Hours**
TRANSACTION
Transaction Concepts - ACID Properties - Schedules - Serializability - Concurrency Control -Need for Concurrency - Locking Protocols - Two-Phase Locking - Deadlock - Transaction Recovery - Save Points - Isolation Levels.

UNIT IV **6 Hours**
FILE AND QUERY PROCESSING
RAID - File Organization - Organization of Records in Files - Indexing and Hashing -Ordered Indices - Static Hashing - Dynamic Hashing - Query Processing Overview - Algorithms for SELECT and JOIN operations.

UNIT V
ADVANCED DATABASES
Distributed Databases: Architecture, Data Storage, Transaction Processing - Object-based Databases: Object Database Concepts, Object-Relational features, ODMG Object Model, ODL, OQL - Graph Database.

List of Laboratory Experiments

Experiment 1 **5 Hours**
Data Definition Commands, Data Manipulation Commands for inserting, deleting, updating and retrieving Tables with suitable examples

Experiment 2 **5 Hours**
Implementation of different types of operators in SQL

- Arithmetic Operators
- Logical Operators
- Comparison Operator
- Special Operator
- Set Operation

Experiment 3 **3 Hours**
Database Querying - Simple queries, Nested queries, Sub queries & Joins

Experiment 4 **3 Hours**
Implement

- Group By & having clause
- Order by clause
- Indexing

Experiment 5 **4 Hours**
Create a student database table currently stored as a single table. Normalize these structures to meet the 3NF requirements and draw ER model Diagram

Experiment 6 **5 Hours**
Implementation of Database Backup & Recovery commands, Rollback, Commit & Savepoint.

Experiment 7 **5 Hours**
Develop database for a BOOK PUBLISHING COMPANY.

Total: 60 Hours

Reference(s)

1. Abraham Silberschatz, Henry F. Korth, S. Sudharshan, Database System Concepts, Sixth Edition, Tata McGraw Hill, 2011.
2. Ramez Elmasri, Shamkant B. Navathe, Fundamentals of Database Systems, Sixth Edition, Pearson Education, 2011.
3. C.J.Date, A.Kannan, S.Swamynathan, An Introduction to Database Systems, Eighth Edition, Pearson Education, 2006.
4. Raghu Ramakrishnan, Database Management Systems, Fourth Edition, McGraw-Hill College Publications, 2015.
5. G.K.Gupta,Database Management Systems, Tata McGraw Hill, 2011.

Online Resource(s)
1. https://www.geeksforgeeks.org/introduction-of-dbms-database-management-system-set-1/
2. https://www.javatpoint.com/dbms-tutorial
3. https://onlinecourses.nptel.ac.in/noc22_cs91

22OAG01 RAINWATER HARVESTING TECHNIQUES 3 0 0 3

Course Objectives

- To enhance the awareness about water resources management and conservation.
- To acquire knowledge about water harvesting techniques and their implementation. To practice the design aspects of sustainable rainwater harvesting solutions for communities.

Programme Outcomes (POs)

PO1: Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2: Problem analysis: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3: 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.
PO7: 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 sources, availability and challenges in water resources management
2. Assess various water harvesting systems in practice
3. Execute design considerations for comparing surface runoff harvesting methods
4. Compare the characteristics and impacts of flood water harvesting techniques
5. Analyze various rainwater harvesting methods for groundwater recharging

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	1	-	-	-	-	-	3	-	-	-	-	-	-	-	-
2	2	1	-	-	-	-		-	-	-	-	-	-	-	-
3	1	1	3	-	-	-	2	-	-	-	-	-	-	-	-
4	1	2	3	-	-	-	2	-	-	-	-	-	-	-	-
5	1	1	3	-	-	-	2	-	-	-	-	-	-	-	-

UNIT I **8 Hours**
WATER RESOURCES AND CONSERVATION CHALLENGES

Global water distribution – primary and secondary sources of water – technical, social and cultural aspects; Global challenges in water and climate – water scarcity – water pollution – Indian scenario; Water resources management – public participation – integrated approach; Water governance – water sharing plans – policy, schemes and concerns.

UNIT II **10 Hours**

WATER RESOURCES AND CONSERVATION CHALLENGES

Principles of water harvesting for rural and urban – collection at micro and macro levels, flow control, storage and uses; Rainwater harvesting systems – traditional and contemporary – groundwater recharge; Water resources inventory – site analysis – database collection – water allocation principles based on demand and supply; Traditional water harvesting systems – practices in India – references in old texts – reasons for their deterioration – way forward; Watershed-based approach – project planning at micro and macro levels – community participation – rain centres.

UNIT III **9 Hours**

SURFACE RUNOFF HARVESTING

Short-term and micro-level harvesting techniques for runoff – terracing and bunding – rock and ground catchments; Long-term and macro-level harvesting techniques for runoff – farm ponds – percolation ponds and nala bunds; Design considerations – site selection – selection of runoff coefficients – computation of rainwater runoff volume – hydrograph analysis – cost estimation; Design of storage structures – storage capacity – selection of component – methods of construction

UNIT IV **9 Hours**

FLOOD WATER HARVESTING

Floods – causes of urban floods and droughts – characteristics of water spread – impacts; Flood water harvesting – permeable rock dams – water spreading bunds – flood control reservoir; Design considerations – computation of flood water quantity; Trenching and Diversion Structures – types – site selection – design criteria – most economic section – design consideration of ditch system

UNIT V **9 Hours**

GROUNDWATER HARVESTING

Rooftop rainwater harvesting – recharge pit – recharge trench – tube well – recharge well; artificial recharge – gully plug – dug well – percolation tank – nala bunds – recharge shaft; Groundwater harvesting – aquifer characteristics – subsurface techniques – infiltration wells – recharge wells – groundwater dams; Design of drainage system – types – design criteria – filter design – causes of failures

Total: 45 Hours

Reference(s)

1. Theib YO, Dieter P, Ahmed YH, Rainwater Harvesting for Agriculture in the Dry Areas, CRC Press, Taylor and Francis Group, London, 2012.
2. Lancaster, Brad. Rainwater Harvesting for Drylands and Beyond, Volume 1, 3rd edition, Rainsource Press. 2019.
3. Das M, Open Channel Flow, Prentice Hall of India Pvt. Ltd., New Delhi, 2008.
4. Michael AM, Ojha TP, Principles of Agricultural Engineering, Volume II, 4th Edition, Jain Brothers, New Delhi, 2003.
5. Suresh R, Soil and Water Conservation Engineering, Standard Publisher Distributors, New Delhi, 2014.

6. Singh G, Venkataramanan C, Sastry G, Joshi BP, Manual of Soil and Water Conservation Practices, CSWCR&TI, Dehradun, 1990

22OEE01 VALUE ENGINEERING 3 0 0 3

Course Objectives

- To understand the concept of value engineering in order to reduce cost of product or process or service.
- To implement creative and innovative techniques using FAST diagram.
- To study benefits of Value Engineering for various industries.

Programme Outcomes (POs)

PO10: 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. PO11: Project management and finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO12: Life-long learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Course Outcomes (COs)

1. Apply the concepts of value and value engineering to prepare a job plan.
2. Analyze the cost and worth of a product/service using the principles of economics.
3. Implement the value of a product/service to take managerial decisions.
4. Apply the soft skills in understanding team building, team work and report writing.
5. Asses the functions and values of product/services in industries using case studies.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	-	-	-	-	-	-	-	-	-	-	3	1	-	-	-
2	-	-	-	-	-	-	-	-	-	1	3	1	-	-	-
3	-	-	-	-	-	-	-	-	-	-	3	1	-	-	-
4	-	-	-	-	-	-	-	-	-	1	3	2	-	-	-
5	-	-	-	-	-	-	-	-	-	2	3	1	-	-	-

UNIT I **8 Hours**

INTRODUCTION TO VALUE ENGINEERING

Historical perspective of Value Engineering, Aims and objectives of Value Engineering, Concept of Value, Value Engineering concerned with Economic Value, Value Engineering Job plan.

UNIT II **9 Hours**

FUNCTIONAL ANALYSIS

Function-Cost-Worth analysis: Function Analysis System Technique (FAST); Review of principles of engineering economics

UNIT III **10 Hours**

EVALUATION OF VALUE ENGINEERING

Evaluation of function, Problem setting system, problem solving system, setting and solving management - decision - type and services problem, evaluation of value

UNIT IV **9 Hours**

HUMAN ASPECTS IN VALUE ENGINEERING

Team building; Life cycle costing; Managing Value Engineering Study; Value Engineering Report writing; Presentation Skill - Individual and Team Presentations; Implementation and follow-up.

UNIT V **9 Hours**

BENEFITS OF VALUE ENGINEERING

Classification of hazardous zones-intrinsically safe and explosion proof electrical apparatus-increase safe Value Engineering Case studies in the Industries like Manufacturing; Construction; Health Care; Process.

Total: 45 Hours

Reference(s)

1. Kumar Mukhopadhyaya, Value Engineering Mastermind - From Concepts to Certification, Response. Business Books from SAGE, Los Angeles / London / New Delhi / Singapore / Washington DC, 2014.
2. Anil Kumar Mukhopadhyaya, Value Engineering -Concepts, Techniques and Applications, Response Books, A Division of SAGE Publications, New Delhi / Thousand Oaks / London, 2003
3. R. D. Miles, Techniques of Value analysis & Engineering, McGraw Hill, 2000.
4. E. Midge Arthur, Value Engineering -A Systematic Approach, McGraw Hill Book Co., New York, 2000.
5. Zimmerman, Value Engineering - A Practical Approach, CBS Publishers & Distributors, New Delhi, 2000.

22OEE02 ELECTRICAL SAFETY 3 0 0 3

Course Objectives

- To provide knowledge on basics of electrical fire and statutory requirements for electrical safety
- To understand the causes of accidents due to electrical hazards
- To know the various protection systems in Industries from electrical hazards
- To know the importance of earthing
- To distinguish the various hazardous zones and applicable fire proof electrical devices

Programme Outcomes (POs)

PO1: Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2: Problem analysis: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO6: 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.
PO7: 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.
PO8: Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO9: 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 basic concepts in electrical circuit and hazards involved in it.
2. Analyze the electrical hazards in the workplace and its impacts.
3. Examine the operation of various protection systems from electrical hazards.
4. Analyze the various safety procedures involved in the industries.
5. Explore the different hazardous zones in Industries and their safety measures.

Articulation Matrix

CO No	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO12	PSO1	PSO2	PSO3
1	1	1	-	-	-	2	1	-	-	-	-	-	-	-	-
2	1	1	-	-	-	1	2	2	-	-	-	-	-	-	-

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

9 Hours

INTRODUCTION

Objectives of safety and security measures - Hazards associated with electric current and voltage - principles of electrical safety - working principles of major electrical equipment - Typical supply situation - Indian electricity act and rules - statutory requirements from electrical inspectorate- International standards on electrical safety.

UNIT II **9 Hours**

ELECTRICAL HAZARDS

Primary and secondary hazards-shocks, burns, scalds, falls-human safety in the use of electricity- Energy leakage-clearances and insulation-classes of insulation-voltage classifications-excess energy- current surges- over current and short circuit current-heating effects of current- Lightning, hazards, lightning arrestor, - national electrical safety code ANSI.

UNIT III **9 Hours**

ELECTRICAL SAFETY EQUIPMENT

Fuse, circuit breakers and overload relays - safe distance from lines - capacity and protection of conductor joints and connections, overload and short circuit protection - earth fault protection. FRLS insulation - insulation and continuity test - system grounding - equipment grounding - earth leakage circuit breaker (ELCB) - ground fault circuit interrupter - electrical guards - Personal protective equipment.

UNIT IV **9 Hours**

ELECTRICAL SAFETY OPERATION AND MAINTENANCE

Role of environment in selection - protection and interlock - discharge rod and earthing devices - safety in the use of portable tools - preventive maintenance - installation – earthing, specifications, earth resistance, earth pit maintenance - Fire Extinguishers - CO2 and Dry Powder schemes.

UNIT V **9 Hours**

HAZARDOUS AREAS

Classification of hazardous zones-intrinsically safe and explosion proof electrical apparatus-increase safe equipment-their selection for different zones-temperature classification-grouping of gases-use of barriers and isolators-equipment certifying agencies – electrical safety standards. (IS, API and OSHA standards)

Total: 45 Hours

Reference(s)

1. Fordham Coope W., “Electrical Safety Engineering, Butterworth and Company”, London, Third Edition, 2013.
2. “Indian Electricity Act and Rules”, Government of India.
3. “Power Engineers”, Handbook of TNEB, Chennai, 2010.
4. “Accident prevention manual for industrial operations”, N.S.C., Chicago, 1982.

5. John Cadick, P.E., Mary Capelli-Schellpfeffer, Dennis K. Neitzel, Al Winfield, “Electrical Safety Handbook”, Fourth Edition, Tata Mcgraw Hill, 2014.

22OCB01 INTERNATIONAL BUSINESS MANAGEMENT 3 0 0 3

Course Objectives

- To enable the students to understand the fundamentals of international business
- To provide competence to the students on making international business decisions
- To enable the students to understand the financial and promotional assistance available for exporters

Programme Outcomes (POs)

PO1. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO7. 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. Demonstrate the role and importance of digital marketing in today's rapidly changing business environment.
2. Integrate the techniques to help organizations to utilize social media for digital marketing.
3. Analyze the key elements and campaign effectiveness of E-Mail marketing and mobile marketing.
4. Assess the effectiveness of a digital marketing campaign using Google Analytics.
5. Apply advanced practical skills to plan, predict and manage digital marketing campaign

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	-	-	-	-	-	2	-	-	-	-	-	-	-	-
2	3	-	-	-	-	-	2	-	-	-	-	-	-	-	-
3	3	-	-	-	-	-	2	-	-	-	-	-	-	-	-
4	3	-	-	-	-	-	2	-	-	-	-	-	-	-	-
5	3	-	-	-	-	-	2	-	-	-	-	-	-	-	-

UNIT I **9 Hours**
INTRODUCTION
Definition, Drivers of International Business, Domestic Vs. International Business, Trade and Investment Theories: Interventionist Theories, Free Trade Theories, Theories Explaining Trade Patterns: PLC Theory, The Porter Diamond, Factor Mobility Theory.

UNIT II **9 Hours**
GLOBALIZATION
Globalization: Implications, Challenges - Protectionism: Tariff Barriers, Non-Tariff Barriers- Forms of Integration, Role of WTO and IMF in International Business, Economic, Political, Cultural and Technological Environments.

9 Hours

UNIT III

INTERNATIONAL BUSINESS STRATEGIES

Market Entry Strategies, Multinational Strategy, Production Strategy, Marketing Strategy, Human Resource Strategy.

UNIT IV **9 Hours**

FOREIGN EXCHANGE

Foreign Exchange Market – Functions, Theories of Exchange Rate Determination, Exchange Rate Forecasting, Convertibility of Currency, Risks associated with Foreign Exchange.

UNIT V **9 Hours**

EXPORTS AND ETHICS IN INTERNATIONAL BUSINESS

Exports – Risks, Management of Exports, Regulatory frameworks, Export financing, Countertrade, Ethics – Issues, Dilemma and Theory.

Suggested Self-Study Topics: Liberalization, GATT, Standardization Vs. Differentiation, FEMA, EXIM Policy Total

Total: 45 Hours

Reference(s)

1. John D Daniels, Lee H.Radebaugh, and Sullivan, "International Business", New Delhi: Pearson Education, 2018.
2. Charles W L Hill and Arun Kumar Jain, "International Business", New Delhi: Tata McGraw Hill, 2017.
3. Francis Cherunilam, "International Business", New Delhi: Prentice Hall of India, 2020.
4. Simon Collinson, Rajneesh Narula, Alan M. Rugman, "International Business", New Delhi: Pearson Education, 2020.
5. K.Aswathappa, "International Business", New Delhi: Tata McGraw Hill, 2020.

22BM0XA REAL TIME BIOSENSORS INTERFACING 1 0 0 1

Course Objectives

- To understand the concepts of embedded programming
- To identify the type of sensor for interfacing in real time data monitoring

Program Outcomes (POs)

PO1. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. 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.
PSO2. Critically analyse the current healthcare systems and develop innovative solutions effectively through problem specific design and development using modern hardware and software tools.
PSO3. Hands-on knowledge on cutting edge hardware and software tools to acquire real time data, model and simulate physiological processes and analyse limitations on real time implementations.

Course Outcomes (COs)

1. Assess the types of sensors used and its characteristics
2. Acquire the knowledge on sensor interfacing in real time data acquisition

Articulation Matrix

CO No	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2	PSO3
1	1	-	-	-	-	-	-	-	-	-	-	-	-	2	3
2	1	2	-	-	-	-	-	-	-	-	-	-	-	2	2

7 Hours

EMBEDDED PROGRAMMING IN SENSOR INTERFACE

Embedded IoT Programming, Open source hardware, Digital Sensor Interfacing applications (Pulse Sensor, Heart Rate, Blood Pressure), Analog sensor Interface (ECG,EMG), Actuator Interfacing

8 Hours

APPLICATION DEVELOPMENT

Application Development using Analog & Digital sensors, Data collection and visualization for real-time systems, Open source IoT cloud and end device, Real time data monitoring application development.

Total: 15 Hours

Reference(s)

1. Khandpur R.S, Handbook of Biomedical Instrumentation, Tata McGraw Hill, New Delhi, 3rd Edition,2014.
2. Leslie Cromwell, Fred J. Weibell, Erich A. Pfeiffer, Biomedical Instrumentation and Measurements, Pearson Education India; 2nd Edition,2015.
3. Joseph J. Carr and John M. Brown, Introduction to Biomedical equipment technology, Pearson Education, 4th Edition,2014.

INDUSTRY PERSON

Mr.P.Kannan

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22BM0XB	Embedded C For Biomedical Device Design	L	T	P	C
		1	0	0	1

Pre-requisite

Embedded Systems

Assessment Pattern

Mode: Continuous Internal Assessment (CIA) 100%

Assessments	Weightage (%)
Test	50
Quiz / Assignment	50
Total	100

Course Objectives

- To learn the programming of embedded systems using the C language, tailored for biomedical device applications
- To learn interfacing biomedical sensors with embedded systems, and implement efficient data processing algorithms.
- To design medical devices for a particular application

Programme Outcomes (POs

PO1 **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2 **Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences

PO3 **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.

PO4 **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.

PO5 **Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

PO6 **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.

PO7 **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.

PO8 **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO9 **Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10 **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.

PO11 **Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO12 **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.

PSO1 Apply knowledge on foundation in Life Science, engineering, mathematics and current biomedical engineering practices with an ability to demonstrate advanced knowledge of a selected area within Biomedical Engineering

PSO2 Critically analyze the current healthcare systems and develop innovative solutions effectively through problem specific design and development using modern hardware and software tools

PSO3 Hands-on knowledge on cutting edge hardware and software tools to acquire real time data, model and simulate physiological processes and analyze limitations on real time implementations

Course Outcomes (COs)

The students will be able to

1. Design and implement embedded C firmware for biomedical sensors and actuators.
2. Develop real-time data processing algorithms for biomedical devices using Embedded C.

Articulation Matrix

COs. No.	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	1	1	3	1	3	2	-	-	3	2	2	2	1	1	1
2	2	1	3	2	3	2	2	2	3	2	2	2	1	1	1

Introduction to STM32 Microcontroller - Basics of Embedded Systems and STM 32 Architecture. STM development Environment setup - GPIO and peripheral configuration - Communication Interface - Analog to Digital and Digital to Analog conversion - Configuration and usage of advanced peripherals (PWM, USART) - Project development for Biomedical device development

Total ***15*** **Hours**

References

1. Discovering the STM32 Microcontroller by by Geoffrey Brown Publisher : Indiana University
2. Getting Started With STM32 Nucleo Development by Agus Kurniawan Publisher : Agus Kurni - 2016

Resource person detail

Name Mr Sarathi T
Designation: Electronics Engineer – Consultant (PSG Medical devices)
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22BM0XC	**Medical Coding – Concepts and Practice**	**L**	**T**	**P**	**C**
		1	**0**	**0**	**1**

Pre-requisite	**Assessment Pattern**	
	Mode: Continuous Internal Assessment (CIA) 100%	
	Assessments	**Weightage (%)**
Human Anatomy and Physiology	Test	50
	Quiz / Assignment	50
	Total	100

Course Objectives

- To understand the concepts and requirements for Medical Coding
- To apply appropriate standards and coding concepts for medical procedures

Programme Outcomes (POs)

PO1 **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2 **Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences

PO4 **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.

PO6 **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.

PO8 **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO12 **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.

PSO1 Apply knowledge on foundation in Life Science, engineering, mathematics and current biomedical engineering practices with an ability to demonstrate advanced knowledge of a selected area within Biomedical Engineering.

PSO2 Critically analyze the current healthcare systems and develop innovative solutions effectively through problem specific design and development using modern hardware and software tools

PSO3 Hands-on knowledge on cutting edge hardware and software tools to acquire real time data, model and simulate physiological processes and analyze limitations on real time implementations

Course Outcomes (COs)

The students will be able to

1. Outline the basics concepts and need for medical coding
2. Implement concepts of medical coding in medical procedures

Articulation Matrix

COs No.	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	1	1	-	2	-	2	-	2	-	-	-	-	2	1	1
2	3	3	-	2	-	3	-	3	-	-	-	3	2	1	1

Overview of Medical coding, Roles and Responsibilities of a Medical Coder, Perquisites & basic code sets, Accreditations, certifications, Global Values & opportunities. Revenue Cycle Management, HIPPA -Patient Rights under HIPAA. Human Anatomy Structure, Medical Terminology -Medical Ethics.
Language Of Medicine (LOM), Common Disease Conditions & Disorders, Deletion & Revision Codes. HCPCS - code types & medical procedures- codes & Code Descriptors, cross walk code, Symbols and Conventions, Medical and Surgical Supplies (A2001-A8004). ICD -10 CM – code format – age, sex –symbols Conventions, codes & Code Descriptors.
Current Procedural Terminology (CPT) – categories, Modifiers –Parent code, Add-on codes, code set update Calendar- Prefixes, Suffixes .Roots, direction Positions, meaning of common medical terminology ,Procedural illustration codes, E/M services Guidelines -Levels of MDM (Medical decision making) E/M –Non-face to face – E/M New born services-surgical Chapter codes. Diagnostics screening process codes, Common abbreviations.

Total 15 Hours

References

1. Principles of CPT Coding, American Medical Association (AMA)
2. Mary Jo Bowie , "Understanding ICD-10-CM and ICD-10-PCS: A Worktext" Cengage Learning
3. Elaine N. Marieb and Katja Hoehn, “Human Anatomy & Physiology" Publisher: Pearson

Resource person detail

Name	Mr. Abdhul Basith
Designation	CEO
Industry details	Medingers Healthcare
Contact number	822033945

22BM0XD	Traceability and Uncertainty challenges in Medical device calibration	L	T	P	C
		1	0	0	1

Pre-requisite

Diagnostic and Therapeutic Equipment

Assessment Pattern

Mode: Continuous Internal Assessment (CIA) 100%

Assessments	**Weightage (%)**
Test	50
Quiz / Assignment	50
Total	100

Course Objectives

- To understand the problems in device calibration techniques.
- To apply appropriate standards and regulatory affairs techniques.
- To analyse the challenges in medical device calibration

Programme Outcomes (POs)

PO1 **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2 **Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences

PO3 **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.

PO4 **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.

PO5 **Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations

PO8 **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO9 **Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings

PO12 **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.

PSO2 Critically analyze the current healthcare systems and develop innovative solutions effectively through problem specific design and development using modern hardware and software tools

PSO3 Hands-on knowledge on cutting edge hardware and software tools to acquire real time data, model and simulate physiological processes and analyze limitations on real time implementations

Course Outcomes (COs)

The students will be able to

1. Find the problems existing during calibration and troubleshooting.
2. Analyze the calibration parameters of a device using DUT.

Articulation Matrix

COs No.	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
1	1	3	2	2	-	-	-	-	-	-	-	-	-	2	2
2	1	3	2	1	2	-	-	2	2	-	-	2	-	2	2

Introduction to Design Thinking, Problem Identification, Clarification and Analysis, Insights on essentialities of Testing and Calibration, Standards and regulatory on Testing and calibration, Parameters of testing / Calibration for Medical Devices, Specific criteria, Traceability, Uncertainty, Practical Exposure.

Total ***15*** **Hours**

References

1. The 2023-2028 World Outlook for Medical Equipment Calibration by Prof Philip M. Parker Ph.D. (Published by ICON Group International, Inc.)
2. The Concise Calibration & Test Equipment Management Guide: The Concise Collection by Adrian Brown (Published by Oppor Apects)

Resource person detail

Name	Dr. K. Venkatraman
Designation	Managing Partner
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22BM0YA OCCUPATIONAL SAFETY AND HEALTH IN PUBLIC HEALTH EMERGENCIES

3 0 0 3

Course Objectives

- Students will be able to know about Occupational safety and health (OSH)
- Students will be able to discuss about risks faced by emergency responders during disease outbreaks and other emergencies
- Students will be able to create awareness on necessary strategies for managing OSH in emergency situations

Program Outcomes (POs)

PO2. 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.
PO3. 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.
PO4. 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.
PO8. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO12. 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.
PSO2. Critically analyse the current healthcare systems and develop innovative solutions effectively through problem specific design and development using modern hardware and software tools.

Course Outcomes (COs)

1. Practice the occupational safety measures by the scientific knowledge to overcome the risks faced by emergency responders
2. Apply appropriate strategies and tools in Occupational safety and healthcare
3. Asses common risks for safety and health in emergencies
4. Implement appropriate occupational safety practices in chemical accidents
5. Analyze Occupational safety measures in radiation incidents

Articulation Matrix

CO No	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
1	-	3	2	1	-	-	-	1	-	-	-	2	-	2	-
2	-	2	2	2	-	-	-	1	-	-	-	2	-	2	-
3	-	3	2	2	-	-	-	1	-	-	-	2	-	2	-
4	-	2	2	2	-	-	-	1	-	-	-	2	-	2	-
5	-	3	2	2	-	-	-	1	-	-	-	2	-	2	-

UNIT I **9 Hours**

MANAGEMENT ASPECTS

Management system approach to occupational safety and health hazards and risks – rights, duties and responsibilities of employers and workers during outbreaks and emergencies – Emergency responders health monitoring and surveillance

UNIT II **9 Hours**

STRATEGIES AND TOOLS

International Health Regulations, 2005 – Incident command system for managing outbreaks and emergencies – Occupational safety and health controls – Strategies for infection prevention and control

UNIT III **9 Hours**

COMMON RISKS FOR SAFETY AND HEALTH IN EMERGENCIES

Vector-borne diseases, water and food-borne diseases, Vaccine-preventable diseases – Heat stress - Slips, trips and falls - Road traffic injuries – Ergonomic hazards - Violence – Psychological stress during outbreaks and injuries

UNIT IV **9 Hours**

OCCUPATIONAL SAFETY AND HEALTH IN CHEMICAL INCIDENTS

Emergencies caused by chemical incidents – occupational safety and health hazards and risks of chemicals – Personal Protective Equipment – Decontamination of emergency response personnel – medical surveillance of emergency responders

UNIT V **9 Hours**

OCCUPATIONAL SAFETY AND HEALTH IN RADIATION INCIDENTS

Sources and scenarios of radiation incidents – guidance for protection of emergency responders - Occupational health surveillance of persons occupationally exposed to radiation in emergencies

Total: 45 Hours

Reference(s)

1. Emergency responder health monitoring and surveillance. National Response Team technical assistance document. Atlanta (GA): National Institute for Occupational Safety andHealth; 2012.
2. Emergency response framework (ERF). Geneva: World Health Organization; 2013
3. Guidelines on occupational safety and health management systems, second edition.Geneva: International Labour Organization; 2009.
4. OSH management system: a tool for continual improvement. Geneva: International Labour Organization; 2011
5. OECD Environmental Outlook to 2050: the consequences of inaction. Paris: Organization for Economic Co-operation and Development; 2012.

22BM0YB AMBULANCE AND EMERGENCY MEDICAL SERVICE MANAGEMENT

3 0 0 3

Course Objectives

- Understand the ambulance & transport management and allied services.
- Compare the ambulance design and equipment, transportation and corporate Profit.
- Carry-out various acts governing transport management.

Program Outcomes (POs)

PO1. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. 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.
PSO1. Apply knowledge on foundation in Life Science, engineering, mathematics and current biomedical engineering practices with an ability to demonstrate advanced knowledge of a selected area within Biomedical Engineering.
PSO2. Critically analyse the current healthcare systems and develop innovative solutions effectively through problem specific design and development using modern hardware and software tools.

Course Outcomes (COs)

1. Outline ambulance services, types and allied services
2. Formulate minimum ambulance rescue equipment and developing a transportation Strategy.
3. Integrate the Emergency response team, Transportation interfaces, Transportation Service Characteristics& regulatory reforms involved.
4. Assess the ambulance services, types and allied services
5. Analyze and apply motor vehicle act for ambulamces .

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	2	-	-	-	-	-	-	-	-	-	-	-	2	-
2	2	-	-	-	-	-	-	-	-	-	-	-	-	3	-
3	-	2	-	-	-	-	-	-	-	-	-	-	-	2	-
4	2	2	-	-	-	-	-	-	-	-	-	-	-	-	-
5	2	-	-	-	-	-	-	-	-	-	-	-	2	-	-

UNIT I **9 Hours**

INTRODUCTION

Introduction-transportation ambulance types-Advanced Life Support Ambulance-Basic Life Support Ambulance-Patient Transport Ambulance-Emergency services-Ambulances-Allied services-telephone management

UNIT II **9 Hours**

AMBULANCE DESIGN AND EQUIPMENT

Design and Equipment of Ambulances -Minimum Ambulance Rescue Equipment-Emergency drugs medicines Recruitment validation Training to handle in house Ambulance emergency procedures Checklist measures Roles of paramedics, midwives, community nurses, hospice workers in emergency handling via ambulance

UNIT III **9 Hours**

TRANSPORTATION REGULATION FOR EMERGENCY MEDICAL SERVICE

Crisis Management-Anxiety & Stress Management-the Emergency response team-police assistance- Information handling & processing-Establishing customer service levels - Developing and Reporting customer service standards - Impediments to an Effective customer Service strategy - Improving customer Service Performance Transportation

UNIT IV **9 Hours**

AMBULANCE PREVENTIVE MAINTENANCE

Legal obligations Switch Console Front, Main Electrical, Patient Compartment Climate Oxygen system On board Suction system 110/12 VOLT system, Modular Body, Medical Equipment - Cot & Stretcher, safety belts-driver(s), passenger, Patients-child restraint device-incubator

UNIT V **9 Hours**

THE MOTOR VEHICLE ACT

The Motor Vehicle Act, 1988- Rules of the road Regulations 1989- Overall Dimensions of Motor Vehicles (Prescription of conditions for exemption) Rules 1991-Use of Red light on the top front of the vehicle

Total: 45 Hours

Reference(s)

1. Fawcett,"Supply Chain Management", Pearson Education India, 01-Sep-2008 - 600 pages.
2. B. Feroz, A. Mehmood, H. Maryam, S. Zeadally, C. Maple and M. A. Shah, "Vehicle-Life Interaction in Fog-Enabled Smart Connected and Autonomous Vehicles," in IEEE Access, vol. 9, pp. 7402-7420, 2021, doi: 10.1109/ACCESS.2020.3049110.
3. R. Jin, T. Xia, X. Liu, T. Murata and K. -S. Kim, "Predicting Emergency Medical Service Demand With Bipartite Graph Convolutional Networks," in IEEE Access, vol. 9, pp. 9903-9915, 2021, doi: 10.1109/ACCESS.2021.3050607.
4. Les Pringle,"Call the Ambulance",Transworld Publishers, 2010.
5. Edward J. Bardi, John Joseph Coyle, Robert A. Novack"Management of Transportation", Thomson/South-Western, 2006

22BM0YC HOSPITAL AUTOMATION 3 0 0 3

Course Objectives

- Introduce the concepts of hospital systems and need for central monitoring
- Exemplify the power generation, utility and protection systems.
- Apply the distributed and central monitoring functions in hospital environment

Program Outcomes (POs)

PO1. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. 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.

PSO1. Apply knowledge on foundation in Life Science, engineering, mathematics and current biomedical engineering practices with an ability to demonstrate advanced knowledge of a selected area within Biomedical Engineering.

PSO2. Critically analyse the current healthcare systems and develop innovative solutions effectively through problem specific design and development using modern hardware and software tools.

Course Outcomes (COs)

1. Outline the factors in central power generating and monitoring systems
2. Implement the sensors and actuators for the automation systems
3. Classify the equipment types and its applications.
4. Apply software tools and digital computer for monitoring of parameters and medical data handling
5. Design central monitoring station for hospitals for control and surveillance applications

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	-	-	-	-	-	-	-	-	-	-	-	-	2	-
2	-	2	-	-	-	-	-	-	-	-	-	-	-	2	-
3	-	2	-	-	-	-	-	-	-	-	-	-	3	-	-
4	-	2	-	-	-	-	-	-	-	-	-	-	-	2	-
5	3	-	-	-	-	-	-	-	-	-	-	-	-	2	-

UNIT I **9 Hours**

AUTOMATION IN HEALTHCARE

Introduction to automation Role of automation in healthcare Remote Patient Monitoring Maximizing resources on patient care Reducing variability, Automating clinician and patient interactions through products.

UNIT II **9 Hours**

POWER GENERATION AND MEDICAL GAS PRODUCTION

Power generator, Battery : Maintenance and troubleshooting, energy conservation and monitoring system - Automation in dryer, compressor, air conditioning, lighting, heating systems.

UNIT III **9 Hours**

AUTOMATION IN PIPING

Monitoring of flow and pressure of medical gas System components Vacuum control units Automatic changeover system - Types of Outlets - Leakage test- Prevention and safety automation.

UNIT IV **9 Hours**
INSTRUMENTATION SYSTEMS

Optical sensors , Pressure Sensors - Ultrasonic Sensors - Tactile Sensors - Thermal sensors -Biosensor - Linear Actuators, Central monitoring station - Alarm system - Regulation and standards.

UNIT V **9 Hours**
APPLICATIONS

Business intelligence & executive dashboards - Radio-Frequency Identification (RFID)- based patient and asset tracking solutions - Tablet-based applications for bed side access to doctors/nurses - Healthcare CRM for patient relationship management - Patient kiosk, tele-health – HIS integration.

Total: 45 Hours

Reference(s)

1. Khandpur RS, Handbook of Biomedical Instrumentation, Prentice Hall of India, New Delhi, 3 rd edition, 2014.
2. Joseph J. Carr and John M. Brown, Introduction to Biomedical Equipment Technology, Pearson Education India, Delhi, 4 th edition 2008
3. Curtis Johnson D Process Control Instrumentation Technology, Prentice Hall of India, 8th edition 2006
4. John V. Grimaldi and Rollin H. Simonds., Safety Management, All India Travelers Book seller, New Delhi, 1989
5. N.V. Krishnan, Safety in Industry, Jaico Publisher House, 1996.