# B.E. (Electronics and Communication Engineering)

# 2022 Regulations, Curriculum & Syllabi

Stay Ahead

BANNARI AMMAN INSTITUTE OF TECHNOLOGY

An Autonomous Institution Affiliated to Anna University - Chennai • Approved by AICTE • Accredited by NAAC with "A+" Grade

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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)**<br>*a. Presentation*<br>*b. Report*<br>*c. Viva voce* | - | **40**<br>*20*<br>*10*<br>*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**<br>*a. Listening*<br>*b. Speaking*<br>*c. Reading*<br>*d. Writing* | **25**<br>*5*<br>*10*<br>*5*<br>*5* | **25**<br>*5*<br>*5*<br>*5*<br>*10* |
| **Test 2** | **25** | **25** |

| | | |
|---|---|---|
| *a. Listening*<br>*b. Speaking*<br>*c. Reading*<br>*d. Writing* | *5*<br>*10*<br>*5*<br>*5* | *5*<br>*5*<br>*5*<br>*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**<br>*a. Listening*<br>*b. Speaking* | - | **30**<br>*5*<br>*10* |

| | | |
|---|---|---|
| *c. Reading*<br>*d. Writing* | | *5*<br>*10* |
| **Test 2**<br>*a. Listening*<br>*b. Speaking*<br>*c. Reading*<br>*d. Writing* | - | **30**<br>*5*<br>*10*<br>*5*<br>*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)**<br>*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)**<br>*a. Report*<br>*b. Presentation & Viva Voce* | -<br><br> | **40**<br>*20*<br>*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**<br>*a. Literature Survey*<br>*b. Identification of topic and Justification*<br>*c. Work plan*<br>*d. Problem Statement and Literature Survey*<br>*e. Contribution to the work*<br>*f. Viva voce* | **20**<br>*5*<br>*5*<br>*10*<br>-<br>-<br>- | **30**<br>-<br>-<br>*10*<br>*5*<br>*10*<br>*5* |
| **Review II**<br>*a. Approach & Results*<br>*b. Conclusion*<br>*c. Methodology & Results*<br>*d. Conclusion with report*<br>*e. Publication*<br>*f. Viva voce* | **30**<br>*15*<br>*15*<br>-<br>-<br>-<br>- | **30**<br>-<br>-<br>*10*<br>*10*<br>*5*<br>*5* |
| **Semester End Examinations (SEE)**<br>*a. Report*<br>*b. Presentation*<br>*c. Viva voce* | **50**<br>*20*<br>*20*<br>*10* | **40**<br>*15*<br>*15*<br>*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**<br>*a. Progress*<br>*b. Problem Statement and Literature Survey*<br>*c. Methodology*<br>*d. Work Contribution*<br>*e. Viva voce* | **10**<br>*10*<br>*-*<br>*-*<br>*-*<br>*-* | **20**<br>*-*<br>*5*<br>*5*<br>*5*<br>*5* |
| **Review II**<br>*a. Approach & Results*<br>*b. Work Contribution*<br>*c. Viva voce* | **10**<br>*10*<br>*-*<br>*-* | **20**<br>*10*<br>*5*<br>*5* |
| **Review III**<br>*a. Conclusion & Final Presentation*<br>*b. Report*<br>*c. Publication of Paper in Conferences / Journals*<br>*d. Results & Discussions*<br>*e. Report and Contribution*<br>*f. Publication*<br>*g. Viva voce* | **30**<br>*10*<br>*15*<br>*5*<br>*-*<br>*-*<br>*-*<br>*-* | **20**<br>*-*<br>*-*<br>*-*<br>*5*<br>*5*<br>*5*<br>*5* |
| **Semester End Examinations (SEE)**<br>*a. Presentation*<br>*b. Viva voce*<br>*c. Report* | **50**<br>*30*<br>*20*<br>*-* | **40**<br>*15*<br>*10*<br>*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 & Repor*t | 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*<br>*(Laboratory Assessment & Report)* | 20 | 25 |
| **Semester End Examinations (SEE)** *<br>*(QP pattern as per (I))* | **50** | **50** |
| **Semester End Examinations (SEE)** #<br>***Courses with L T P C: 2 0 2 3***<br>*a. Theory Examinations*<br>*b. Laboratory Assessment* | - | 25<br>25 |
| **Semester End Examinations (SEE)** #<br>***Courses with L T P C: 3 0 2 4, 2 1 2 4, 3 1 2 5***<br>*a. Theory Examinations*<br>*b. Laboratory Assessment* | - | 35<br>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


| | **Page No.** |
|---|---|
| Vision and Mission | 3 |
| PEOs | 3 |
| POs | 4 |
| Mapping of PEOs and POs | 6 |
| Connectivity Chart | 7 |
| Curriculum | 8 |
| Syllabi | 19 |
| Electives | 138 |

## VISION OF THE DEPARTMENT

To foster academic excellence in Electronics and Communication Engineering education and research and turn out students into competent professionals to serve society.

## MISSION OF THE DEPARTMENT

- To establish a unique learning environment and to enable the students to face the challenges in Electronics and Communication Engineering.
- To provide a framework for professional career, higher education, and research activities.
- To impart ethical and value-based education by promoting activities addressing the social needs.

## PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)

I. Design and develop electronic circuits and systems, based on the existing as well as emerging technologies.

II. Pursue higher education, research, and continue to learn in their profession.

III. Become a successful professional engineer in Electronics/Communication/allied fields.

## 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 analyze 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. Able to apply the concepts of Electronics, Communication, Signal processing and VLSI in the design and implementation of application oriented engineering systems.
2. Able to solve the complex engineering problems using state-of-the-art hardware and software tools, along with analytical and managerial skills to arrive at appropriate solutions.

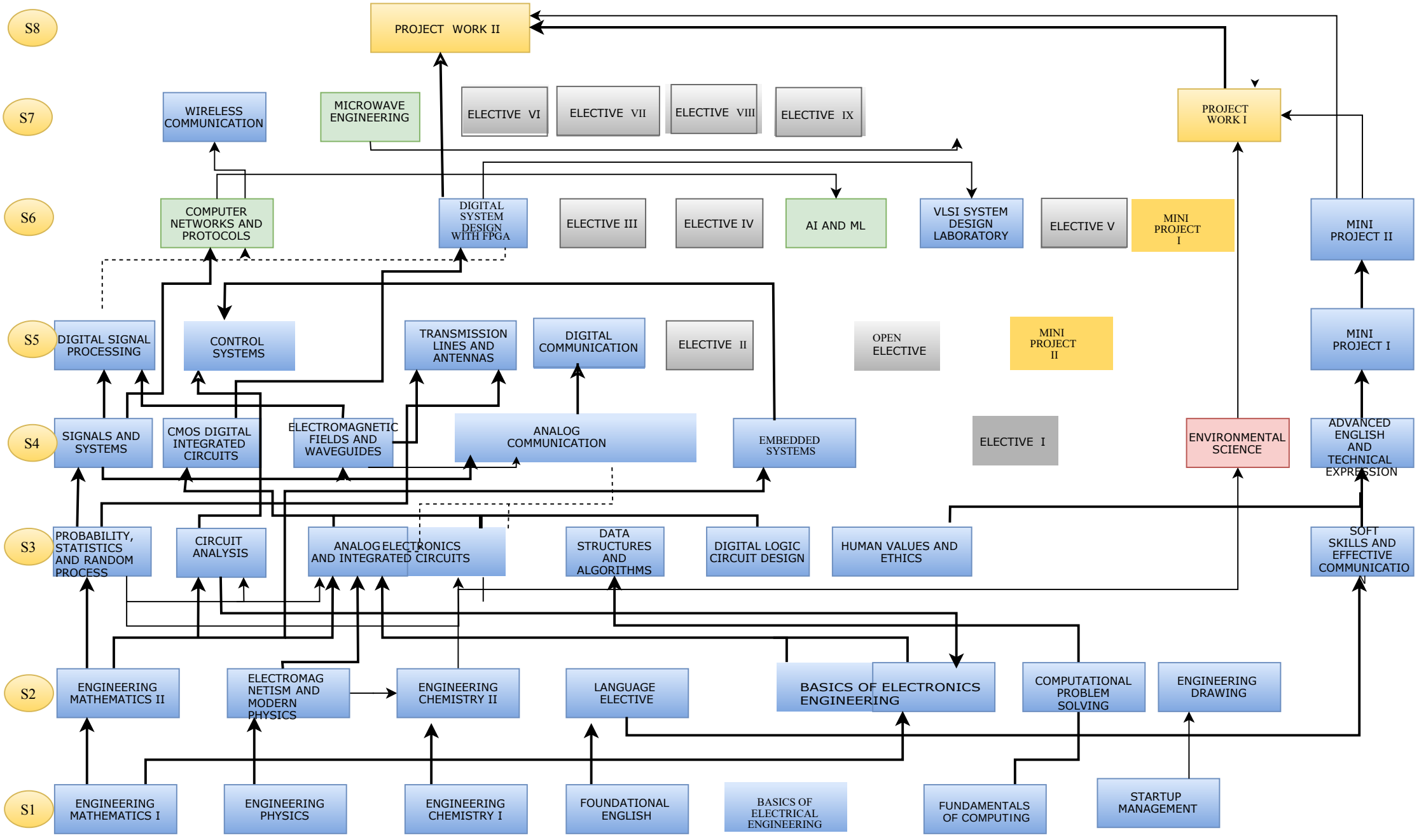
## MAPPING OF PEOs AND POs

| PEO(s) | Programme Outcomes(s) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
| I | | | X | X | X | X | X | | | | X | |
| II | X | X | X | X | X | X | | X | X | X | X | X |

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

CURRICULUM DESIGN & INTERLINKING OF COURSES 2022 R

Electives are the courses offered by the departments that do not require any kind of prerequisite. It depends upon the student's interest.



| **DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING**<br>**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 | 50 | 50 | 100 | HSS |
| 22GE003 | BASICS OF ELECTRICAL ENGINEERING | 2 | 0 | 2 | 3 | 4 | 50 | 50 | 100 | ES |
| 22HS002 | STARTUP MANAGEMENT | 1 | 0 | 2 | 2 | 3 | 50 | 50 | 100 | EEC |
| 22HS003* | தமிழர் மரபு<br>HERITAGE OF TAMILS | 1 | 0 | 0 | 1 | 1 | 40 | 60 | 100 | HSS |
| 22EC108$ | 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** |
| | | | | | | | **CA** | **ES** | **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 | 50 | 50 | 100 | ES |
| | LANGUAGE ELECTIVE | 1 | 0 | 2 | 2 | 3 | 50 | 50 | 100 | HSS |
| 22HS006* | தமிழரும் தொழில்நுட்பமும்<br>TAMILS AND TECHNOLOGY | 1 | 0 | 0 | 1 | 1 | 40 | 60 | 100 | HSS |
| 22HS009* | COCURRICULAR OR EXTRACURRICULAR ACTIVITIE | - | - | - | NC | - | 100 | 0 | 100 | HSS |
| **Total** | | **15** | **1** | **10** | **21** | **26** | **-** | **-** | **-** | **-** |

* Applicable for the students admitted during academic year 2024-2025. The lateral entry students have to complete these courses during III and IV semesters.
# 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** | |
| 22EC301 | PROBABILITY, STATISTICS AND RANDOM PROCESS* | 3 | 1 | 0 | 4 | 3 | 40 | 60 | 100 | BS |
| 22EC302 | CIRCUIT ANALYSIS | 3 | 1 | 0 | 4 | 4 | 40 | 60 | 100 | ES |
| 22EC303 | DIGITAL LOGIC CIRCUIT DESIGN | 3 | 0 | 2 | 4 | 5 | 50 | 50 | 100 | PC |
| 22EC304 | ANALOG ELECTRONICS AND INTEGRATED CIRCUITS | 3 | 0 | 2 | 4 | 5 | 50 | 50 | 100 | PC |
| 22EC305 | DATA STRUCTURES AND ALGORITHMS | 2 | 0 | 2 | 3 | 4 | 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** | | **16** | **2** | **8** | **22** | **25** | **-** | **-** | **-** | **-** |
| **IV SEMESTER** | | | | | | | | | | |
| **Code No.** | **Course** | **L** | **T** | **P** | **C** | **Hours/ Week** | **Maximum Marks** | | | **Category** |
| | | | | | | | **CIA** | **SEE** | **Total** | |
| 22EC401 | SIGNALS AND SYSTEMS | 3 | 1 | 0 | 4 | 4 | 40 | 60 | 100 | BS |
| 22EC402 | ANALOG COMMUNICATION | 3 | 0 | 2 | 4 | 5 | 50 | 50 | 100 | PC |
| 22EC403 | ELECTROMAGNETIC FIELDS AND WAVEGUIDES | 3 | 1 | 0 | 4 | 4 | 40 | 60 | 100 | BS |
| 22EC404 | CMOS DIGITAL INTEGRATED CIRCUITS | 3 | 0 | 2 | 4 | 5 | 50 | 50 | 100 | PC |
| 22EC405 | 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 |
| 22HS010[$] | SOCIALLY RELEVANT PROJECT | - | - | - | NC | - | 100 | 0 | 100 | HSS |
| **Total** | | **20** | **2** | **8** | **24** | **30** | **-** | **-** | **-** | **-** |

$ Applicable for the students admitted during academic year 2024-2025.

* 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** | |
| 22EC501 | DIGITAL COMMUNICATION | 3 | 0 | 2 | 4 | 5 | 50 | 50 | 100 | PC |
| 22EC502 | DIGITAL SIGNAL PROCESSING | 3 | 0 | 2 | 4 | 5 | 50 | 50 | 100 | PC |
| 22EC503 | TRANSMISSION LINES AND ANTENNAS | 3 | 0 | 2 | 4 | 5 | 50 | 50 | 100 | PC |
| 22EC504 | INTERNET OF THINGS AND ITS APPLICATIONS | 3 | 0 | 2 | 4 | 5 | 50 | 50 | 100 | PC |
| | PROFESSIONAL ELECTIVE II | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |
| | OPEN ELECTIVE | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | OE |
| 22EC507 | MINI PROJECT I | 0 | 0 | 2 | 1 | 2 | 60 | 40 | 100 | EEC |
| **Total** | | **18** | **0** | **10** | **23** | **28** | **-** | **-** | **-** | **-** |
| **VI SEMESTER** | | | | | | | | | | |
| **Code No.** | **Course** | **L** | **T** | **P** | **C** | **Hours /Week** | **Maximum Marks** | | | **Category** |
| | | | | | | | **CIA** | **SEE** | **Total** | |
| 22EC601 | COMPUTER NETWORKS AND PROTOCOLS | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PC |
| 22EC602 | DIGITAL SYSTEM DESIGN WITH FPGA | 3 | 0 | 2 | 4 | 5 | 50 | 50 | 100 | PC |
| 22EC603 | 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 |
| 22EC607 | MINI PROJECT II | 0 | 0 | 2 | 1 | 2 | 60 | 40 | 100 | EEC |
| **Total** | | **18** | **0** | **6** | **21** | **24** | **-** | **-** | **-** | **-** |

| **VII SEMESTER** | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Code No.** | **Course** | **L** | **T** | **P** | **C** | **Hours /Week** | **Maximum Marks** | | | **Category** |
| | | | | | | | **CIA** | **SEE** | **Total** | |
| 22EC701 | MICROWAVE ENGINEERING | 2 | 0 | 2 | 3 | 4 | 50 | 50 | 100 | PC |
| 22EC702 | WIRELESS COMMUNICATION | 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 |
| 22EC707 | PROJECT WORK I | 0 | 0 | 4 | 2 | 4 | 60 | 40 | 100 | EEC |
| **Total** | | **17** | **0** | **8** | **21** | **25** | **-** | **-** | **-** | **-** |
| **VIII SEMESTER** | | | | | | | | | | |
| **Code No.** | **Course** | **L** | **T** | **P** | **C** | **Hours /Week** | **Maximum Marks** | | | **Category** |
| | | | | | | | **CIA** | **SEE** | **Total** | |
| 22EC801 | 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 | 50 | 50 | 100 | HSS |
| 22HSH01 | HINDI | 1 | 0 | 2 | 2 | 3 | 50 | 50 | 100 | HSS |
| 22HSG01 | GERMAN | 1 | 0 | 2 | 2 | 3 | 50 | 50 | 100 | HSS |
| 22HSJ01 | JAPANESE | 1 | 0 | 2 | 2 | 3 | 50 | 50 | 100 | HSS |
| 22HSF01 | FRENCH | 1 | 0 | 2 | 2 | 3 | 50 | 50 | 100 | HSS |

| **PROFESSIONAL ELECTIVES** | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **VERTICAL I - EMBEDDED SYSTEM DESIGN** | | | | | | | | | | |
| 22EC001 | ADVANCED PROCESSOR ARCHITECTURES | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |
| 22EC003 | EMBEDDED C PROGRAMMING | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |
| 22EC002 | COMMUNICATION PROTOCOLS AND STANDARDS | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |
| 22EC004 | REAL TIME OPERATING SYSTEMS | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |
| 22EC005 | EMBEDDED LINUX | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |
| 22EC006 | VIRTUAL INSTRUMENTATION IN EMBEDDED SYSTEMS | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |
| **VERTICAL II - SENSOR TECHNOLOGIES AND IOT** | | | | | | | | | | |
| 22EC007 | IoT PROTOCOLS AND INDUSTRIAL SENSORS | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |
| 22EC008 | IoT PROCESSORS | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |
| 22EC009 | IoT SYSTEM DESIGN | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |
| 22EC010 | WIRELESS SENSOR NETWORK DESIGN | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |
| 22EC011 | INDUSTRIAL IOT AND INDUSTRY 4.0 | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |
| 22EC012 | DATA ANALYTICS FOR IoT | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **VERTICAL III- SEMICONDUCTOR CHIP DESIGN AND VERIFICATION** | | | | | | | | | | |
| 22EC013 | ADVANCED DIGITAL SYSTEM DESIGN | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |
| 22EC014 | ANALOG VLSI DESIGN | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |
| 22EC015 | ASIC DESIGN | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |
| 22EC016 | LOW POWER VLSI DESIGN | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |
| 22EC017 | DSP INTEGRATED CIRCUITS | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |
| 22EC018 | VLSI VERIFICATION | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |
| **VERTICAL IV - SIGNAL AND IMAGE PROCESSING** | | | | | | | | | | |
| 22EC019 | ADVANCED DIGITAL SIGNAL PROCESSING | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |
| 22EC020 | SPEECH SIGNAL PROCESSING | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |
| 22EC021 | DIGITAL IMAGE PROCESSING | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |
| 22EC022 | MULTIMEDIA COMPRESSION TECHNIQUES | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |
| 22EC023 | COMPUTER VISION | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |
| 22EC024 | WAVELET TRANSFORMS AND APPLICATIONS | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |
| **VERTICAL V – WIRED AND WIRELESS COMMUNICATION** | | | | | | | | | | |
| 22EC025 | UNDERWATER ACOUSTIC COMMUNICATIONS | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |
| 22EC026 | SATELLITE COMMUNICATION | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |
| 22EC027 | OPTICAL COMMUNICATION AND NETWORKS | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |
| 22EC028 | MIMO COMMUNICATION | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |
| 22EC029 | SIGNAL PROCESSING FOR MMWAVE COMMUNICATION | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |
| 22EC030 | MACHINE LEARNING FOR WIRELESS COMMUNICATIONS | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **VERTICAL VI – RADIO FREQUENCY AND ANTENNA SYSTEMS** | | | | | | | | | | |
| 22EC034 | ELECTROMAGNETIC INTERFERENCE AND COMPATIBILITY | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |
| 22EC031 | MICROWAVE CIRCUITS AND SYSTEMS | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |
| 22EC032 | MICROWAVE INTEGRATED CIRCUITS | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |
| 22EC035 | ANTENNA TECHNOLOGIES FOR WIRELESS APPLICATIONS | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |
| 22EC033 | RF SYSTEM DESIGN | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |
| 22EC036 | SMART ANTENNAS | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |
| **VERTICAL VII - ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING** | | | | | | | | | | |
| 22EC040 | PYTHON PROGRAMMING FOR AI AND ML | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |
| 22EC037 | SOFT COMPUTING TECHNIQUES | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |
| 22EC038 | OPTIMIZATION TECHNIQUES | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |
| 22EC039 | MACHINE LEARNING TECHNIQUES | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |
| 22EC041 | DEEP LEARNING TECHNIQUES | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |
| 22EC042 | NATURAL LANGUAGE PROCESSING | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |
| **VERTICAL VIII – DIVERSIFIED ELECTIVES** | | | | | | | | | | |
| 22EC043 | MEDICAL ELECTRONICS AND INSTRUMENTATION | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |
| 22EC044 | CONSUMER ELECTRONICS | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |
| 22EC045 | NANO ELECTRONICS | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |
| 22EC046 | AUTOMOTIVE ELECTRONICS AND NETWORKING | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |
| 22EC047 | PCB DESIGN AND FABRICATION | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |
| 22EC048 | CRYPTOGRAPHY AND NETWORK SECURITY | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |
| 22EC049 | SCRIPTING LANGUAGES FOR VLSI DESIGN AUTOMATION | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |
| 22EC050 | 5G MOBILE AND WIRELESS COMMUNICATION | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **HONOURS - VERTICAL COURSES - SENSOR TECHNOLOGIES AND IOT** | | | | | | | | | | |
| 22ECH01 | ADVANCED PROCESSOR ARCHITECTURES | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |
| 22ECH07 | IoT PROTOCOLS AND INDUSTRIAL SENSORS | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |
| 22ECH08 | IoT PROCESSORS | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |
| 22ECH09 | IoT SYSTEM DESIGN | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |
| 22ECH10 | WIRELESS SENSOR NETWORK DESIGN | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |
| 22ECH11 | INDUSTRIAL IOT AND INDUSTRY 4.0 | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |
| 22ECH12 | DATA ANALYTICS FOR IoT | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |
| **MINOR VERTICAL COURSES SENSOR TECHNOLOGIES AND IOT** | | | | | | | | | | |
| 22ECM07 | IoT PROTOCOLS AND INDUSTRIAL SENSORS | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |
| 22ECM08 | IoT PROCESSORS | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |
| 22ECM09 | IoT SYSTEM DESIGN | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |
| 22ECM10 | WIRELESS SENSOR NETWORK DESIGN | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |
| 22ECM11 | INDUSTRIAL IOT AND INDUSTRY 4.0 | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |
| 22ECM12 | DATA ANALYTICS FOR IoT | 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 |
| 22OEI01 | PROGRAMMABLE LOGIC CONTROLLER | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | OE |
| 22OEI04 | OPTOELECTRONICS AND LASER INSTRUMENTATION | 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 |
| 22OME04 | SAFETY 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 OILSEED 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 |
| 22OPH03 | APPLIED LASER SCIENCE | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | OE |
| 22OPH04 | BIOPHOTONICS | 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 |
| 22OBM01 | OCCUPATIONAL SAFETY AND HEALTH IN PUBLIC HEALTH EMERGENCIES | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | OE |
| 22OBM02 | AMBULANCE AND EMERGENCY MEDICAL SERVICE MANAGEMENT | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | OE |
| 22OBM03 | HOSPITAL AUTOMATION | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | OE |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 22OAG01 | RAIN WATER HARVESTING TECHNIQUES | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | OE |
| 22OEE01 | VALUE ENGINEERING | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | OE |
| **ONE CREDIT COURSES** | | | | | | | | | | |
| 22EC0XA | MIMO ANTENNA DESIGN AND ITS ANALYSIS | 1 | 0 | 0 | 1 | - | 100 | 0 | 100 | EEC |
| 22EC0XB | NLP BEYOND BASICS | 1 | 0 | 0 | 1 | - | 100 | 0 | 100 | EEC |
| 22EC0XC | 32-BIT MICROPROCESSORS (MPUS) WITH EDGE AI | 1 | 0 | 0 | 1 | - | 100 | 0 | 100 | EEC |
| 22EC0XD | IoT APPLICATION DESIGN USING LoRa TECHNOLOGY | 1 | 0 | 0 | 1 | - | 100 | 0 | 100 | EEC |
| 22EC0XE | EXPERIMENTING NETWORK PROTOCOLS USING ANALYZING TOOLS | 1 | 0 | 0 | 1 | - | 100 | 0 | 100 | EEC |
| 22EC0XF | AUTOMOTIVE COMMUNICATION BOOT CAMP LIN, OBD AND AUTOSAR | 1 | 0 | 0 | 1 | - | 100 | 0 | 100 | EEC |
| 22EC0XG | SEMICONDUCTOR LIFE CYCLE | 1 | 0 | 0 | 1 | - | 100 | 0 | 100 | EEC |
| 22EC0XH | GENERATIVE AI | 1 | 0 | 0 | 1 | - | 100 | 0 | 100 | EEC |
| 22EC0XI | FROM CONCEPT TO PROTOTYPE PCB ELECTRONIC DESIGN ESSENTIALS | 1 | 0 | 0 | 1 | - | 100 | 0 | 100 | EEC |
| 22EC0XJ | PROTOCOLS IN AUTOMOTIVE COMMUNICATION TECHNOLOGIES | 1 | 0 | 0 | 1 | - | 100 | 0 | 100 | EEC |
| 22EC0XK | PHYSICAL COMPUTING WITH UNITY AND CONTROLLER | 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 | 8 | | | | | 32 | 20 | 15% | 20% |
| 2 | ES | 6 | 8 | 4 | | | | | | 18 | 11 | 15% | 20% |
| 3 | HSS | 3 | 3 | 2 | 1 | | | | | 9 | 6 | 5% | 10% |
| 4 | PC | | | 11 | 12 | 16 | 11 | 7 | | 57 | 35 | 30% | 40% |
| 5 | PE | | | | 3 | 6 | 9 | 12 | | 30 | 18 | 15% | 20% |
| 6 | EEC | | | | | 1 | 1 | 2 | 10 | 17 | 10 | 5% | 10% |
| Total | | 21 | 21 | 22 | 24 | 23 | 21 | 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
CA - Continuous Assessment
ES - End Semester 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.

**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.

**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 | PS01 | PS02 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1 | 2 | - | - | - | - | - | - | - | - | - | - | - | - |
| 2 | 2 | 2 | - | - | - | - | - | - | - | - | - | - | - | - |
| 3 | 2 | 1 | - | - | - | - | - | - | - | - | - | - | - | - |
| 4 | 2 | 2 | - | - | - | - | - | - | - | - | - | - | - | - |
| 5 | 1 | 2 | - | - | - | - | - | - | - | - | - | - | - | - |

**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 - Eigenvalues 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, Taylor's 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 decay - Exponential equations have a variable as an exponent and take the form $y = ab^x$ 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 Publishers, 2014.
3. S. C. Gupta, V. K. Kapoor, Fundamentals of Mathematical Statistics, Sultan Chand & Sons, 2020.
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

**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 analyze 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.

**Course Outcomes (COs)**

1. Apply the work-energy theorem to analyze and optimize mechanical system performance
2. Analyze free and forced mechanical oscillations in vibrational energy systems
3. Analyze the propagation of energy in mechanical systems through 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 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 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 voice - 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 behavior 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 behavior 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 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.

**Course Outcomes (COs)**

1. Apply the mechanism of nuclear transmutation reactions, such as fusion and neutron capture, in the formation of elements in the universe.
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. Analyse endothermic and exothermic processes and exchange of energy during chemical reactions
5. Analyse 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 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 1 | - | - | - | - | - | - | - | - | - | - | - | - |
| 2 | 2 | 1 | - | - | - | - | - | - | - | - | - | - | - | - |
| 3 | 2 | 1 | - | - | - | - | - | - | - | - | - | - | - | - |
| 4 | 2 | 1 | - | - | - | - | - | - | - | - | - | - | - | - |
| 5 | 2 | 1 | - | - | - | - | - | - | - | - | - | - | - | - |

**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 plant in BIT. Ensure the suitability of outlet water for the growth of aquatic animals (fishes).

**EXPERIMENT 2** **5 Hours**

Investigate the amount of Iron ($Fe^{2+}$) 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.

**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.

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

PSO2 Able to solve complex engineering problems using state-of-the-art hardware and software tools, along with analytical and managerial skills to arrive appropriate solutions.

**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 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 1 | 1 | 1 | - | - | - | - | - | - | - | - | 1 | 1 |
| 2 | 3 | 3 | 3 | 1 | - | - | - | - | - | - | - | - | 1 | 1 |
| 3 | 2 | 2 | 2 | 1 | - | - | - | - | - | - | - | - | 1 | 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 - its flow, functions and control - 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 and reading fluency in formal and informal contexts
- Prowess and sevelop ability as critical readers and writers in interpreting complex texts

**Program 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. 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 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | - | - | - | - | - | - | - | - | 2 | 3 | - | 2 | - | - |
| 2 | - | - | - | - | - | - | - | - | 2 | 3 | - | 2 | - | - |
| 3 | - | - | - | - | - | - | - | - | 2 | 3 | - | 2 | - | - |
| 4 | - | - | - | - | - | - | - | - | 2 | 3 | - | 2 | - | - |
| 5 | - | - | - | - | - | - | - | - | 2 | 3 | - | 2 | - | - |

**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 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.

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

PSO2 Able to solve complex engineering problems using state-of-the-art hardware and software tools, along with analytical and managerial skills to arrive appropriate solutions

**Course Outcomes (COs)**

1. Interpret 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. Interpret 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 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 3 | 2 | 2 | - | - | - | - | - | - | - | - | - | 1 | 1 |
| 2 | 2 | 2 | 2 | 3 | - | - | - | - | - | - | - | - | 1 | 1 |
| 3 | 2 | 2 | 1 | 3 | - | - | - | - | - | - | - | - | 1 | 1 |

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

**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 behavior of a Fixed Resistor in an Electric Heater.

**EXPERIMENT 2** **7 Hours**

Construct an Electrical Wiring Layout for a Basic Household Applications.

**EXPERIMENT 3** **8 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 Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

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

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.

PO11 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 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 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.

## Program 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. Understand 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. Identify and differentiate various forms of folk and martial arts in Tamil heritage.
4. Understand 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 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 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, Leather puppetry, 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 பௌத்த 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.

**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.

**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 | PS01 | PS02 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1 | 2 | - | - | - | - | - | - | - | - | - | - | - | - |
| 2 | 2 | 2 | - | - | - | - | - | - | - | - | - | - | - | - |
| 3 | 2 | 2 | - | - | - | - | - | - | - | - | - | - | - | - |
| 4 | 2 | 1 | - | - | - | - | - | - | - | - | - | - | - | - |
| 5 | 1 | 2 | - | - | - | - | - | - | - | - | - | - | - | - |

**UNIT I** **9 Hours**

**FIRST ORDER LINEAR DIFFERENTIAL EQUATIONS**

Formation of differential equations - Solutions of first order linear ODE: Leibnitz's 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 and 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 D. Greenberg, Advanced Engineering Mathematics, Second Edition, Pearson Education, 2018.
3. George B. Thomas, Maurice D. Weir and Joel Hass, Thomas Calculus, Thirteenth Edition, Pearson Education, 2013.
4. Erwin Kreyszig, Advanced Engineering Mathematics, Tenth Edition, Wiley, 2015.
5. J. Stewart, Essential Calculus, Second Edition, Cengage, 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

**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.

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.

**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 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 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**

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

**EXPERIMENT 2** **5 Hours**

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

**EXPERIMENT 3** **5 Hours**

Investigate the photonic behavior of laser source for photo copier device

**EXPERIMENT 4** **5 Hours**

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

**EXPERIMENT 5** **5 Hours**

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

**EXPERIMENT 6** **5 Hours**

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

**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.

PO7 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 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 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 - recent applications of radioactive isotopes.

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

PSO2 Able to solve complex engineering problems using state-of-the-art hardware and software tools, along with analytical and managerial skills to arrive appropriate solutions.

**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 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 1 | 1 | 2 | - | - | - | - | - | - | - | - | - | 1 |
| 2 | 3 | 3 | 3 | 3 | - | - | - | - | - | - | - | - | - | 1 |
| 3 | 2 | 2 | 2 | 3 | - | - | - | - | - | - | - | - | 1 | - |
| 4 | 2 | 2 | 2 | 2 | - | - | - | - | - | - | - | - | 1 | - |

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 5 | 2 | 2 | 2 | 2 | - | - | - | - | - | - | - | - | 1 | - |

**UNIT I** **6 Hours**

**VISUAL PROCESS MODELING**

Scenario decomposition - logical sequencing - drawing flowchart - preparing 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 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 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 Able to apply the concepts of Electronics, Communication, Signal processing and VLSI in the design and implementation of application oriented engineering systems.

PSO2 Able to solve complex engineering problems using state-of-the-art hardware and software tools, along with analytical and managerial skills to arrive appropriate solutions.

**Course Outcomes (COs)**

1. Attribute 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 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 3 | 3 | 3 | 1 | - | - | - | - | - | - | - | - | 1 | 1 |
| 2 | 3 | 3 | 3 | 2 | - | - | - | - | - | - | - | - | 1 | 1 |
| 3 | 3 | 3 | 3 | 2 | - | - | - | - | - | - | - | - | 1 | 1 |
| 4 | 3 | 3 | 3 | 2 | - | - | - | - | - | - | - | - | 1 | 1 |
| 5 | 3 | 3 | 3 | 1 | - | - | - | - | - | - | - | - | 1 | 1 |

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

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

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. Understand 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 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 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.

## Program 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. Understand the significance of the weaving industry during the Sangam Age and its cultural importance.
2. Understand 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 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 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 & 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 & TAMIL COMPUTING**

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**

**Reference(s)**


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 Civilization 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.

## 22HS009 COCURRICULAR OR EXTRACURRICULAR ACTIVITIE

**Course Objectives**

- To develop Interpersonal and Leadership Skills
- To Foster Personal Growth and Time Management
- To enhance Community Engagement and Social Responsibility

## Program Outcomes (POs)

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

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. Build leadership skills and teamwork capabilities by engaging in group activities through organization and participation of events
2. Demonstrate the technical, creative, and interpersonal skills through active participation in technical events.
3. Exhibit balanced academics with diverse cultural, sports, and literary activities, showcasing improved time management and organizational skills.
4. Enhance the social responsibility and community engagement by participating in outreach and extension activities.
5. Gain practical experience and industry insights through field visits, industrial training, and internships.

**Articulation Matrix**

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

Every student shall be required to undergo a minimum of 40 hours of Co-curricular / Extracurricular activities organized through society chapters, technical and non-technical Club activities during the II semester, failing which he/she shall not be permitted to appear for the VIII Semester examination. Such students are permitted to appear for the Semester End examinations only after completing the requirements. The attendance of the courses / events shall be maintained on the regular basis by the concerned Co-coordinators and made available in the Office of the Controller of Examinations before the commencement of Semester end examinations of Semester II.

The following co-curricular and extra-curricular activities are conducted on a regular basis and is compulsory for all students. The students' performances are assessed on the basis of their participation and organization of events in voluntary services, performance in technical and nontechnical events, games and sports, performance in literary activities, performance in cultural activities and their participation in District/Regional/State/National and International level events.

**Co-Curricular activity**

Technical events organized through departments, Special labs, Clubs, Society and Chapters etc. includes but not limited to Workshop, Seminar, Conference, Symposium Technical Contest Competition, Field visit, Industrial Training, and Internships.

**Extracurricular activity**

Non-Technical Events Organized through departments, Special labs, Clubs, Society and Chapters etc. includes but not limited to NSS Camp, NCC Camp, YRC activity, Yoga, Sports and games, Cultural events, Outreach activity and Extension activity.

**Total: 40 Hours**

## 22EC301 PROBABILITY, 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 analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

**Course Outcomes (COs)**

1. Demonstarte the concepts of basic probability axioms and apply it the core areas of engineering.
2. Apply the concepts of probability distributions in an appropriate place of science and engineering.
3. Apply basic statistical inference techniques, including confidence intervals, hypothesis testing to engineering problems.
4. Design an experiment for an appropriate situation using ANOVA technique.
5. Analyze the concepts of random process techniques to the problems of random input signals.

**Articulation Matrix**

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

**UNIT I** **9 Hours**

**PROBABILITY AND RANDOM VARIABLE**

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

## 22EC302 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 Able to apply the concepts of Electronics, Communication, Signal processing and VLSI in the design and implementation of application oriented engineering systems.

PSO2 Able to solve complex engineering problems using state-of-the-art hardware and software tools, along with analytical and managerial skills to arrive appropriate solutions.

**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 networks and classify different two port networks.

**Articulation Matrix**

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

**UNIT I** **9 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, Thevenins theorem, Nortons 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, 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, TASKs 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.

## 22EC303 DIGITAL LOGIC CIRCUIT DESIGN 3 0 2 4

**Course Objectives**

- To acquire the basic knowledge of digital logic levels and digital electronic circuits
- To design and analyze the combinational logic circuits
- To design and analyze the sequential logic circuits

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

PSO2 Able to solve complex engineering problems using state-of-the-art hardware and software tools, along with analytical and managerial skills to arrive appropriate solutions.

**Course Outcomes (COs)**

1. Analyze the weighted, non-weighted number systems and Codes
2. Analyze the boolean laws and K-Map for minimization of logic circuits
3. Design and analyze the combinational logic circuits
4. Design and analyze the sequential logic circuits
5. Design and analyze the synchronous & asynchronous counters, logic families and Programmable Logic Devices (PLDs)

**Articulation Matrix**

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

**UNIT I** **6 Hours**

**NUMBER SYSTEMS AND CODES**

Introduction to Digital Systems, Review of Number Systems, Representation of signed numbers, Binary Arithmetic using 1s and 2s Complements, Codes and their types.

**UNIT II** **10 Hours**

**BOOLEAN THEOREMS AND LOGIC REDUCTION**

Logic gates, Basic Theorems and Properties of Boolean Algebra, Boolean Functions, AOI, NAND and NOR Implementation - Canonical and Standard Forms of representation, Karnaugh-Map Method

**UNIT III** **10 Hours**

**COMBINATIONAL LOGIC CIRCUITS**

Binary adders, Binary Subtractor, Parallel Binary Adders, BCD Adders, Encoder, Decoder, Comparator, Code Convertor, Multiplexers, Demultiplexers, Parity Generator and Checker

**UNIT IV** **10 Hours**

**SEQUENTIAL LOGIC CIRCUITS**

Gated Latches & Flip Flops- Level and Edge triggered flip-flops, Flip Flop Conversion. Shift registers, General model of sequential circuits- Mealy/Moore models -Excitation table- State table- State diagram

**UNIT V** **9 Hours**

**COUNTERS, LOGIC FAMILIES AND PLDS**

Design of Synchronous & Asynchronous Counters, shift register counters, Hazards in logic circuits, Logic Families, Programmable Logic Devices (PLDs)

## EXPERIMENT 1 **2 Hours**

Design and construct combinational circuit to implement two-way connection for staircase light application.

## EXPERIMENT 2 **3 Hours**

Design a circuit for Conveyor belt transporting bottled products to packaging, where a deflector plate is activated to deflect bottles into a reject bin if either the weight is not within certain tolerances or there is no cap on the bottle.

## EXPERIMENT 3 **5 Hours**

Design a calculator circuit with a seven segment display using encoder, decoder & logic gates.

## EXPERIMENT 4 **5 Hours**

Design a Logic Gate-Based Data Routing System: Multiplexer & Demultiplexer Circuit Design

**EXPERIMENT 5** **5 Hours**

Design the comparator circuit to compare the number of products/boxes/objects for packaging industries using magnitude comparator

**EXPERIMENT 6** **5 Hours**

Design circuit based on direction of data movement and the way data is loaded and unloaded for shopping complex.

**EXPERIMENT 7** **5 Hours**

Design and implement automated car parking system using flip fop - counters

**Total: 75 Hours**

**Reference(s)**

1. M. Morris Mano and Michael D. Ciletti, Digital Design, Pearson, 5th Edition, 2013
2. Thomas L.Floyd, Digital Fundamentals, Prentice Hall, 11th Edition, 2015
3. A.Anand Kumar, Fundamentals of Digital Circuits, 4th Edition PHI Learning Private Limited, 2016
4. Charles H. Roth, Jr., Fundamentals of Logic Design, 2014, 7th Edition Reprint, Brooks/Cole, Pacific Grove, US.
5. Ronald J. Tocci, Digital System Principles and Applications, 10th ed., Pearson Education, 2009

**22EC304 ANALOG ELECTRONICS AND INTEGRATED CIRCUITS** **3 0 2 4**

**Course Objectives**

- To learn the fundamental concepts behind transistor biasing and to differentiate small signal and large signal circuit models
- To understand the performance metrics of Multistage and Power amplifiers and the working of signal generating and wave shaping circuits
- To analyze the linear and non-linear applications of operational amplifiers.
- To illustrate the operating principle of comparators, Data Converters and various special function ICs.

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

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.

PSO2 Able to solve complex engineering problems using state-of-the-art hardware and software tools, along with analytical and managerial skills to arrive appropriate solutions.

**Course Outcomes (COs)**

1. Analyze different biasing methods for Bipolar Junction Transistors and model different Transistor configurations for BJT
2. Design feedback and power amplifier circuits using Bipolar Junction Transistors
3. Analyze the internal structure of operational amplifiers, its characteristics and applications
4. Design Oscillator and Multivibrator circuits using Bipolar Junction Transistors and operational amplifiers.
5. Design comparator, Data converters and analyze the special function ICs and its application in modern electronic equipment.

**Articulation Matrix**

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

**UNIT I** **9 Hours**

**BIASING**

Review of Transistor Biasing- Bias Stability, Bias Compensation - Small Signal CB, CE and CC - Hybrid pi model (High Frequency) - Simplified T Model

**UNIT II** **9 Hours**

**FEEDBACK AMPLIFIERS AND POWER AMPLIFIERS**

Cascade and Cascode Amplifier, Difference Amplifier - Feedback amplifiers - Current Series, Voltage Shunt, Current shunt and Voltage Series. Power Amplifiers: Class A, Class B, Class C and Class AB Power Amplifiers, Distortion in Power Amplifiers.

**UNIT III** **9 Hours**

**OP-AMP CHARACTERISTICS**

Ideal Op Amp, Operational Amplifier Internal Circuit, DC Characteristics, AC Characteristics , Slew Rate ,Inverting and Non inverting Amplifiers, Voltage Follower, Summing Amplifier , Subtractor , Differentiator, Integrator, Instrumentation amplifier, 1st Order LPF, HPF and all-pass filters.

**UNIT IV** **9 Hours**

**WAVEFORM GENERATORS**

Barkhausen criterion , Oscillators using BJT: LC , Hartley, Colpitts and Crystal Oscillators ,Principles of Op-Amp based Sine Wave Oscillator , RC Phase Shift, Wien Bridge Oscillator ,Multivibrators (Op-Amp & 555) - Astable, Monostable

**UNIT V** **9 Hours**

**COMPARATORS, DATA CONVERTERS AND SPECIAL FUNCTION ICS**

Open Loop Op Amp Configuration, Comparator, Schmitt trigger, Sample and Hold circuits, Flash ADC, Dual Slope ADC - Binary Weighted Resistor DAC - R-2R Ladder DAC, VCO, Voltage regulator: Fixed and Adjustable

**EXPERIMENT 1** **8 Hours**

Design and implementation of an audio amplifier in home theaters.
Design and implementation of audio volume control using differential amplifiers.

**EXPERIMENT 2** **8 Hours**

Design and implementation of light detector using Operational amplifier.
Design and implementation of Analog arithmetic circuits (Summer/ Subtractor/ Comparator/ Differentiator/ Integrator).

**EXPERIMENT 3** **8 Hours**

Design and implementation of ambulance siren circuit using Timer IC.
Design and implementation of Op-Amp based clocks for digital circuits.

**EXPERIMENT 4** **6 Hours**

Design and implementation of Analog Temperature Monitor with ADC

**Total: 75 Hours**

**Reference(s)**

1. Adel. S. Sedra, Kenneth C. Smith, Microelectronic Circuits Theory and Applications, 7th Edition, Oxford University, 2017.
2. Donald.A. Neamen, Electronic Circuit Analysis and Design, Tata McGraw Hill, 3rd Edition, 2010
3. David A. Bell, Electronic Devices and Circuits, Oxford Higher Education press, 5th Edition, 2010.
4. D.Roy Choudhry, Shail Jain, Linear Integrated Circuits, New Age International Pvt. Ltd, 5th Edition, 2018.
5. Sergio Franco, Design with Operational Amplifiers and Analog Integrated Circuits, 4th Edition, Tata Mc Graw-Hill, 2016
6. William D.Stanely, Operational Amplifiers with Linear Integrated Circuits. Pearson Education, 4th Edition, 2009.

## 22EC305 DATA STRUCTURES AND ALGORITHMS 2 0 2 3

**Course Objectives**

- To understand the concept of computer programming.
- To develop problem solving skills and troubleshooting techniques in electronics.
- To develop critical reasoning and problem solving abilities including the use of simulation software for designing and troubleshooting.

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

PSO2 Able to solve complex engineering problems using state-of-the-art hardware and software tools, along with analytical and managerial skills to arrive appropriate solutions.

**Course Outcomes (COs)**

1. Develop abstract data type models and design recursive algorithms.
2. Develop applications by using the concept of Stack, Queues and List.
3. Analyze various sorting and searching algorithms.
4. Apply the Binary Search tree, AVL search tree and Heap tree in writing C++ programs.
5. Apply minimum spanning tree and shortest path algorithms for real time problems.

**Articulation Matrix**

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

**UNIT I** **6 Hours**

**INTRODUCTION**

Pseudo code-Abstract Data types-Model for an ADT-ADT Implementations-Algorithm Efficiency-Designing Recursive Algorithms-Recursive Examples.

**UNIT II** **7 Hours**

**LINEAR LIST: STACKS, QUEUES AND LISTS**

Arrays: Basic Stack Operation-Stack ADT - Applications of Stack : Queues Operations- Queue ADT - Queue Applications-Linked List-Operations- Basic concepts of Circular and Doubly Linked List.

**UNIT III** **6 Hours**

**SORTING AND SEARCHING**

Sorting: Insertion Sort-Selection Sort-Bubble Sort - Quick sort-Heap sort-shell sort-External Sorts-Merge sort-Searching: Sequential search- Binary Search - Hashing-General Idea - Hash Function - Separate Chaining - Open Addressing - Linear Probing.

**UNIT IV** **5 Hours**

**NON LINEAR LIST: TREES**

Basic Tree concepts - Binary Trees-Tree Traversals -Expression Trees-Binary Search Trees - AVL Search Trees-Heap concepts-Implementation-Heap Applications: Priority Queue.

**UNIT V** **6 Hours**

**GRAPHS**

Definitions - Graph Representations - Adjacency matrix- Adjacency List-Traverse Graph: Depth first Traversal-Breadth first Traversal-Shortest Path Algorithms: Dijkstra"s Algorithm. Minimum Spanning Tree: Prim's Algorithm- Kruskal's Algorithm.

**EXPERIMENT 1** **4 Hours**

Design an MP3 player using singly linked list and its operations.

**EXPERIMENT 2** **3 Hours**

Design a shopping cart using stack and generate the history of the customer purchase details using queue.

**EXPERIMENT 3** **4 Hours**

Implementation of storing a web browser's history.

**EXPERIMENT 4** **4 Hours**

Interrupt handling in real-time systems.

**EXPERIMENT 5** **3 Hours**

Design a program to implement a phonebook using sorting.

**EXPERIMENT 6** **4 Hours**

Design a program to store the possible moves in a chess game using tree data structure.

**EXPERIMENT 7** **4 Hours**

Design a postfix calculator (1 3 2 4 * - should calculate 1 - (3 * (2 4))) using stack.

**EXPERIMENT 8** **4 Hours**

Scanning a hierarchical file system directory structure.

**Total: 60 Hours**

**Reference(s)**

1. F.Richard Gilberg, A.Behrouz. Forouzan, Data Structures, A Pseudocode Approach with C, Thomson,2007.
2. M. A. Weiss, Data Structures and Algorithm Analysis in C, Pearson Education, 2009.
3. Y. Langsam, M. J. Augenstein and A. M. Tenenbaum, Data Structures using C, Pearson Education,2004.
4. A. M.AhoHopcroft and J.D. Ullman, Data Structures and Algorithms, Pearson education, 2000.

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

**Course Outcomes (COs)**

1. Understand the 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 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | - | - | - | - | - | - | - | 3 | 2 | 1 | - | - | - | - |
| 2 | - | - | - | - | - | - | - | 3 | 2 | 1 | - | - | - | - |
| 3 | - | - | - | - | - | - | - | 3 | 2 | 1 | - | - | - | - |
| 4 | - | - | - | - | - | - | - | 3 | 2 | 1 | - | - | - | - |
| 5 | - | - | - | - | - | - | - | 3 | 2 | 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 efficaciously and proficiently.
- 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 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 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 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | - | - | - | - | - | - | - | - | 2 | 3 | - | - | - | - |
| 2 | - | - | - | - | - | - | - | - | 2 | 3 | - | - | - | - |
| 3 | - | - | - | - | - | - | - | - | 2 | 3 | - | - | - | - |
| 4 | - | - | - | - | - | - | - | - | 2 | 3 | - | - | - | - |
| 5 | - | - | - | - | - | - | - | - | 2 | 3 | - | - | - | - |

**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.Mitra, Oxford University Press, 2012
6. Business English by Ken Taylor, Orient Blackswan, 2011

## 22EC401 SIGNALS AND SYSTEMS 3 1 0 4

**Course Objectives**

- Understand the Mathematical Representation of Signals and Systems
- Interpret the concept of Linear Time Invariant Systems and the Convolution property.
- Represent Continuous Time and Discrete Time signals using Fourier Series and Fourier Transform
- Represent Continuous Time and Discrete Time systems using Laplace and z Transforms

**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.

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

PSO2 Able to solve complex engineering problems using state-of-the-art hardware and software tools, along with analytical and managerial skills to arrive appropriate solutions.

**Course Outcomes (COs)**

1. Analyze a given signal or a system by applying the mathematical representation.
2. Apply the concept of Convolution to predict the behavior of a given Linear Time Invariant System
3. Analyze the frequency domain representation of a given Continuous Time periodic signal using Fourier Series and aperiodic signal using Fourier Transform
4. Analyze the frequency domain representation of a given Discrete Time periodic signal using Discrete Time Fourier series and aperiodic signal using Discrete Time Fourier Transform.
5. Analyze the frequency response and stability of a Continuous Time System using Laplace Transform and Discrete Time System using z Transform.

**Articulation Matrix**

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

**UNIT I** **10 Hours**

**INTRODUCTION TO SIGNALS AND SYSTEMS**

Definition of Signal, Classification of Signals, Elementary Signals, Operations on Signals, Correlation of Signals, Definition of System, Classification of Systems.

**UNIT II** **8 Hours**

**TIME DOMAIN ANALYSIS OF LINEAR TIME INVARIANT SYSTEMS**

Concept of Impulse Response, Convolution Integral and Convolution Sum, Properties of LTI Systems, Interconnection of LTI Systems, System Stability.

**UNIT III** **9 Hours**

**FREQUENCY DOMAIN ANALYSIS OF CONTINUOUS TIME SIGNALS**

Continuous Time Fourier Series (CTFS), Properties of CTFS, Continuous Time Fourier Transform (CTFT), Properties of CTFT, Gibbs Phenomena, Dirichlet Conditions.

**UNIT IV** **8 Hours**

**FREQUENCY DOMAIN ANALYSIS OF DISCRETE TIME SIGNALS**

Discrete Time Fourier Series, Properties of DTFS, Discrete Time Fourier Transform, Properties of DTFT, Comparison of CTFS, CTFT, DTFS and DTFT.

**UNIT V** **10 Hours**

**FREQUENCY DOMAIN ANALYSIS OF SYSTEMS**

Laplace Transform, Properties of Laplace Transform, Stability of Continuous Time Systems, Frequency Response of Continuous Time Systems, The z Transform, Properties of z Transform, Stability of Discrete Time Systems, Frequency Response of Discrete Time Systems.

**Tutorial: 15 Hours**

**Total: 60 Hours**

**Reference(s)**

1. Signals and Systems, Alan V. Oppenheim, Alan S. Willsky, Syed Hamid Nawab, 2nd Edition, Pearson, 2013.
2. Principles of Linear Systems and Signals, B. P. Lathi, 2nd Edition, Oxford University Press, 2009.
3. Signals and Systems, Simon Haykin, Barry Van Veen, 2nd Edition, John Wiley & Sons, 2007.
4. Signals and Systems, Tarun Kumar Rawat, Oxford University Press, 2010.
5. Signals, Systems, Transforms, and Digital Signal Processing with MATLAB, Michael Corithios, CRC Press, 2018.

## 22EC402 ANALOG COMMUNICATION 3 0 2 4

**Course Objectives**

- To analyze various analog modulation and demodulation techniques.
- To describe the behavior of analog communications in the presence of noise and also analyze the noise performance of various AM and FM receivers.
- To design and analyze various Pulse analog modulations.

**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.

PO7 Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

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

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.

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

PSO2 Able to solve complex engineering problems using state-of-the-art hardware and software tools, along with analytical and managerial skills to arrive appropriate solutions.

**Course Outcomes (COs)**

1. Analyze the mathematical model for generation and detection of different AM systems based on time domain representation and its spectrum
2. Design of FM Transmission & Reception system and analyze it with its mathematical model.
3. Analyze the effect of noise on communication receivers.
4. Compare the noise performance of AM and FM receivers.
5. Apply the concepts of the sampling process and determine the characteristics of Pulse Analog Modulation schemes.

**Articulation Matrix**

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

**UNIT I** **9 Hours**

**AMPLITUDE MODULATION SYSTEMS**

Generation and demodulation of AM, DSB-SC, SSB-SC, VSB Signals, Filtering of sidebands, Comparison of Amplitude modulation systems, Frequency translation, Frequency Division multiplexing, AM transmitters, AM receivers.

**UNIT II** **9 Hours**

**FREQUENCY MODULATION SYSTEMS**

Angle modulation, frequency modulation, Narrowband and wideband FM, transmission bandwidth of FM signals, Generation of FM signal: Direct FM, indirect FM, Demodulation of FM signals, FM stereo multiplexing, PLL: Nonlinear model and linear model of PLL, Non-linear effects in FM systems, FM Broadcast receivers, FM stereo receiver.

**UNIT III** **9 Hours**

**NOISE PERFORMANCE OF DSB, SSB RECEIVERS**

Noise: Shot noise, thermal noise, White noise, Noise equivalent Bandwidth, Narrowband noise, Representation of Narrowband noise in terms of envelope and phase components, Sine wave plus Narrowband Noise, Receiver model, Noise in DSB-SC receiver, Noise in SSB receiver.

**UNIT IV** **9 Hours**

**NOISE PERFORMANCE OF AM AND FM RECEIVERS**

Noise in AM receivers threshold effect, Noise in FM receivers capture effect, FM threshold effect, FM threshold reduction, Pre-emphasis and de-emphasis in FM, Comparison of performance of AM and FM systems.

**UNIT V** **9 Hours**

**PULSE MODULATION**

Sampling process: sampling theorem for band limited signals, ideal and practical sampling, Anti-aliasing and reconstruction filters, Generation and detection of Pulse Amplitude Modulation (PAM), Generation and detection of Pulse Width Modulation (PWM), Generation and detection of Pulse Position Modulation (PPM), Generation and detection of Pulse Time Modulation (PTM), Time division Multiplexing, Crosstalk effect.

## EXPERIMENT 1 **7 Hours**

Design and Construct AM Radio Circuit to receive radio signal from all India radio.

## EXPERIMENT 2 **7 Hours**

Design and Construct FM Radio Circuit to receive radio signal from BIT FM.

**EXPERIMENT 3** **8 Hours**

Generate a Pulse width modulated signal using a Controller and vary the speed of the DC motor using the PWM signal.

**EXPERIMENT 4** **8 Hours**

Generate an audio file and music file with different frequencies. Develop a mixer circuit to produce single output by combining both signals.

**Total: 75 Hours**

**Reference(s)**

1. Simon Haykin, Communication Systems, John Wiley & sons, NY, 5th Edition, 2016
2. Michael P. Fitz, Fundamentals of Communication Systems, Tata McGraw-Hill, 2nd Edition-2013.
3. Taub and Schilling, Principles of communication systems, TMH, New Delhi, 4th Edition, 2017.
4. Bruce Carlson et al, Communication systems, McGraw-Hill Int., 4th Edition, 2007.
5. Michael Moher Simon Haykin, An Introduction to Analog & Digital Communications, 2nd Edition, 2012.

## 22EC403 ELECTROMAGNETIC FIELDS AND WAVEGUIDES

**3 1 0 4**

**Course Objectives**

- To understand the concepts of electrostatics, electric potential, energy density, magnetostatics and their applications.
- To analyse the electric field in material space and understand to solve boundary value problems
- To apply Maxwells equations to determine field waves, potential waves, energy and charge conservation conditions

**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

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.

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

PSO2 Able to solve complex engineering problems using state-of-the-art hardware and software tools, along with analytical and managerial skills to arrive appropriate solutions.

**Course Outcomes (COs)**

1. Apply vector calculus to static electromagnetic fields and analyse the behaviour of static electric field of various geometries and its scalar potential using Coulomb"s Law and Gauss Law.
2. Analyze the behavior of static magnetic field for various applications and its vector potential using Biot-Savart Law and Amperes Circuital Law.
3. Analyze the boundary conditions of electric and magnetic field and determine the capacitance and inductance of various geometries.
4. Analyze Maxwells equation in different forms to determine field waves, potential waves, energy and charge conservation conditions.
5. Analyze the concept of propagating modes, TE and TM decomposition, evanescent modes and cut off frequency in waveguides.

**Articulation Matrix**

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

**UNIT I** **9 Hours**

**ELECTROSTATIC FIELDS**

Coordinate System, Del- Gradient- Divergence- Curl, Coulomb"s Law - Electric Field Intensity and its analysis of various geometries -Electric Scalar Potential - Relationship between potential and electric field-electric flux density- Gauss Law and its Applications.

**UNIT II** **9 Hours**

**MAGNETOSTATICS FIELDS**

Biot- Savart Law and Field Intensity - Analysis of Magnetic Field intensity due to various geometries - Amperes Circuital Law and its Applications -Magnetic Scalar and Vector Potentials-Magnetic Flux Density.

**UNIT III** **9 Hours**

**ELECTROMAGNETIC FIELDS IN MATERIAL SPACE AND BOUNDARY VALUE PROBLEMS**

Boundary Condition - Boundary conditions for electric fields. Capacitance - Capacitance of various geometries using Laplace equation- - Magnetic boundary conditions- Inductors-inductances - magnetic energy stored in inductors, EMI/EMC concepts and definitions, Sources of EMI.

**UNIT IV** **9 Hours**

**TIME VARYING ELECTROMAGNETIC FIELDS**

Maxwells Equations -Time-Varying Potentials. Wave Propagation-Helmholtz wave Equation-wave motion in free space- perfect dielectric- lossy dielectric and good conductor- skin effect. Poynting vector and power considerations.

**UNIT V** **9 Hours**

**WAVEGUIDES**

Plane Waves- Waves between parallel planes of perfect conductors, Rectangular waveguides- Transverse Magnetic (TM) Modes -Transverse Electric (TE) Modes, Impossibility of TEM waves in waveguides, Dominant mode in rectangular wave guide, Velocities of propagation.

**Tutorial: 15 Hours**

**Total: 60 Hours**

**Reference(s)**

1. Matthew Sadiku,Elements of Electromagnetics,Oxford University seventh edition-2018
2. Edward C. Jordon, Keith G. Balmain,Electromagnetic Waves and Radiating Systems,Pearson, prentice hall.2015
3. Joseph A. Edminister, Theory and Problems of Electromagnetics-Schaum series-TMH-4/E-2014
4. William H Hayt, John A Buck, Engineering Electromagnetics, McGraw-Hill Higher Education, 8th edition, 2011
5. J.D. Kraus and D.A Fleisch, Electromagnetics with applications,5/e-Tata McGraw-Hill- 2017.
6. Bhag Guru and Huseyin Hiziroglu, Electromagnetic Field Theory Fundamentals, Cambridge University Press, 2nd edition, 2009

## 22EC404 CMOS DIGITAL INTEGRATED CIRCUITS 3 0 2 4

**Course Objectives**

- To understand the CMOS fabrication process, circuits and physical design
- To design and analyze the MOS circuits using various logic styles.
- To analyze the different test methods for CMOS circuits

**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 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 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. Attribute various fabrication technologies used to represent MOS circuits.
2. Design MOS circuits and analyze the factors influencing the operation of CMOS transistors
3. Analyze the different styles to construct CMOS logic circuits.
4. Analyze CMOS logic to design various digital modules for VLSI system design
5. Analyze the different methods to test VLSI circuits

**Articulation Matrix**

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

**UNIT I** **9 Hours**

**FABRICATION OF CMOS IC AND PHYSICAL DESIGN**

Silicon Semiconductor technology: Wafer processing, Oxidation, Epitaxy, Diffusion and Silicon gate process, NMOS fabrication , CMOS fabrication: n-well, p-well, Twin tub and SOI Process , Layout design rules , Stick Diagrams, CMOS Logic Gate, Implementation of given logic function using CMOS logic.

**UNIT II** **9 Hours**

**MOS CIRCUIT DESIGN PROCESS**

Basic MOS transistors: Symbols, Enhancement mode, Depletion mode transistor operation - Regions of operation, Second order effects of MOSFET, MOS Scaling, Fundamental limits of MOS scaling , CMOS inverter: DC Characteristics, Power dissipation.

**UNIT III** **9 Hours**

**CMOS LOGIC STYLES**

Static CMOS design, Pass Transistor, Transmission Gate, Tri State Circuits, Pseudo Nmos, Clocked CMOS logic , Dynamic CMOS logic: Domino logic, Charge Keeper Circuits , Dual Rail logic networks: Cascode Voltage Switch Logic.

**UNIT IV** **9 Hours**

**VLSI SYSTEM COMPONENTS**

Ripple Carry Adder, Carry Look Ahead Adder, Carry Skip Adder, Carry select Adder, Carry save Adder, Multiplier, Array, Booth, Baugh Wooley.

**UNIT V** **9 Hours**

**TESTING OF VLSI CIRCUITS**

Importance of testing, Challenges in VLSI Testing, Faults in digital circuits, Fault models in CMOS, Test pattern generation methods: Path sensitization, Boolean Difference, Built in self test.

## EXPERIMENT 1 **7 Hours**

Design and implementation of audio volume control using CMOS transistors.

## EXPERIMENT 2 **7 Hours**

Design and implementation of automated car parking system

## EXPERIMENT 3 **8 Hours**

Design a temperature control system for a greenhouse to maintain an optimal environment for plant growth

## EXPERIMENT 4 **8 Hours**

Design and simulation of Digital Calculator using EDA tools

**Total: 75 Hours**

**Reference(s)**

1. Neil.H. E Weste David Harris CMOS VLSI Design: A Circuits and Systems Perspective, 4th edition, Pearson Addison Wesley, 2015.
2. John P. Uyemura, Introduction to VLSI circuits and systems, John Wiley, 2016.
3. Kamran Eshraghian, Douglas A. Pucknell, Essentials of VLSI Circuits and Systems Prentice Hall of India, 2015.
4. Kang and Yusuf Leblebici, CMOS Digital Integrated Circuits, Tata McGraw Hill, 2014
5. Rabaey, Chandrakasan and Nikolic, Digital Integrated Circuit: A design Perspective, PHI, Second Edition ,2016.
6. Abramovici .M, Breuer M.A and Friedman A.D, Digital Systems and Testable Design, Jaico Publishing House, 2002.

**22EC405 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

**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.

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

PSO2 Able to solve complex engineering problems using state-of-the-art hardware and software tools, along with analytical and managerial skills to arrive appropriate solutions.

**Course Outcomes (COs)**

1. Construct the 8086 architecture and write ALP for 8086 processor.
2. Breakdown hardware and software architectures of Embedded Systems
3. Analyse 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 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 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 microprocessors.

**EXPERIMENT 3** **5 Hours**

Design a ranking system for students using 8086 microprocessors.

**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

**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

PO7 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 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. Select suitable strategies for sustainable management of components of environmental science
5. Analyze the impacts of population and human activities on environment

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1 | 2 | - | - | - | - | - | - | - | - | - | - | - | - |
| 2 | 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, biomagnification). 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 appreciate the nuances of the language and engage an audience
- Use advanced tools of language to improve communicative competence and prepare for professional demands at the workplace

**Program Outcomes (POs)**

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

PO10 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. 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 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 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

## 22HS010 SOCIALLY RELEVANT PROJECT

**Course Objectives**

- To develop Problem-Solving Skills
- To enhance Research and Analytical Abilities
- To promote Social Responsibility and Ethical Awareness

**Program Outcomes (POs)**

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.

PO5 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 Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

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. Interact with society conduct a field surveys and identify societal issues.
2. Analyze societal problems using engineering principles.
3. Develop plan and provide optimal solutions for social issues using their engineering knowledge and skills.
4. Prepare comprehensive reports on their findings and proposed solutions.
5. Enhance the social responsibility and ethical considerations in engineering.
6. Develop community interaction and managerial skills

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | - | 2 | - | - | 2 | - | - | 3 | 3 | 3 | - | 2 | - | - |
| 2 | - | 3 | - | - | - | - | - | 3 | 3 | 3 | - | 2 | - | - |
| 3 | - | - | 3 | - | 2 | - | - | 3 | 3 | 2 | - | 2 | - | - |
| 4 | - | - | - | - | - | - | - | 2 | 2 | 2 | - | 2 | - | - |
| 5 | - | - | - | - | - | - | - | 3 | 3 | 3 | - | 2 | - | - |
| 6 | - | - | - | - | - | - | - | 2 | 1 | 2 | - | 2 | - | - |

Students have to interact with society, conduct a field survey and identify the issues / problems available in the society. Analyze the issues using engineering knowledge, skills and attitude and provide the optimal solutions to solve the social issues and submit the report.

**Total: 40 Hours**

## 22EC501 DIGITAL COMMUNICATION 3 0 2 4

**Course Objectives**

- To infer the basics of different Digital communication techniques
- To interpret the basics concept of information theory
- To demonstrate the concept and details of error control coding techniques

**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.

PO7 Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

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

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.

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

PSO2 Able to solve complex engineering problems using state-of-the-art hardware and software tools, along with analytical and managerial skills to arrive appropriate solutions

**Course Outcomes (COs)**

1. Analyze Pulse Code Modulation schemes for digitizing analog signals and apply digital multiplexing concept for different applications
2. Design a system that transmits baseband signals with minimum distortion and analyze the level of ISI using eye pattern
3. Analyze the performance of different digital modulation /demodulation techniques
4. Evaluate the efficiency of source coding for data compression of digital data transmission
5. Perform channel coding for error detection/controlling of digital data transmission

**Articulation Matrix**

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

**UNIT I** **9 Hours**

**PULSE MODULATION**

Sources and Signals, Basic Signal Processing Operations in Digital Communication, Channels for Digital Communication.Review of Sampling process (Qualitative): Low pass and Band pass sampling, Aliasing, Signal Reconstruction Quantization: Uniform & non uniform quantization, quantization noise, Logarithmic Companding of speech signal Waveform coding: Pulse Code Modulation (PCM), Differential pulse code modulation, Adaptive differential pulse code modulation, Delta modulation

**UNIT II** **9 Hours**

**BASEBAND TRANSMISSION**

Line codes: Need for line shaping of signals, Properties of Line codes, Power Spectral Density of Unipolar / Polar RZ & NRZ, Bipolar NRZ, Manchester, Matched Filter, Inter symbol Interference, Nyquist criterion for distortion less transmission. Pulse shaping and raised cosine filter, Correlative coding, M ary schemes, Eye pattern, Equalization

**UNIT III** **9 Hours**

**CARRIER MODULATION**

Signal Representation: Orthogonality, Representation of Signals, Generation and detection of Amplitude Shift Keying (ASK) Modulation, Generation and detection of Frequency Shift Keying (FSK) Modulation, Generation and detection of Binary Phase Shift Keying (BPSK) Modulation, Generation and detection of Quaternary Phase Shift Keying QPSK) and QAM Performance of BPSK, QPSK and QAM in AWGN channel structure of Non-coherent Receivers, Principle of DPSK.

**UNIT IV** **9 Hours**

**INTRODUCTION TO INFORMATION THEORY**

Measure of information, entropy. Channel capacity and Shannons theorems, source coding techniques: Prefix code, Huffman Coding, Shannon Fano Elias Coding, Arithmetic Coding, Run length code. Channel capacity, channel coding theorem, Information capacity theorem

**UNIT V** **9 Hours**

**ERROR CONTROL CODING**

Channel coding theorem, Linear Block codes, Hamming codes, Cyclic codes, Convolutional codes, Viterbi Decoder, Turbo Codes.

## EXPERIMENT 1 **6 Hours**

Transmit and decode an audio signal (voice, music) with and without sampling which should involve reading an audio file and selecting specific samples to decode the signal.

## EXPERIMENT 2 **6 Hours**

Design a Wi-Fi (IEEE 802.11) standard at 2.4. GHz using any simulator to test practically the wifi topology in the lab environment.

**EXPERIMENT 3** **6 Hours**

Determine the coverage area, number of users, bandwidth requirements, and security needs during voice transmission in mobile communication.

**EXPERIMENT 4** **6 Hours**

Design a RFID card reader that uses QPSK modulation for long-range communication with low power consumption.

**EXPERIMENT 5** **6 Hours**

Compute error rate in the transmission of data using Bluetooth device for voice and image transmission among the users.

**Total: 75 Hours**

**Reference(s)**

1. Simon Haykins, Communication Systems John Wiley & Sons 4th Edition, 2016.
2. B.P. Lathi, Communication Systems, BS Publication, 2004.
3. K. Sam Shanmugam, Analog and Digital Communication, Wiley, 2005.
4. Proakis, J.G., Salehi, M., Digital Communications, 5th Ed., McGraw-Hill International,2008.
5. Couch II, L.W., Digital and Analog Communication Systems, 7th Ed., Pearson, 2009.
6. Sklar, B., Digital Communications, 2nd Ed., Pearson, 2001.

## 22EC502 DIGITAL SIGNAL PROCESSING 3 0 2 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

**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.

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

PSO2 Able to solve complex engineering problems using state-of-the-art hardware and software tools, along with analytical and managerial skills to arrive appropriate solutions.

**Course Outcomes (COs)**

1. Analyze the frequency domain behaviour of a given Discrete Time signal using Discrete Fourier Transform
2. Construction of Realization structures and design for IIR filters
3. Construction of Realization structures and design for FIR filters
4. Analyze the effect of finite word length for fixed & floating point number representation.
5. Develop an algorithm using TSM320C6X Processor for simple signal processing applications.

**Articulation Matrix**

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

**UNIT I** **9 Hours**

**DISCRETE FOURIER TRANSFORM: PROPERTIES, APPLICATIONS AND COMPUTATION**

The Discrete Fourier Transform, Need for DFT, DFT as a linear transformation. Properties of DFT, Linear Filtering based on DFT-Circular Convolution, Efficient Computation of DFT-Radix-2 FFT algorithm, Applications of FFT algorithm.

**UNIT II** **9 Hours**

**DESIGN OF IIR FILTERS**

Introduction to FIR and IIR filters, General consideration in the design of digital filters, Design of analogue Butterworth and Chebyshev Filters. Design of IIR digital filters using impulse invariance technique, bilinear transform. 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, Frequency sampling technique, Windowing technique. Design of FIR Differentiators, Realization of FIR filters, Direct and Linear phase realization structures.

**UNIT IV** **9 Hours**

**FINITE WORD LENGTH EFFECT IN DIGITAL FILTERS**

Fixed and Floating Point Number Representation, Quantization Noise, Finite Word Length Effects in Digital filters, Input Quantization, Product Quantization, Coefficient quantization error, Limit Cycle Oscillations, Introduction to Multirate Signal Processing, Interpolation, Decimation.

**UNIT V** **9 Hours**

**DIGITAL SIGNAL PROCESSORS**

Introduction to Digital Signal Processors, Basic Classification, Features. TMS320C6713 Architecture, Functional Unit, Pipelining, Addressing Modes, Instruction set, Simple Assembly Language Program.

**EXPERIMENT 1** **7 Hours**

Design of spectrum analyser for audio systems

**EXPERIMENT 2** **7 Hours**

Dual role of noise canceller as enhancer in headphones

**EXPERIMENT 3** **8 Hours**

Peak signal analyser with IIR filters for Pulse Oximeter Signal Applications

**EXPERIMENT 4** **8 Hours**

Ultrasonic image edge detection in frequency domain for analyzing tumour size.

**Total: 75 Hours**

**Reference(s)**

1. Digital Signal Processing by John G. Proakis and Dimitris K. Manolakis, 4th edition, Pearson Education India
2. Chasssing, Rulph, DSP applications using C and the TMS320C6x DSK. Vol 13. John Wiley and Sons,2003
3. Discrete-Time Signal Processing by Alan V. Oppenheim and Ronald W. Schafer, 3rd edition, 2010, Prentice Hall
4. Digital Signal Processing by Sanjit Mitra, 4th edition, 2011, McGraw-Hill, New York, NY.
5. Understanding Digital Signal Processing, Lyons, Richard G., 3/e, Pearson Education India,2004
6. Digital Signal Processing: A Practical Approach, Barrie W. Jervis and Emmanuel C. I feachor 2 edition, Pearson Education India,2009

## 22EC503 TRANSMISSION LINES AND ANTENNAS 3 0 2 4

**Course Objectives**

- To understand the different types of transmission lines at radio frequencies.
- To determine the radiation field of different wire antennas and analyze its parameters.
- To analyze and design travelling wave antennas and derive the radiation fields of aperture and slot antennas.
- To understand the characteristics of signals in sky wave, space wave and ground wave propagation 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

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.

PO6 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 Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

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

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

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

PSO2 Able to solve complex engineering problems using state-of-the-art hardware and software tools, along with analytical and managerial skills to arrive appropriate solutions.

**Course Outcomes (COs)**

1. Find the voltage, current and impedance of the transmission line as a function of its characteristics impedance and propagation constant.
2. Analyze the characteristics of the transmission line at radio frequencies and apply smith chart for impedance matching.
3. Determine the radiation fields of different wire antennas, array antennas and analyze its fundamental parameters
4. Analyze the fields of different travelling wave antennas and compute the radiation fields of the Huygens source, aperture, slot and complementary dipole antennas.
5. Analyze the refractive, reflection and attenuation characteristics of the sky wave, space wave and ground wave propagation and explain the gain and directivity measurements of the antenna.

**Articulation Matrix**

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

**UNIT I** **9 Hours**

**TRANSMISSION LINE THEORY**

Different types of transmission lines, transmission line as a cascade of T Sections- Characteristic impedance and Propagation Constant. General Solution of the transmission line- wavelength and velocity of propagation, Distortions, Distortion less transmission line. The telephone cable- Inductance loading of telephone cables.

**UNIT II** **9 Hours**

**THE LINE AT RADIO FREQUENCIES**

Input impedance of lossless lines. Standing waves and standing wave ratio on a line, Input impedance of a lossless line terminated by impedance- One eighth wave line, Quarter waveline, Half wave line. Smith chart- Application of the Smith Chart, single stub matching.

**UNIT III** **9 Hours**

**ANTENNA FUNDAMENTALS AND RADIATION FIELDS OF WIRE ANTENNAS**

Concept of retarded vector potential- Half-wave dipole and folded dipole. Antenna Parameters, Reciprocity theorem and Friis transmission formula. Linear arrays- N-element Uniform linear array, Principle of pattern multiplication, Broadside and End-fire array- Array synthesis: Binomial array.

**UNIT IV** **9 Hours**

**TRAVELING WAVE ANTENNAS**

Analysis of V antenna. Analysis and Design of Rhombic antenna, Aperture concept, Huygens principle, Radiation from a rectangular aperture treated as an array of Huygens sources. Babinets principle- Equivalence of fields of a slot and complementary dipole, Horn antennas, parabolic reflector antennas.

**9 Hours**

**UNIT V**

**PROPAGATION AND ANTENNA MEASUREMENTS**

Sky wave propagation: Refractive index, Critical frequency. Skip distance. Effect of earth"s magnetic field. Maximum usable frequency. Space wave propagation: Reflection from ground for vertically and horizontally polarized waves, Duct propagation. Ground wave propagation: Attenuation characteristics for ground wave propagation.

**EXPERIMENT 1** **4 Hours**

Construct the transmission line to transmit the signal without any loss for the FM radio station.

**EXPERIMENT 2** **4 Hours**

Design and simulate the wired antennas for the TV reception system.

**EXPERIMENT 3** **4 Hours**

Design and simulate the array antennas to transmit/ receive the signals in the 4G Airtel network

**EXPERIMENT 4** **4 Hours**

Design and simulate the array antenna to avoid interference in a wireless environment of the 5G Jio network

**EXPERIMENT 5** **4 Hours**

Construct the Cellular antenna set up to measure the radiation pattern.

**EXPERIMENT 6** **5 Hours**

Design and simulate the Microstrip Patch antenna for mobile applications.

**EXPERIMENT 7** **5 Hours**

Design and simulate the Microstrip slot antenna for wi-fi applications

**Total: 75 Hours**

**Reference(s)**

1. Constantine A. Balanis, Antenna Theory Analysis and Design, John Wiley, 3rd Edition, 2016.
2. K.D. Prasad, Antenna and Wave Propagation, Sathya Praksham, 2001.
3. E.C. Jordan & K.G. Balmain, Electromagnetic Waves and Radiating Systems, Prentice Hall of India 2nd edition 2003.
4. J.D. Ryder, Networks, Lines and Fields, PHI, 2nd Edition, 2010.
5. Warren L. Stutzman, Gary A. Thiele, Antenna Theory and Design, Wiley, 3rd Edition 2012.
6. Miano, Giovanni, and Maffucci, Antonio, Transmission Lines and Lumped Circuits: Fundamentals and Applications, Ukraine, Elsevier Science, 2001.

## 22EC504 INTERNET OF THINGS AND ITS APPLICATIONS

**3 0 2 4**

**Course Objectives**

- To evaluate the performance of STM32 Microcontroller.
- To analyze the various protocols of IoT with application development.
- To analyze the distinct architecture and framework of LoRa WAN IoT.
- To evaluate the diverse applications of 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 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 Able to apply the concepts of Electronics, Communication, Signal processing and VLSI in the design and implementation of application oriented engineering systems.

PSO2 Able to solve complex engineering problems using state-of-the-art hardware and software tools, along with analytical and managerial skills to arrive appropriate solutions.

**Course Outcomes (COs)**

1. Analyse the specifications of STM32 Microcontroller.
2. Breakdown the architecture, monitoring and controlling by IoT with target boards.
3. Analyse the various protocols of IOT deployed in applications.
4. Differentiate the architecture and procedure involved in communication through LoRa and LoRaWAN.
5. Execute IoT in desperate applications.

**Articulation Matrix**

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

**UNIT I** **9 Hours**

**STM32 MICROCONTROLLER**

ARM Cortex-M Processors - Instruction Set Architecture - Data Flow and Register Set- GPIO Registers - ADC-USART-I2C-Timers

**UNIT II** **9 Hours**

**IoT ARCHITECTURE -STATE OF THE ART**

IoT reference Model and Architecture- Functional View, Information View, Deployment and Operational View, Other Relevant architectural views, Middleware Introduction-Fi Ware etc., Remote monitoring and sensing, remote controlling and performance analysis, layering concepts, communication pattern, 6LoWPAN, Sensors and sensor Node and interfacing using any Embedded Target boards.

**UNIT III** **9 Hours**

**IoT APPLICATION DEVELOPMENT**

IoT Protocols - Protocol Standardization for IoT - Efforts - M2M and WSN Protocols, Application protocols: IEEE802.15.4 - Modbus, MQTT, REST/HTTP, MySQL, Back-end Application Designing Apache for handling HTTP Requests, HTML, CSS & jQuery for UI Designing, JSON lib for data processing, Security & Privacy during development, IoT Devices and deployment models.

**UNIT IV** **9 Hours**

**LoRaWAN IoT**

LoRaWAN architecture, Difference between LoRa and LoRaWAN architecture, Configuring Gateway for LoRa Communication, Introduction to Application Server, Data Monitoring & Device Control between End Node and Application server using LoRa communication & MQTT/HTTP, Introduction to Open Source LoRaWAN Server, Configuring Gateway for LoRaWAN Communication.

**UNIT V** **9 Hours**

**CASE STUDIES**

Security, Privacy and Trust in IoT-Data-Platforms for Smart Cities, First Steps towards a Secure Platform, Data Aggregation for the IoT in Smart Cities, IoT applications for industry: Industry 4.0, Future Factory Concepts, Brownfield IoT, Smart Objects.

## EXPERIMENT 1 **6 Hours**

Real-Time Weather Monitoring and Cloud-Based Data Logging.

## EXPERIMENT 2 **6 Hours**

Real-Time IoT Monitoring and Cloud Integration for Industrial Safety: Vibration Detection and Hazardous Gas Monitoring.

**EXPERIMENT 3** **6 Hours**

Real-Time Soil Nutrient Monitoring for Smart Agriculture.

**EXPERIMENT 4** **6 Hours**

Real-Time IoT Integration for Smart Manufacturing: Interfacing PLC-Controlled Conveyor.

**EXPERIMENT 5** **6 Hours**

Industrial Energy Monitoring by Interfacing EL Energy Meter.

**Total: 75 Hours**

**Reference(s)**

1. Geoffrey Brown, Discovering the STM32 Microcontroller, Indiana University, 2016.
2. Colin Dow, Perry Lea, Mastering IOT, Packt Publishing, First Published by 2019.
3. Mohammad Ali Jabraeil Jamali, Bahareh Bahrami, Arash Heidari, Parisa Allahverdizadeh, Farhad Norouzi, Towards the Internet of Things, Architectures, Security, and Applications, Springer International Publishing, 2020.
4. Information Resources Management Association, Smart Cities and Smart Spaces Concepts, Methodologies, Tools, and Applications, IGI Global, 7 September 2018.
5. Cristian Gonzalez Garcia, Vicente Garcia-Diaz, IoT Protocols and Applications for Improving Industry, Environment, and Society, IGI Global, 2021

**22EC507 MINI PROJECT I 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 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.

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

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.

PO11 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 Able to apply the concepts of Electronics, Communication, Signal processing and VLSI in the design and implementation of application oriented engineering systems.

PSO2 Able to solve complex engineering problems using state-of-the-art hardware and software tools, along with analytical and managerial skills to arrive appropriate solutions.

**Course Outcomes (COs)**

1. Find a real world problem, identify the requirement and develop the design solutions.
2. Predict 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 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1 | 2 | 1 | 1 | 2 | - | - | 2 | 2 | 2 | - | - | 1 | 1 |
| 2 | 1 | 2 | 1 | 1 | 2 | - | - | 2 | 2 | 2 | - | - | 1 | 1 |
| 3 | 1 | 2 | 1 | 1 | 2 | - | - | 2 | 2 | 2 | 2 | - | 1 | 1 |
| 4 | 1 | 2 | 1 | 1 | 2 | - | - | 2 | 2 | 2 | 2 | - | 1 | 1 |
| 5 | 1 | 2 | - | - | 2 | - | - | 2 | 2 | 2 | - | - | 1 | 1 |

## 22EC601 COMPUTER NETWORKS AND PROTOCOLS

**3 0 0 3**

**Course Objectives**

- To understand the fundamental concept of networks and issues involved in the network system.
- To acquire an insight view and knowledge to design various layer protocols.
- To realize the concepts of application layer protocol including client/server models.

**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.

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

PSO2 Able to solve complex engineering problems using state-of-the-art hardware and software tools, along with analytical and managerial skills to arrive appropriate solutions.

**Course Outcomes (COs)**

1. Use OSI and TCP/IP models, basic topologies with emerging computer networks.
2. Apply the appropriate random access protocols, flow and error control schemes to solve the data link layer issues.
3. Analyze the network layer impairments for switchingtechniques, routing algorithms and protocols.
4. Analyze the performance of transport layer protocols by adopting suitable congestion control schemes.
5. Apply the knowledge of application layer protocols to design energy efficient networks.

**Articulation Matrix**

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

**UNIT I** **9 Hours**

**INTRODUCTION TO NETWORKS**

Network architecture, Topology, Types (LAN, MAN, WAN &PAN), Network Switching Types: Circuit and packet switching, OSI Reference Model, TCP/IP model, Comparison. Different types of transmission media, Errors in transmission: attenuation, noise, Repeaters.

**UNIT II** **9 Hours**

**DATA LINK LAYER**

MAC Layer: Aloha, CSMA, CSMA/CD, CSMA/CA protocols, IEEE standards: Ethernet, Token Ring, Bluetooth, Wi-Fi, VLAN, Error detection codes: Parity, CRC, Checksum.

**UNIT III** **9 Hours**

**NETWORK LAYER**

Internet Protocol, IPv4, IPv6, ARP, DHCP, Inter domain routing, Subnetting, Classless addressing, Network Address Translation.

**UNIT IV** **9 Hours**

**TRANSPORT LAYER**

Connectionless: UDP, Connection Oriented: TCP Connection establishment and termination, flow and congestion control, Noiseless channel: Stop and Wait, Noisy channel: Stop and Wait ARQ, Go back N ARQ, Selective repeat ARQ.

**UNIT V** **9 Hours**

**APPLICATION LAYER**

DNS, Electronic Mail: SMTP, POP3, IMAP, Client server &P2P Architecture, HTTP, SNMP.

**Total: 45 Hours**

**Reference(s)**

1. Ying-Dar Liu, Ren-Hung Hwang, Fred Baker, "Computer Networks: An Open Source Approach", McGraw-Hill, 2011.
2. W Stallings, Cryptography and Network Security, Principles and Practice, 5th Ed., Prentice-Hall, 2010
3. Srinivasan Keshav - Mathematical Foundations of Computer Networking-Addison-WesleyProfessional (2012)
4. Andrew S. Tanenbaum, "Computer Networks", Fifth Edition, Pearson Education India, 2013.
5. Michael Donahoo, Ken Calvert, Pocket Guide to TCP/IP Socket Programming in C, Morgan Kaufmann Series in Networking, 2000.

## 22EC602 DIGITAL SYSTEM DESIGN WITH FPGA 3 0 2 4

**Course Objectives**

- To understand the capabilities of PLDs and FPGA IC technologies
- To perform Verilog FPGA Programming
- To realize the digital systems in an FPGA

**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.

PO6 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 Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

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

PSO2 Able to solve complex engineering problems using state-of-the-art hardware and software tools, along with analytical and managerial skills to arrive appropriate solutions

**Course Outcomes (COs)**

1. Analyze the different programmable IC technologies
2. Design a digital logics using Verilog HDL
3. Design a digital logics using advanced Verilog HDL and verify using test bench
4. Design a digital systems using Verilog HDL
5. Design a advanced digital system using Verilog HDL

**Articulation Matrix**

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

**UNIT I** **9 Hours**

**PROGRAMMABLE IC TECHNOLOGIES**

PROM, PLA, PAL, CPLD Programmable IC Technologies: Introduction to FPGA, FPGA Implementation Process, FPGA EDA Tools, FPGA Internal Architectures, Actel ACT1, Function generators, Xilinx FPGA Internal Architecture, LUT- Programmable Interconnections.

**UNIT II** **9 Hours**

**BASICS OF VERILOG HDL**

Importance of HDL: Design Methodologies, Basic Concepts, Data Types, Verilog Operators, Dataflow Modeling, Gate Level Modeling, Behavioural Modeling: if, else, case statement, For, While Loop: Design Examples.

**UNIT III** **9 Hours**

**ADVANCED VERILOG HDL**

Switch Level Modeling: Tasks, Functions, User Defined Primitives (UDP), Timing and Delays, Verilog Test Benches for Combinational Logic Modules and Sequential Digital Circuits - Design Examples.

**UNIT IV** **9 Hours**

**SYSTEM DESIGN USING VERILOG**

ALU: Magnitude Comparator, Multiplication Unit, Adder/Subtractor, MAC Unit, Universal Shift Register, Barrel Shifter, Random Number Generator.

**UNIT V** **9 Hours**

**ADVANCED DIGITAL SYSTEM DESIGN USING VERILOG**

Traffic Light Controller: Vending Machine Controller, Single and Dual Port RAM, Real Time Clock, PCI Arbiter Design, Nth Order W-bit FIR & IIR Filter with Constant Coefficients, FIFO.

**EXPERIMENT 1** **4 Hours**

Design and Implementation of 16 Bit Magnitude Comparator using Behavioral HDL.

**EXPERIMENT 2** **4 Hours**

Design of Universal shift register using Structural Modeling.

**EXPERIMENT 3** **5 Hours**

Design and Implementation of Adder/Subtractor Design using HDL.

**EXPERIMENT 4** **5 Hours**

Design and Implementation ALU using HDL.

**EXPERIMENT 5** **6 Hours**

Design and Simulation of Real Time Clock using Behavioral HDL.

**EXPERIMENT 6** **6 Hours**

Design and Simulation of Traffic Light Controller FSM using Behavioral HDL.

**Total: 75 Hours**

**Reference(s)**

1. Ming Bo Lin, Wiley, Digital System Designs and Practices using Verilog HDL and FPGAs, 2012.
2. Samir Palnitkar, Verilog HDL, Pearson Education,2ndEdition,2004.
3. J. Bhaskar, A Verilog Primer, Prentice Hall, 2005.
4. Bob Zeidman, Designing with FPGAs and CPLDs, Elsevier, CMP Books, 2002.
5. Ion Grout, Digital Systems Design with FPGAs and CPLDs, Elsevier, 2008.

## 22EC603 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 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.

PO6 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 Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

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

PSO2 Able to solve complex engineering problems using state-of-the-art hardware and software tools, along with analytical and managerial skills to arrive appropriate solutions

**Course Outcomes (COs)**

1. Analyze the concepts of intelligent agents and its structure
2. Apply 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. Apply 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 | - | - | - | - | - | - | 1 | 2 |
| 2 | 2 | 2 | 1 | 2 | - | - | - | - | - | - | - | - | 2 | 2 |
| 3 | 2 | 2 | 2 | 3 | - | - | - | - | - | - | - | - | 2 | 2 |
| 4 | 3 | 2 | 2 | 1 | - | - | 2 | - | - | - | - | - | 1 | 2 |
| 5 | - | 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.

**EXPERIMENT 1** **4 Hours**

Develop PEAS descriptions for given AI Experiment.

**EXPERIMENT 2** **5 Hours**

Implement basic search strategies for selected AI applications.

**EXPERIMENT 3** **5 Hours**

Implement a classifier for the sales data.

**EXPERIMENT 4** **5 Hours**

Develop a predictive model for predicting house prices.

**EXPERIMENT 5** **5 Hours**

Apply reinforcement learning and develop a game of your own.

**EXPERIMENT 6** **6 Hours**

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

**22EC607 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 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.

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

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.

PO11 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 Able to apply the concepts of Electronics, Communication, Signal processing and VLSI in the design and implementation of application oriented engineering systems.

PSO2 Able to solve complex engineering problems using state-of-the-art hardware and software tools, along with analytical and managerial skills to arrive appropriate solutions.

**Course Outcomes (COs)**

1. Find a real-world problem, identify the requirements, and develop the design solutions.
2. Assess 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 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1 | 2 | 1 | 1 | 2 | - | - | 2 | 2 | 2 | - | - | 1 | 1 |
| 2 | 1 | 2 | 1 | 1 | 2 | - | - | 2 | 2 | 2 | - | - | 1 | 1 |
| 3 | 1 | 2 | 1 | 1 | 2 | - | - | 2 | 2 | 2 | 2 | - | 1 | 1 |
| 4 | 1 | 2 | 1 | 1 | 2 | - | - | 2 | 2 | 2 | 2 | - | 1 | 1 |
| 5 | 1 | 2 | - | - | 2 | - | - | 2 | 2 | 2 | - | - | 1 | 1 |

## 22EC701 MICROWAVE ENGINEERING 2 0 2 3

**Course Objectives**

- To understand the importance of various microwave components in several communication applications.
- To study the performance of microwave components using certain performance estimation parameters
- To understand the fundamental concepts about microwave semiconductor 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 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 Able to apply the concepts of Electronics, Communication, Signal processing and VLSI in the design and implementation of application oriented engineering systems.

PSO2 Able to solve complex engineering problems using state-of-the-art hardware and software tools, along with analytical and managerial skills to arrive appropriate solutions.

**Course Outcomes (COs)**

1. Analyze the working and performance of RF and its network characterisation of waveguide.
2. Analyze the working and performance of Microwave signal generators.
3. Analyze the working of high frequency semiconductor devices.
4. Analyze the measurement techniques using microwave test bench, Vector Network Analyzer and Spectrum Analyzer
5. Analyze the performance of planar transmission lines.

**Articulation Matrix**

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

**UNIT I** **6 Hours**

**HIGH FREQUENCY NETWORK CHARACTERIZATION**

Scattering Parameters: Definition, Chain Scattering Matrix, Conversion of S-parameters, Generalized S-parameters and Practical Measurements; S parameter representation of N port networks, properties - S Matrix of a Directional Coupler- waveguide tees and rat race coupler-Qualitative discussion on: Waveguide Corners- Bends- Twists- Matched loads and movable shorts.

**UNIT II** **6 Hours**

**MICROWAVE SIGNAL GENERATOR**

Two cavity Klystron amplifier - Transit time effect- Velocity modulation - current modulation-bunching - Reflex Klystron-Slow-Wave structures - Helix Travelling -Wave Tubes- Convection Current- Axial Electric Field- Wave Modes- Bandwidth, Power and Gain Considerations - cross field device. Magnetron - power and frequency considerations.

**UNIT III** **6 Hours**

**HIGH FREQUENCY SEMICONDUCTOR DEVICES**

Gunn-Effect -Gunn Diode- Differential Negative Resistance- Modes of Operation-Amplification-Microwave Generation Read Diode- Physical Description- Avalanche Multiplication IMPATT Diodes-TRAPATT Diode- BARITT Diode-Principles of Operation- Physical Structures; RF Bipolar Junction Transistor

**UNIT IV** **6 Hours**

**MICROWAVE MEASUREMENTS**

Slotted line VSWR measurement- impedance measurement- insertion loss and attenuation measurements-measurement of scattering parameters - Return loss measurement using directional coupler-Introduction to vector network analyzer and its uses- return loss and insertion loss-Measurement of return loss and Insertion loss using Spectrum analyzer.

**UNIT V** **6 Hours**

**PLANAR TRANSMISSION LINES**

Introduction- Microstrip Lines- Derivation of Characteristic Impedance of Microstrip Lines using Quasi Static analysis- Losses in Microstrip Lines- Quality Factor Q of Microstrip Lines- Parallel Strip Lines-Characteristic Impedance-Attenuation losses- Coplanar Strip Lines- Shielded Strip Line-Problems

## EXPERIMENT 1 **2 Hours**

Study of Microwave components

## EXPERIMENT 2 **2 Hours**

Reflex klystron characteristics

**EXPERIMENT 3** **2 Hours**
Gunn diode VI characteristics

**EXPERIMENT 4** **2 Hours**
VSWR measurement (low and High VSWR)

**EXPERIMENT 5** **2 Hours**
Attenuation measurement, Impedance and frequency measurement

**EXPERIMENT 6** **2 Hours**
Directional coupler characteristics

**EXPERIMENT 7** **2 Hours**
Scattering parameters of E-plane Tee, H-plane and Magic Tee

**EXPERIMENT 8** **2 Hours**
Radiation Characteristics of Horn Antenna and Parabolic antenna

**EXPERIMENT 9** **2 Hours**
Frequency and wavelength determination in a rectangular wave guide working in TE10 mode.

**EXPERIMENT 10** **2 Hours**
Study of Circulator and Isolator characteristics.

**EXPERIMENT 11** **2 Hours**
Design and simulation of microwave couplers

**EXPERIMENT 12** **4 Hours**
Design of Linear and circular polarisation of antennas

**EXPERIMENT 13** **4 Hours**
Design and Simulation of transmission and reception using advanced antennas

**Total: 60 Hours**

**Reference(s)**

1. David.M. Pozar, Microwave Engineering, John Wiley, 2003
2. Samuel.Y. Liao, MicrowaveDevices and Circuits, PHI, 2000.
3. Reinhold Ludwig, Gene Bogdanow, RF Circuit Design-Therory and Applications, Pearson, 2011
4. Annapurna Das and SisirK.Das, Microwave Engineering, Tata Mc Graw-Hill,2000.
5. R.E. Collin, Foundations for Microwave Engineering - IEEE Press 2002.International, 1999.
6. Sushrut Das, Microwave Engineering, Oxford university Press, 2014

## 22EC702 WIRELESS COMMUNICATION 3 0 2 4

**Course Objectives**

- To impart the fundamental concepts of wireless communication systems.
- To compare various technologies and protocols involved in wireless cellular communication
- To understand the concepts of signalling schemes for fading channels and analyze its channel capacity.

**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.

PO6 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 Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

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. Assess wave propagation mechanisms and reason for fading to select the appropriate propagation path loss model depending on wireless channel model.
2. Apply innovative ideas in the field of wireless communication, in particular how to communicate effectively and efficiently in wireless cellular communication.
3. Compare the performance of various digital signaling techniques implemented in fading channels of wireless systems.
4. Analyse the mathematical framework for design of wireless systems developed based on suitable equalization and diversity techniques.
5. Apply the innovative ideas to improve the existing technology in the field of digital communication through Multiple access techniques and multicarrier modulation

**Articulation Matrix**

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

**UNIT I** **9 Hours**

**WIRELESS CHANNELS**

Electromagnetic Wave Propagation Mechanisms, Reflection, Diffraction, Scattering Models, Large scale path loss, Path loss models: Free Space and Two-Ray models, Link Budget design, Small scale fading- Parameters of mobile multipath channels, Time dispersion Parameters-Coherence bandwidth, Doppler spread and Coherence time, fading due to Multipath time delay spread, flat fading, frequency selective fading, Fading due to Doppler spread, fast fading, slow fading.

**UNIT II** **9 Hours**

**CELLULAR MOBILE WIRELESS SYSTEMS**

Cellular concept, Frequency reuse, channel assignment Strategies, Hand off, Interference and system capacity, Trunking & grade of service, Coverage and capacity improvement.

**UNIT III** **9 Hours**

**DIGITAL SIGNALING FOR FADING CHANNELS**

Modulation techniques: Offset-QPSK, p/4-DQPSK, MSK- GMSK, M QAM, M PSK, OFDM, Spread Spectrum Systems: PN sequence, m sequence, Direct Sequence Spread Spectrum, Frequency Hopping Spread Spectrum.

**UNIT IV** **9 Hours**

**EQUALIZATION AND DIVERSITY TECHNIQUES**

Fundamentals of equalization, Equalizers in communication receivers: Linear equalization, Non-linear equalization: DFE, MLSE Equalizer, Adaptive Equalizer. Diversity Techniques: Time diversity, Antenna diversity, Frequency diversity, Polarization diversity, RAKE Receiver

**UNIT V** **9 Hours**

**MULTIPLE ACCESS TECHNIQUES AND MULTICARRIER MODULATION**

Multiple Access techniques, FDMA, TDMA, CDMA, OFDMA- Multicarrier Modulation, Data Transmission Using Multiple Carriers, Multicarrier Modulation with Overlapping Sub channels, Mitigation of Subcarrier Fading, Coding with Interleaving over Time and Frequency, Frequency Equalization, Challenges in Multicarrier Systems, Case Study: OFDM design in the Wi-Fi Standard.

**EXPERIMENT 1** **3 Hours**

Simulation of Channel model for Free space propagation loss and log normal shadowing models

**EXPERIMENT 2** **3 Hours**

Simulation of Frequency Division Multiple access transmitter and receiver systems using MATLAB

**EXPERIMENT 3** **3 Hours**

BER simulation of OFDM system over multipath fading channel.

**EXPERIMENT 4** **3 Hours**
BER simulation of OFDM system over multipath fading channel.

**EXPERIMENT 5** **3 Hours**
Simulation of Frequency Division Multiple access techniques for communication systems

**EXPERIMENT 6** **3 Hours**
Simulation of CDMA transmitter and receiver using MATLAB

**EXPERIMENT 7** **3 Hours**
Simulation of Direct sequence spread spectrum modulation and demodulation using MATLAB

**EXPERIMENT 8** **3 Hours**
Analysis and comparison of BPSK/QPSK BER performance in Rayleigh and Racian fading channel

**EXPERIMENT 9** **3 Hours**
Generation of OFDM Transmitter and receiver systems using SDR kit

**EXPERIMENT 10** **3 Hours**
Generation of OFDM Transmitter and receiver systems using SDR kit

**Total: 75 Hours**

**Reference(s)**

1. Cory Beard and William Stallings, "Wireless Communication Networks and Systems" Pearson, 2015.
2. ITI Saha Misra, "Wireless Communication and Networks: 3G and beyond", McGraw Hill Education Pvt Ltd., Second edition, 2013.
3. K. Daniel Wong, "Fundamentals of Wireless Communication Engineering Technologies" Wiley, 2012.
4. David Tse and Pramod Viswanath, Fundamentals of Wireless Communication, Cambridge University Press, 2005
5. T.S. Rappaport, Wireless Communications: Principles and Practice, Second Edition, Pearson Education/ Prentice Hall of India, Third Indian Reprint 2003.
6. Mischa Schwartz, "Mobile Wireless Communications", Cambridge University Press, 2005

## 22EC707 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 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.

PO6 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 Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

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

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.

PO11 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 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.

PSO2 Able to solve complex engineering problems using state-of-the-art hardware and software tools, along with analytical and managerial skills to arrive appropriate solutions.

**Course Outcomes (COs)**

1. Find a real-world problem, identify the requirements, and develop the design solutions.
2. Assess 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 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 |

## 22EC801 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 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.

PO6 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 Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

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

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.

PO11 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 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.

PSO2 Able to solve complex engineering problems using state-of-the-art hardware and software tools, along with analytical and managerial skills to arrive appropriate solutions.

**Course Outcomes (COs)**

1. Find a real-world problem, identify the requirement, and develop the design solutions.
2. Assess 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 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.

**Program 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 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 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-EXPRESSIONRESSION**

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 TASKs, 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 FoundationBooks, 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

**Program 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 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 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

**Program 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 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 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

**Program 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 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 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 owels - Pronunciation of in, tsu, ga -Letters combined with ya, yu, yo - Daily Greetings and Expressions - umerals. 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.

**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

**Program 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 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 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

## 22EC001/22ECH01 ADVANCED PROCESSOR ARCHITECTURES

**3 0 0 3**

**Course Objectives**

- To introduce the concept of RISC and CISC microcontrollers.
- To analyze the principles of parallel processing.
- To understand the concept of shared memory architecture in multiprocessing.

**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.

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

PSO2 Able to solve complex engineering problems using state-of-the-art hardware and software tools, along with analytical and managerial skills to arrive appropriate solutions.

**Course Outcomes (COs)**

1. Implement multiprocessor cache mapping techniques, cache coherence and memory consistency models.
2. Analyze the RISC processor and interface with PIC microcontroller and various peripherals.
3. Analyze 16bit microcontroller RL78 and design microcontroller based systems for a Real Time application.
4. Apply various types of pipelining methodologies.
5. Analyze the concept of parallel architecture and programming.

**Articulation Matrix**

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

**UNIT I** **9 Hours**

**PROCESSORS AND MEMORY HIERARCHY**

Advanced processor Technology, Super scalar and vector processor, Memory hierarchy technology, Virtual Memory Technology.

**UNIT II** **9 Hours**

**RISC PROCESSOR**

RISC Vs CISC, RISC properties and evolution, Advanced RISC microcontrollers, PIC18xx microcontroller family, Architecture, Instruction set, ROM, RAM, Timer programming Serial port programming, Interrupt programming, ADC and DAC interfacing, CCP module and programming.

**UNIT III** **9 Hours**

**CISC PROCESSORS**

RL78 16 BIT Microcontroller architecture, Addressing modes, On Chip memory, ADC, Interrupts, MAC unit, Barrel shifter, Internal and external clock generation, Memory CRC, On chip debug function and self programming.

**UNIT IV** **9 Hours**

**PIPELINING AND SUPERSCALAR TECHNIQUES**

Linear Pipeline, Nonlinear pipeline, Instruction pipeline, Arithmetic pipeline, Superscalar and super pipeline design, Parallel and scalable architectures, Multiprocessor and Multicomputer.

**UNIT V** **9 Hours**

**PARALLEL ARCHITECTURE AND PROGRAMMING**

Overview of parallelism, Basic concepts in parallel programming, Microprocessor design phases and trends, Categorizations of multicore architectures, Multicore parallel processing models, Parallelization of programs, Levels of parallelism: Instruction level parallelism and Data level parallelism.

**Total: 45 Hours**

**Reference(s)**

1. Hwang. K, Advanced computer Architecture, Parallelism, Scalability, Programmability, Tata McGraw Hill, 3rd Edition, 1993.
2. Alexander G, James M. Conard, creating fast, Responsive and energy efficient Embedded systems using the Renesas RL78 microcontroller, Micrium press, USA, Reprinted by S.P Printers, 2011.
3. V.Rajaraman and C. Siva Ram Murthy, Parallel Computers Architecture and Programming, PHI, 2000.
4. Quinn, M.J., Designing Efficient Algorithms for Parallel Computers, McGraw - Hill, 2003.
5. Muhammad Ali Mazidi, Rolind D. Mckinlay and Danny Causey. PIC Microcontroller and Embedded Systems, Pearson Education, 2008.
6. Darryl Gove, Multicore Application Programming: for Windows, Linux, and Oracle Solari, Pearson Education Inc., 2011.

## 22EC002 COMMUNICATION PROTOCOLS AND STANDARDS

**3 0 0 3**

**Course Objectives**

- To analyze the components and need for communication in ECU
- To analyze the functions and frame format of CAN protocols
- To analyze the concept of LINBus, MODbus and Flex Ray protocols
- To analyze the functions of OBD communication in inter vehicle communication
- To understand the Autosar Standard and its architecture

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

PSO2 Able to solve complex engineering problems using state-of-the-art hardware and software tools, along with analytical and managerial skills to arrive appropriate solutions.

**Course Outcomes (COs)**

1. Select the suitable ECU components for different communication
2. Analyze the performance of CAN protocols
3. Analyze the performance of LINBus, MODbus and Flex Ray protocols
4. Analyze the architecture of OBD communication
5. Analyze the architecture of Autosar Standard

**Articulation Matrix**

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

**UNIT I** **9 Hours**

**INTRODUCTION**

Introduction to ECU Functions and Components, Need for Communication in ECU, Types of Communication Onboard Communication, Diagnostic Communication, Measurement and Calibration, Protocols and Comparison to ISO OSI, In Vehicle Cybersecurity Issues and Challenges

**UNIT II** **9 Hours**

**CAN FUNDAMENTALS**

Introduction to CAN, Electrical properties-CAN signaling and data rates, CAN data frame format, CAN controller block diagram and working, CAN driver configurations, Software for CAN controller interfacing-CAN development tools

**UNIT III** **9 Hours**

**LINBUS, AND MODBUS, FLEX RAY**

LIN bus, basics LIN bus protocol, master slave configuration, Basics of MODBUS, MODBUS protocol, MODBUS application, Flex ray and Automotive Ethernet Introduction and Usage, CAN vs Automotive Ethernet

**UNIT IV** **9 Hours**

**HIGH-LEVEL COMMUNICATION PROTOCOLS**

Onboard Communication J1939, Introduction, Key Characteristics, J1939 Standard and Layer Model, J1939 PGN and SPN, J1939 Transport Protocol, OBD II, OBD vs ISO OSI Layers, OBD Connectors, OBD Services, OBD Parameter ID (PIDs), OBD Connectors

**UNIT V** **9 Hours**

**AUTOSAR ARCHITECTURE**

Introduction to Autosar Standard and Consortium, Need for Autosar Architecture, Virtual Function Bus, Layered Architecture Model, Microcontroller Abstraction Layer, ECU Abstraction Layer, Service layer, Autosar example

**Total: 45 Hours**

**Reference(s)**

1. Olaf Pfeiffer, Andrew Ayre and Christian Keydel, Embedded networking with CAN and CANopen, Copperhill Technologies Corporation, 2008
2. Reference: www.can cia.org
3. SGS-Thompson, Lin Application note AN1278, SGS Thompson Ltd. 2002
4. Modbus-IDA, MODBUS application protocol specification, ModbusIDA, 2006
5. Siemens, Profibus network manual, Simens manual, 2009
6. Xiu Ji, Profibus in practice: System Architecture and Design, CRC press, 2015

## 22EC003 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 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. Analyze the fundamentals of C and Data Structures
2. Analyze 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 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 2 | - | - | - | - | - | - | - | - | - | 1 | - |
| 2 | 2 | 3 | 2 | - | 2 | - | - | - | - | - | - | - | 1 | - |
| 3 | 2 | 3 | 2 | - | 2 | - | - | - | - | - | - | - | 1 | - |
| 4 | 2 | 2 | 2 | - | 2 | - | - | - | - | - | - | - | 2 | - |
| 5 | 2 | 1 | - | 3 | - | - | - | - | - | - | - | - | 3 | - |

**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/O Handling, 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.

## 22EC004 REAL TIME OPERATING SYSTEMS 3 0 0 3

**Course Objectives**

- To expose the students to the fundamentals of interaction of OS with a computer and User computation.
- To teach the fundamental concepts of how process are created and controlled with OS.
- To study programming logic of modeling Process based on range of OS features.
- To compare types and Functionalities in commercial OS, application development using RTOS.
- To involve Discussions/ Practice/Exercise onto revising & familiarizing the concepts acquired.

**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.

PSO2 Able to solve complex engineering problems using state-of-the-art hardware and software tools, along with analytical and managerial skills to arrive appropriate solutions.

**Course Outcomes (COs)**

1. Analyze Operating System structures and types.
2. Analyze the operating systems tasks and its assess to the resources.
3. Analyze the scheduling, disciplining of various processes execution.
4. Demonstrate commercial RTOS Suite features to work on real time processes design.
5. Develop Employability and entrepreneurship capacity due to knowledge up gradation on recent trends in RTOS and embedded automation design.

**Articulation Matrix**

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

**UNIT I** **9 Hours**

**INTRODUCTION TO OPERATING SYSTEMS**

Basic Principles, Operating System structures, Operating Systems functions, System Calls, Files, Processes, Design and Implementation of processes, Communication between processes, Introduction to Distributed operating system, Embedded operating systems.

**UNIT II** **9 Hours**

**OVERVIEW OF RTOS**

RTOS Task and Task state, Process Synchronization, Message queues, shared memory, Mail boxes, pipes, Critical section, Semaphores, mutex, priority inversion and ceiling, circular and swinging buffers.

**UNIT III** **9 Hours**

**TASK MANAGEMENT AND RTOS SCHEDULING**

Process and Threads, Process Control Block, Process Attributes, Interrupt processing, memory management, Priority based scheduling, Rate-Monotonic scheduling, Earliest Deadline first scheduling

**UNIT IV** **9 Hours**

**REALTIME KERNEL**

Principles, Kernel, Monolithic and Microkernel, Design issues, Polled Loop Systems, RTOS Porting to a Target, Comparison and Basic study of various RTOS like VX works Linux supportive RTOS.

**UNIT V** **9 Hours**

**APPLICATION DEVELOPMENT**

Discussions on Basics of Linux supportive RTOS, uCOS-C Executive for development of RTOS Application, Case study.

**Total: 45 Hours**

**Reference(s)**

1. Herma K., Real Time Systems, Design for distributed Embedded Applications, 2011, 2nd edition, Springer, USA
2. Tanenbaum, Andrew, Modern Operating Systems, 2015, 4th ed., Pearson Prentice Hall, USA.
3. Ivan CibrarioBertolotti, Politecnico di Torino and Gabriele Manduchi, Real-Time Embedded Systems: Open-Source Operating Systems Perspective, 2012, 1st ed., CRC Press, USA.
4. Lyla B. Das, Embedded Systems an Integrated Approach, 2012, 1st ed., Pearson Education, India.
5. Karim Yaghmour, Building Embedded Linux System, O reilly Pub,2003
6. MukeshSighal and N G Shi, Advanced Concepts in Operating System, McGraw Hill,2000

## 22EC005 EMBEDDED LINUX 3 0 0 3

**Course Objectives**

- To understand the concept of embedded linux and desktop linux
- To Configure Linux environment and Tool-Chain
- To Demonstrate Linux Booting Process and to configure Linux Kernels

**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.

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. Analyze the concepts of embedded Linux development model.
2. Construct a Linux Board Support Package and storage for a hardware platform
3. Analyze the features and internal architecture of kernel and tool chain
4. Analyze the porting issues in Linux Environment.
5. Apply the various development tools to customize the embedded linux application.

**Articulation Matrix**

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

**UNIT I** **9 Hours**

**INTRODUCTION**

History of Embedded Linux, Embedded Linux versus Desktop Linux, Embedded Linux Distributions, Architecture of Embedded Linux, Linux Kernel Architecture, Linux StartUp Sequence

**UNIT II** **9 Hours**

**LINUX FUNDAMENTALS**

Board Support Package: Inserting BSP in Kernel Build Procedure, Boot Loader Interface, Memory Map, Interrupt Management, PCI Subsystem Embedded Storage: Flash Map, MTD: Memory Technology Device, MTD Architecture, MTD Block and Character devices, Optimizing Storage Space.

**UNIT III** **9 Hours**

**ARCHITECTURE OF EMBEDDED LINUX**

Kernel Architecture, Kernel Functional Overview, Commands in Linux, Configuring the Linux Environment, Tool-chain: Configuration and Cross-Compilation, Linux Bootloader & U-Boot, Embedded Linux Kernel, Building Root File System.

**UNIT IV** **9 Hours**

**PORTING APPLICATIONS**

Architectural Comparison, Application Porting Road Map, Programming with Pthreads, Operating System Porting Layer (OSPL), Kernel API Driver

**UNIT V** **9 Hours**

**DEVELOPMENT TOOLS**

Embedded development environment, GNU debugger, tracing & profiling tools, binary utilities, kernel debugging, debugging embedded Linux applications, porting Linux, Linux and real time, SDRAM interface

**Total: 45 Hours**

**Reference(s)**

1. Chris Simmonds "Mastering Embedded Linux Programming", Second Edition, PACKT Publications Limited. 3rd Edition, 2021.
2. Karim Yaghmour, Jon Masters, Gillad Ben Yossef, Philippe Gerum, "Building embedded Linux systems", O'Reilly, 2008.
3. P Raghvan, Amol Lad, Sriram Neelakandan, "Embedded Linux System Design and Development", Auerbach Publications, 2019.
4. Christopher Hallinan, "Embedded Linux Primer: A Practical Real World Approach", Prentice Hall, 2nd Edition, 2010
5. Derek Molloy, "Exploring Beagle Bone: Tools and Techniques for Building with Embedded Linux", Wiley, 1st Edition, 2014.
6. Christopher Hallinan, "Embedded Linux Primer: A practical real world approach", Prentice Hall, 2007

## 22EC006 VIRTUAL INSTRUMENTATION IN EMBEDDED SYSTEMS

**3 0 0 3**

**Course Objectives**

- To develop graphical programming environment in Virtual Instrumentation
- To develop skills in data acquisition, instrumentation and control.
- To develop Virtual Instruments system for the Real-Time applications

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

PSO2 Able to solve complex engineering problems using state-of-the-art hardware and software tools, along with analytical and managerial skills to arrive appropriate solutions.

**Course Outcomes (COs)**

1. Analyze the concepts of traditional instruments and virtual instruments
2. Analyze the overview of modular programming and the structuring concepts in VI programming
3. Develop the procedure to install DAQ in various OS and its interfacing methods
4. Develop virtual instrument using NI software and hardware
5. Analyse the performance of signal processing tool kits in virtual instrumentation

**Articulation Matrix**

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

**UNIT I** **9 Hours**

**INTRODUCTION**

Virtual Instrumentation: Historical perspective, advantages, block diagram and architecture of a virtual instrument, Conventional Instruments versus Traditional Instruments, data-flow techniques, 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 - graphs and charts - string and file I/O - High level and Low-level file I/Os - local and global variables - VIs and sub-Vis.

**UNIT III** **9 Hours**

**DATA ACQUISITION**

Introduction to data acquisition on PC, Sampling fundamentals, Input/output techniques and buses. Digital and Analog I/O function - Buffered I/O - counters and timers, Data acquisition interface requirements, Issues involved in selection of Data acquisition cards.

**UNIT IV** **9 Hours**

**VI IN EMBEDDED SYSTEM**

Laboratory Virtual Instrumentation and Engineering Workbench (LabVIEW) - NI Multisim - NI ELVIS III Hardware - MyDAQ: Measurements & datalogging - MyRIO: Embedded Monitoring & Control - 5G wireless communication: NI SDR Hardware bundle for RF & Wireless communication system design - PCI, PXI system controllers, Ethernet control of PXI.

**UNIT V** **9 Hours**

**ANALYSIS TOOLS AND APPLICATIONS**

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. Gary Johnson, LabVIEW Graphical Programming, Second edition, McGraw Hill, Newyork, 1997.
2. Behzad Ehsani, Data Acquisition Using LabVIEW, Packt Publishing, 2016
3. Lisa K. wells & Jeffrey Travis, LabVIEW for everyone, Prentice Hall, New Jersey,1997.
4. Nitesh Pradhan CLAD Preparation Book, Blue Rose Publishers, 2020.
5. Kevin James, PC Interfacing and Data Acquisition: Techniques for Measurement, Instrumentation and Control, Newness, 2000.

## 22EC007/22ECH07/22ECM07 IoT PROTOCOLS AND INDUSTRIAL SENSORS

**3 0 0 3**

**Course Objectives**

- Understand the basic principles, architectures, physical and logical designs of IOT
- Explain the IoT communication principles and their protocols.
- Explain the transport and application layer principles and their protocols.
- Understand the working principles of motion, proximity and ranging sensors
- Explain the principles of force, magnetic and heading sensors and its case studies with real time applications.

**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.

PSO2 Able to solve complex engineering problems using state-of-the-art hardware and software tools, along with analytical and managerial skills to arrive appropriate solutions.

**Course Outcomes (COs)**

1. Apply the concepts of IoT Architecture, physical design, logical design and their technologies.
2. Analyze the working principles & concepts of IoT Communication Protocols.
3. Analyze the working principles & concepts of Transport and Application layer Protocols.
4. Apply the various sensors in the Automotive and Mechatronics applications
5. Analyze the working principles and characteristics of force, magnetic and heading sensors.

**Articulation Matrix**

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

**UNIT I** **9 Hours**

**INTRODUCTION TO IOT**

Architectural Overview- IoT applications- Sensing - Actuations -Basics of Networking - M2M and IoT Technology fundamentals - Devices and gateways - Design of Internet of Things: Physical Design of IoT, Logical Design of IoT - IoT Enabling Technologies.

**UNIT II** **9 Hours**

**IOT COMMUNICATION PROTOCOLS**

IoT Data Link Layer & Network Layer Protocols, PHY/MAC Layer -3GPP MTC, IEEE 802.11, IEEE 802.15 - Wireless HART, ZWave, Bluetooth Low Energy, Zigbee Smart Energy, DASH7 - Network Layer-IPv4, IPv6, 6LoWPAN.

**UNIT III** **9 Hours**

**TRANSPORT**

Transport Layer Protocols-Application Protocols for IoT: UPnP, CoAP, MQTT, XMPP, SCADA, Authentication Protocols; IEEE 802.15.4, REST and Websocket.

**UNIT IV** **9 Hours**

**MOTION, PROXIMITY AND RANGING SENSORS**

Motion Sensors - Potentiometers, Resolver, Encoders - Optical, Magnetic, Inductive, Capacitive, LVDT, RVDT - Synchro, Microsyn, Accelerometer, GPS, Bluetooth, Range Sensors - RF beacons, Ultrasonic Ranging, Reflective beacons.

**UNIT V** **9 Hours**

**CASE STUDIES/INDUSTRIAL APPLICATIONS**

IoT applications in home appliances, infrastructures, buildings, security, Industries 4.0

**Total: 45 Hours**

**Reference(s)**

1. Vijay Madisetti, Arshdeep Bahga, Internet of Things, A Hands on Approach, University Press.
2. David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Rob Barton and Jerome Henry, IoT Fundamentals: Networking Technologies, Protocols and Use Cases for Internet of Things, Cisco Press, 2017.
3. Peter Waher, Learning Internet of Things, Packt Publishing,UK, 2015.
4. Adrian McEwen, Hakim Classically, Designing the Internet of Things, Wiley Publishing, 2015.
5. Dieter Uckelmann, Mark Harrison and Florian Michahelles, Architecting the Internet of Things, Springer, NewYork, 2011.

**22EC008/22ECH08/22ECM08 IoT PROCESSORS 3 0 0 3**

**Course Objectives**

- To learn embedded system architecture with its application software.
- To understand ARM and cortex-m3 Architecture
- To learn about various Cortex exception handling and interrupts
- To build simple cortex-m3/m4 programming.
- To understand cortex-m3/m4 development and debugging tools

**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 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 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. Analyze the embedded system architecture with its application software.
2. Analyze ARM and cortex-M3 architecture and bus
3. Analyze cortex exception handling and interrupts
4. Apply concept of Cortex-M3/M4 Programming for a simple application
5. Analyze Cortex-M3/M4 Development and Debugging Tools.

**Articulation Matrix**

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

**UNIT I** **9 Hours**

**INTRODUCTION TO EMBEDDED CONCEPTS**

Introduction to embedded systems, Application Areas, Categories of embedded systems, Overview of embedded system architecture, Specialties of embedded systems, recent trends in embedded systems, Hardware architecture, Software architecture.

**UNIT II** **9 Hours**

**OVERVIEW OF ARM AND CORTEX M3**

Background of ARM Architecture, Processor Naming, Instruction Set Development, Thumb-2 and Instruction Set Architecture.Cortex-M3 Instruction Sets.Cortex-M3 Implementation Overview: Pipeline, Block Diagram, Bus. Interfaces on Cortex-M3, I-Code Bus, D Code Bus, System Bus.

**UNIT III** **9 Hours**

**CORTEX EXCEPTION HANDLING AND INTERRUPTS**

Exceptions: Exception Types, Priority, Vector Tables, Interrupt Inputs and Pending Behavior, Fault Exceptions, NVIC: Nested Vectored Interrupt Controller Overview, Basic Interrupt Configuration, Software Interrupts, Interrupt/Exception Sequences.

**UNIT IV** **9 Hours**

**CORTEXM3/M4 PROGRAMMING**

Cortex M3/M4 Programming: Overview, Typical Development Flow, Using C, CMSIS (Cortex Microcontroller Software Interface Standard). Exception Programming: Using Interrupts, Exception/Interrupt Handlers.Memory Protection Unit, MPU Registers, Setting Up the MPU.

**UNIT V** **9 Hours**

**CORTEXM3/M4 DEVELOPMENT AND DEBUGGING TOOLS**

STM32L15xxx ARM Cortex M3/M4 Microcontroller: Memory and Bus Architecture, Power Control.STM32L15xxx, Peripherals: GPIOs, System Configuration Controller, Comparators, USART.Development and Debugging Tools: Software and Hardware tools like Cross Assembler, Compiler, Debugger.

**Total: 45 Hours**

**Reference(s)**

1. Joseph Yiu, The Definitive Guide to the ARM Cortex-M3, Second Edition, Elsevier Inc.2010.
2. Andrew N Sloss, Dominic Symes, Chris Wright, ARM System Developers Guide Designing and Optimizing System Software, Elsevier Publications,2006
3. Steve Furber, ARM System-on-Chip Architecture,2nd Edition, Pearson Education, India ISBN:9788131708408,8131708403,2015
4. Dr.K.V.K. Prasad, Embedded/Real Time Systems: Concepts, Design and Programming Black Book, New edition (MISL-DT) Paperback 12 Nov 2003
5. David Seal ARM Architecture Reference Manual Addison Wesley England Morgan Kaufmann Publishers 2001

**22EC009/22ECH09/22ECM09 IoT SYSTEM DESIGN 3 0 0 3**

**Course Objectives**

- To learn how to design and implement IoT applications that manage big data, streaming data, and/or distributed data.
- To understand Smart Objects and IoT Architectures.
- To learn about various IOT-related protocols.
- To build simple IoT Systems using Arduino and Raspberry Pi.
- To understand data analytics and cloud in the context of IoT.
- To develop IoT infrastructure for popular applications.

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

PSO2 Able to solve complex engineering problems using state-of-the-art hardware and software tools, along with analytical and managerial skills to arrive appropriate solutions.

**Course Outcomes (COs)**

1. Analyze the fundamentals of IoT and its architecture.
2. Analyze various protocols for IoT.
3. Design a PoC of an IoT system using Rasperry Pi/Arduino.
4. Apply data analytics and use cloud offerings related to IoT.
5. Analyze applications of IoT in real time scenario.

**Articulation Matrix**

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

**UNIT I** **9 Hours**

**FUNDAMENTALS OF IOT**

Evolution of Internet of Things, Enabling Technologies, IoT Architectures: Simplified IoT Architecture and Core IoT Functional Stack, Fog, Edge and Cloud in IoT, Sensors, Actuators, Smart Objects and Connecting Smart Objects.

**UNIT II** **9 Hours**

**IOT PROTOCOLS**

IoT Access Technologies: IEEE 802.15.4, 802.15.4e, Zigbee protocol, IP versions, CoAP and MQTT. Modern databases: No SQL, New SQL, MongoDb.

**UNIT III** **9 Hours**

**DESIGN AND DEVELOPMENT**

Design Methodology, Embedded computing logic, Microcontroller, System on Chips, IoT system building blocks, Arduino Board details, IDE programming, Raspberry Pi and Interfaces.

**UNIT IV** **9 Hours**

**DATA ANALYTICS AND SUPPORTING SERVICES**

Role of Machine Learning: Hadoop Ecosystem, Edge Streaming Analytics and Network Analytics, Google Spreadsheet for IoT & Analytics, ThingSpeak and Firebase, Cloud for IoT, Python Web Application Framework.

**UNIT V** **9 Hours**

**CASE STUDIES/INDUSTRIAL APPLICATIONS**

Cisco IoT system, IBM Watson IoT platform, Power Utility in Industry, Smart and Connected Cities: Smart Lighting, Smart Parking Architecture and Smart Traffic Control.

**Total: 45 Hours**

**Reference(s)**

1. David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Rob Barton and Jerome Henry, IoT Fundamentals: Networking Technologies, Protocols and Use Cases for Internet of Things, Cisco Press, 2017.
2. Arshdeep Bahga, Vijay Madisetti, Internet of Things - A hands-on approach, Universities Press, 2015
3. Olivier Hersent, David Boswarthick, Omar Elloumi, The Internet of Things Key applications and Protocols, Wiley, 2012
4. Jan Holler, Vlasios Tsiatsis, Catherine Mulligan, Stamatis, Karnouskos, Stefan Avesand, DavidBoyle, From Machine-to-Machine to the Internet of Things Introduction to a New Age of Intelligence, Elsevier, 2014.
5. Dieter Uckelmann, Mark Harrison, Michahelles, Florian (Eds), Architecting the Internet of Things, Springer, 2011.
6. Michael Margolis, Arduino Cookbook, Recipes to Begin, Expand, and Enhance Your Projects, 2nd Edition, O Reilly Media, 2011.

## 22EC010/22ECH10/22ECM10 WIRELESS SENSOR NETWORK DESIGN

**3 0 0 3**

**Course Objectives**

- To understand the fundamentals of wireless sensor networks and its application to critical real time scenarios
- To familiarize with learning of the Architecture of WSN
- To understand the concepts of Networking and Networking in WSN
- To study the design consideration of topology control and solution to the various problems.
- To introduce the hardware and software platforms and tool in WSN.

**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 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 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. Analyze basics and technologies for wireless networks
2. Analyze and compare various architectures of Wireless Sensor Networks
3. Analyze design issues and challenges in wireless sensor networks
4. Develop the infrastructure and its simulations
5. Demonstrate, the concept of programming in the WSN environment

**Articulation Matrix**

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

**UNIT I** **10 Hours**

**OVERVIEW OF WIRELESS SENSOR NETWORKS**

Introduction: Fundamentals of wireless communication technology, SingleNode Architecture, Network Characteristics, characteristics of wireless channels, modulation techniques, Types of wireless sensor networks.

**UNIT II** **10 Hours**

**ARCHITECTURES**

Network Architecture, Sensor Networks Scenarios, Design Principle, Physical Layer and Transceiver Design Considerations, Optimization Goals and Figures of Merit, Gateway Concepts, Operating Systems and Execution Environments, Internet to WSN Communication.

**UNIT III** **9 Hours**

**NETWORKING SENSORS**

Routing protocols, MAC Protocols for Wireless Sensor Network, Low Duty Cycle Protocols And Wakeup Concept, SMAC IEEE 802.15.4 standar, Wakeup Radio Concepts, Address and Name Management Assignment of MAC Addresses, Routing Protocols Energy Efficient Routing, Geographic Routing.

**UNIT IV** **8 Hours**

**INFRASTRUCTURE ESTABLISHMENT**

Topology Control, Clustering Time Synchronization Localization and Positioning Sensor Tasking and Control Real-time traffic support and security protocols.

**UNIT V** **8 Hours**

**SENSOR NETWORK PLATFORMS AND TOOLS**

Sensor Node Hardware Berkeley Motes Programming Challenges, Nodelevel software platforms Node level Simulators, StateÃ‚Âcentric programming.

**Total: 45 Hours**

**Reference(s)**

1. Holger Karl & Andreas Willig, "Protocols and Architectures for Wireless Sensor Networks", John Wiley, 2005.
2. Feng Zhao and Leonidas J. Guibas, Wireless Sensor Networks: An Information Processing Approach, Elsevier, 2007.
3. Waltenegus Dargie, Christian Poellabauer, Fundamentals of Wireless Sensor Networks Theory and Practice, John Wiley and Sons Publications, 2011
4. K. Akkaya and M. Younis, A survey of routing protocols in wireless sensor networks, Elsevier Ad Hoc Network Journal, Vol. 3, no. 3, pp. 325--349
5. Philip Levis, TinyOS Programming
6. Anna Hac, Wireless Sensor Network Designs, John Wiley & Sons Ltd,

**22EC011/22ECH11/22ECM11 INDUSTRIAL IoT AND INDUSTRY 4.0** **3 0 0 3**

**Course Objectives**

- To provide the overview about evolution and importance of Industrial IoT in the era of Industry 4.0
- To introduce the Industrial IoT reference architectures and Business models in industrial automation systems
- To understand the on-site key technologies for the requirement of a smart factory
- To get the knowledge of Industrial IoT data Analytics
- To apply the technologies of Industrial IoT in various Industries as case studies.

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

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

PSO2 Able to solve complex engineering problems using state-of-the-art hardware and software tools, along with analytical and managerial skills to arrive appropriate solutions.

**Course Outcomes (COs)**

1. Analyze about the evolution of Industry 4.0 in smart factories and cyber physical systems
2. Find the process of industrial automation system network and control
3. Demonstrate the reference architectural models and business models with key enabling technologies
4. Analyse the data of the industrial IoT systems with security
5. Apply the technologies to various sectors and case study the application of Industrial IoT in smart industries.

**Articulation Matrix**

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

**UNIT I** **9 Hours**

**INTRODUCTION AND KEY TECHNOLOGIES**

Industrial revolutions. Cyber physical systems and Next generation sensors. On-site key technologies in Industry 4.0, AR-VR, Big data Analytics, Smart factories and Lean Manufacturing system.

**UNIT II** **9 Hours**

**INDUSTRIAL AUTOMATION AND IOT**

Evolution of IT and OT convergence. Industrial sensing, Industrial Processes and Industrial Network. Business models and IIRA Reference architecture of IIOT, Industrial internet Consortium (IIC).

**UNIT III** **9 Hours**

**INDUSTRIAL DATA TRANSMISSION AND COMPUTING**

Foundation Fieldbus, Profibus, CC-link, MODBUS, DigitalSTROM, CAN, DeviceNet, ISA 100.11a, Wireless HART, NB-IoT. Edge and Fog Computing solutions. Cloud services.

**UNIT IV** **9 Hours**

**DATA ANALYTICS AND SECURITY**

Necessity of Analytics and IIOT Data Analytics. Machine Learning and Data Science applications in Industries. Artificial Intelligence for IIOT, IoT Security- Vulnerabilities, Threat Analysis, Security model for IoT.

**UNIT V** **9 Hours**

**APPLICATIONS OF IIOT**

Healthcare Applications, Inventory Management and Quality Control. Case studies in Manufacturing Industry, Automotive Industry, Mining Industry, Textile Industry.

**Total: 45 Hours**

**Reference(s)**

1. Industry 4.0: The Industrial Internet of Things, by Alasdair Gilchrist A press, 2017.
2. Industrial Internet of Things: Cybermanufacturing Systems, by Sabina Jeschke, Christian Brecher, Houbing Song, Danda B. Rawat Springer, 2017
3. Hands-On Industrial Internet of Things: Create a powerful Industrial IoT by Giacomo Veneri, Antonio Capasso, Packt, 2018.
4. Misra, Sudip, Chandana Roy, and Anandarup Mukherjee. Introduction to industrial Internet of Things and industry 4.0. CRC Press, 2021.
5. Jesús Hamilton Ortiz, William Gutierrez Marroquin and Leonardo Zambrano Cifuentes, Industry 4.0: Current status and future trends, 2020.
6. Ustundag, Alp, and Emre Cevikcan. Industry 4.0: managing the digital transformation. Springer, 2017.

**22EC012/22ECH12/22ECM12 DATA ANALYTICS FOR IoT** **3 0 0 3**

**Course Objectives**

- To understand the basics of nature of data
- To understand basic operation in data analysis using python
- To understand data manipulation using pandas library
- Data visualization using different types of charts
- To understand basic python program for IoT application

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

PSO2 Able to solve complex engineering problems using state-of-the-art hardware and software tools, along with analytical and managerial skills to arrive appropriate solutions.

**Course Outcomes (COs)**

1. Analyze the nature of the data processing quantitatively and qualitatively using python
2. Analyze the various data operations performed using NumPy library
3. Analyze the data manipulation process using pandas library in python
4. Apply data visualization techniques to interpret the data with various parameters
5. Construct IoT projects using python and RaspberryPi

**Articulation Matrix**

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

**UNIT I** **9 Hours**

**INTRODUCTION TO DATA ANALYSIS AND PYTHON**

Data Analysis, Knowledge Domains of the Data Analyst, Understanding the Nature of the Data, The Data Analysis Process, Quantitative and Qualitative, Data Analysis Python and Data Analysis, Installing Python, and writing Python Code, IPython, The IDEs for Python SciPy.

**UNIT II** **9 Hours**

**BASIC OPERATIONS USING PYTHON**

The NumPy Library, The NumPy Installation, Basic Operations Indexing, Slicing, and Iterating Conditions and Boolean Arrays, Shape Manipulation, Array Manipulation, General Concepts, Structured Arrays, Reading and Writing Array Data on Files

**UNIT III** **9 Hours**

**DATA ANALYSIS**

The Python Data Analysis, Library Pandas, Introduction to pandas, Data Structures, operations between data structures, Function application and mapping, Sorting and Ranking, Not a Number data, Reading and Writing data, Reading data in CSV or Text files, Excel files

**UNIT IV** **9 Hours**

**DATA MANUPULATION**

Data Manipulation, Data Preparation, loading, assembling, merging, Concatenating, combining, reshaping, removing, Data Transformation, removing duplicates, mapping, Detecting and filtering outliers, random sampling, String Manipulation, Data Aggregation, Group Iteration, Chain of Transformation, functions on groups

**UNIT V** **9 Hours**

**DATA VISUALIZATION**

Matplotlib Installation, pyplot, using the Kwargs, Adding further elements to the chart, Handling Date Values, Line chart, Histogram, Bar Chart, Pie Charts, Advanced charts mplot3d, Multi panel plots, Case study, Meteorological data, Recognizing Handwritten Digits

**Total: 45 Hours**

**Reference(s)**

1. Fabio Nelli, Python Data Analytics, APRESS, 2015
2. Gary Smart, Practical Python Programming for IoT, PACKT Publishing, Birmingham, UK, 2020
3. Samir Madhavan, Mastering Python for Data Science, PACKT Publishing, Birmingham, UK, 2015
4. Peters Morgan, Data Analysis from Scratch with Python, AI Sciences, 2016
5. Agus kurniawan, Micropython for ESP8266 Development workshop, PE PRESS, 2016
6. Charles Bell, MicroPython for the internet of Things, Apress, 2017

## 22EC013 ADVANCED DIGITAL SYSTEM DESIGN 3 0 0 3

**Course Objectives**

- Understand the concepts of Synchronous and Asynchronous Sequential Circuit Design.
- Analyze the concepts of Fault Diagnosis and Testability Algorithms for digital circuits.
- Illustrate the concepts of programmable logic devices and system design Using VHDL.

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

PSO2 Able to solve complex engineering problems using state-of-the-art hardware and software tools, along with analytical and managerial skills to arrive appropriate solutions.

**Course Outcomes (COs)**

1. Demonstrate the design of synchronous sequential circuit
2. Analyze the design of asynchronous sequential circuit
3. Find and analyze the fault diagnosis and testing
4. Design the PLD and ROM
5. Design and use programming tools for implementing digital circuits of industry standards.

**Articulation Matrix**

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

**UNIT I** **9 Hours**

**SEQUENTIAL CIRCUIT DESIGN**

Analysis of Clocked Synchronous Sequential Networks (CSSN) Modeling of CSSN - State Stable Assignment and Reduction - Design of CSSN -Design of Iterative Circuits - ASM Chart -ASM Realization.

**UNIT II** **9 Hours**

**ASYNCHRONOUS SEQUENTIAL CIRCUIT DESIGN**

Analysis of Asynchronous Sequential Circuit (ASC) - Flow Table Reduction - Races in ASC - State Assignment -Problem and the Transition Table - Design of ASC - Hazards.

**UNIT III** **9 Hours**

**FAULT DIAGNOSIS AND TESTING**

Fault Table Method - Path Sensitization Method - Boolean Difference Method - Tolerance Techniques - Fault in PLA - Test Generation - Built- in Self Test.

**UNIT IV** **9 Hours**

**SYNCHRONOUS DESIGN USING PROGRAMMABLE DEVICES**

EPROM to Realize a Sequential Circuit- Programmable Logic Devices - Designing a Synchronous Sequential Circuit using a GAL - EPROM - Realization State machine using PLD.

**UNIT V** **9 Hours**

**SYSTEM DESIGN USING VHDL**

VHDL Description of Combinational Circuits - Arrays -VHDL Operators - Compilation and Simulation of VHDL Code -Modeling using VHDL - Flip Flops - Registers - Counters - Sequential Machine - Combinational Logic Circuits - VHDL Code for - Serial Adder, Binary Multiplier - Binary Divider.

**Total: 45 Hours**

**Reference(s)**

1. G. Donald Givone, Digital principles and Design, Tata McGraw Hill 2003.
2. N. Nripendra Biswas, Logic Design Theory, Prentice Hall of India, 2001.
3. H. Charles Roth, Digital System Design using VHDL, Third Edition, Cengage Learning, 2016.
4. H. Charles Roth, Fundamentals of Logic design, Sventh Edition, Cengage Learning, 2014.
5. Stephen Brown and Zvonk Vranesic, Fundamentals of Digital Logic with VHDL Design, Tata McGraw Hill, 2008.

## 22EC014 ANALOG VLSI DESIGN 3 0 0 3

**Course Objectives**

- To understand the basics of analog integrated circuits
- To understand the basic building blocks like current sources, sinks and mirrors
- To comprehend the performance metrics of amplifier circuits and design single stage amplifiers
- To understand differential amplifiers and common mode rejection ratio
- To design an operational amplifier and operational transconductance amplifier

**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 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 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. Design the MOSFET models at different frequencies
2. Analyze and design current sources and voltage references for given specifications
3. Analyze and design single stage MOS amplifiers
4. Analyze CMOS differential amplifiers
5. Analyze and design CMOS operational amplifiers

**Articulation Matrix**

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

**UNIT I** **9 Hours**

**INTRODUCTION TO ANALOG VLSI**

MOS design considerations in Analog Circuit Design, Recent Trends in Analog VLSI Circuits, Low Frequency MOSFET models, Temperature effects in MOSFET, Noise in MOSFET

**UNIT II** **9 Hours**

**CMOS SUBCIRCUITS**

MOS Switch, MOS Diode/ Active Resistor, Simple Current Sinks and Sources, Basic Current Mirrors, Current and Voltage References, and Bandgap references

**UNIT III** **9 Hours**

**CMOS AMPLIFIERS**

Performance Metrics of amplifier circuits, Common Source Amplifier, Common Gate Amplifier, Frequency Response of Amplifiers, Stability of Amplifiers

**UNIT IV** **9 Hours**

**CMOS DIFFERENTIAL AMPLIFIER**

Differential Signaling, Source Coupled Pair, Current Source Load, Common Mode Rejection Ratio, CMOS Differential amplifier with Current Mirror Load, Differential to single-ended Conversion

**UNIT V** **9 Hours**

**CMOS OPERATIONAL AMPLIFIER**

Block Diagram of Op-Amplifier, Ideal characteristics of Op-Amplifier, Design of two stages Op-Amplifier, Compensation and Frequency response of Op-Amplifier, Operational Transconductance Amplifier

**Total: 45 Hours**

**Reference(s)**

1. Behzad Razavi, Design of Analog CMOS Integrated Circuits, Second Edition, McGraw-Hill, 2000
2. R. Jacob Baker, CMOS: Circuit Design, Layout and Simulation, Third Edition, Wiley Publication, 2010
3. Tony Chan Carusone, David A. Johns, Kenneth W. Martin, Analog Integrated Circuit Design, Second Edition, Wiley Publication,2011
4. Behzad Razavi, Fundamentals of Microelectronics, Second Edition, Wiley Publication, 2013
5. Phillip Allen, Douglas Holmberg, CMOS Analog Circuit Design, Second Edition, Oxford University Press, 2004

## 22EC015 ASIC DESIGN 3 0 0 3

**Course Objectives**

- The course focuses on the semi-custom IC Design and introduces the principles of design logic cells, I/O cells and interconnect architecture, with equal importance given to FPGA and ASICstyles.
- The entire FPGA and ASIC design flow is dealt with from the circuit and layout design point of view.

**Program Outcomes (POs)**

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

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 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 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. Analyze different CMOS logics for ASIC library design
2. Analyze the different techniques available in programmable ASICs
3. Construct the programmable ASIC architecture
4. Demonstrate the different techniques available in logic synthesis, placement and routing
5. Apply high performance algorithms to design ASICs

**Articulation Matrix**

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

**UNIT I** **9 Hours**

**INTRODUCTION TO ASICS, CMOS LOGIC AND ASIC LIBRARY DESIGN**

Types of ASICs - Design flow - CMOS transistors - Combinational Logic Cell - Sequential logic cell - Data path logic cell - Transistors as Resistors - Transistor Parasitic Capacitance.

**UNIT II** **9 Hours**

**PROGRAMMABLE ASICS, PROGRAMMABLE ASIC LOGIC CELLS AND PROGRAMMABLE ASIC I/O CELLS**

Anti-fuse - static RAM - EPROM and EEPROM technology - Actel ACT - Xilinx LCA - Altera FLEX - Altera MAX DC & AC inputs and outputs - Clock & Power inputs.

**UNIT III** **9 Hours**

**PROGRAMMABLE ASIC ARCHITECUTRE**

Architecture and configuration of Spartan and Virtex FPGAs - Micro-Blaze based embedded systems - Signal probing techniques.

**UNIT IV** **9 Hours**

**LOGIC SYNTHESIS, PLACEMENT AND ROUTING**

Logic synthesis - ASIC floor planning- placement and routing - power and clocking strategies.

**UNIT V** **9 Hours**

**HIGH PERFORMANCE ALGORITHMS FOR ASICS/ SOCS. SOC CASE STUDIES**

DAA and computation of FFT and DCT. High performance filters using delta-sigma modulators. Case Studies: Digital camera, SDRAM.

**Total: 45 Hours**

**Reference(s)**

1. M.J.S. Smith, "Application - Specific Integrated Circuits", Pearson,2003
2. Mohammed Ismail and Terri Fiez, "Analog VLSI Signal and Information Processing", McGraw Hill, 1994.
3. Douglas J. Smith, HDL Chip Design, Madison, AL, USA: Doone Publications, 1996.
4. Jose E. France, YannisTsividis, "Design of Analog - Digital VLSI Circuits for Telecommunication and Signal Processing", Prentice Hall, 1994.
5. Roger Woods, John McAllister, Dr. Ying Yi, Gaye Lightbod, "FPGA-based Implementation of Signal Processing Systems", Wiley, 2008
6. Steve Kilts, "Advanced FPGA Design", Wiley Inter-Science

## 22EC016 LOW POWER VLSI DESIGN 3 0 0 3

**Course Objectives**

- Identify sources of power in an IC.
- Identify the power reduction techniques based on technology independent and technology dependent.
- Power dissipation mechanism in various MOS logic style.
- Identify suitable techniques to reduce the power dissipation.
- Design memory circuits with low power dissipation.

**Program Outcomes (POs)**

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

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 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 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. Analyze different sources of power dissipation in VLSI circuits
2. Apply the different techniques involved in low power adders and multipliers
3. Analyze leakage power reduction mechanism at device level and circuit level
4. Analyze the techniques involved in low power SRAM
5. Apply advanced and special techniques for reducing power consumption in memories

**Articulation Matrix**

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

**UNIT I** **9 Hours**

**POWER DISSIPATION IN CMOS**

Basics of power dissipation in CMOS Field Effect Transistors - Hierarchy of limits of power - Sources of power consumption - Static Power Dissipation, Active Power Dissipation - Designing for Low Power, Circuit Techniques for Leakage Power Reduction - Basic principle of low power design.

**UNIT II** **9 Hours**

**POWER OPTIMIZATION**

Logic level power optimization - Circuit level low power design - Standard Adder Cells, CMOS Adders Architectures-BiCMOS adders - Low Voltage Low Power Design Techniques, Current Mode Adder.

**UNIT III** **9 Hours**

**DESIGN OF LOW POWER CMOS CIRCUITS**

Computer arithmetic techniques for low power system - low voltage low power static Random access and dynamic Random access memories - low power clock, inter connect and layout design.

**UNIT IV** **9 Hours**

**POWER ESTIMATION**

Power Estimation techniques - logic power estimation - Simulation power analysis - Probabilistic power analysis.

**UNIT V** **9 Hours**

**SYNTHESIS AND SOFTWARE DESIGN FOR LOW POWER**

Synthesis for low power - Behavioral level transform - software design for low power.

**Total: 45 Hours**

**Reference(s)**

1. Kaushik Roy and S.C. Prasad, "Low power CMOS VLSI circuit design", Wiley, 2000.
2. Gary Yeap, "Practical low power digital VLSI design", Kluwer, 1998.
3. Kiat-send Yeo, Kaushik Roy "Low-Voltage, Low-power VLSI Subsystem", Tata McGraw-Hill, 2009
4. AbdelatifBelaouar, Mohamed. I. Elmasry, "Low power digital VLSI design", Kluwer, 1995.
5. A.P. Chandrasekaran and R.W. Broadersen, "Low power digital CMOS design", Kluwer,1995.
6. DimitriosSoudris, C. Pignet, Costas Goutis, "Designing CMOS Circuits for Low Power", Kluwer, 2002.

## 22EC017 DSP INTEGRATED CIRCUITS 3 0 0 3

**Course Objectives**

- To understand the importance of DSP IC design
- To analyze the frequency domain behaviour of a given Discrete Time signal using Discrete Fourier Transform
- To analyse the DSP architectures and implementation methods
- To develop various arithmetic strategies for the design of digital signal processing systems
- To design a various digital signal processing elements

**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.

PO5 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 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. Analyze the DSP IC and CMOS Technologies
2. Analyze the frequency domain behaviour of a given Discrete Time signal using Discrete Fourier Transform
3. Analyze the DSP architectures and its implementation
4. Organize an Arithmetic Architectures required for processing a digital signal
5. Design an VLSI architecture for the Signal Processing Elements

**Articulation Matrix**

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

**UNIT I** **9 Hours**

**DSP INTEGRATED CIRCUITS AND VLSI CIRCUIT TECHNOLOGIES**

Standard digital signal processors-Application specific ICs for DSP-DSP systems-DSP system design-Integrated circuit design-MOS transistors-MOS logic

**UNIT II** **9 Hours**

**DSP ARCHITECTURES**

DSP system architectures-Standard DSP architecture-Ideal DSP architectures-Multiprocessors and Multicomputers-Systolic and Wave front arrays

**UNIT III** **9 Hours**

**SYNTHESIS OF DSP ARCHITECTURES**

Shared memory architectures-Mapping of DSP algorithms onto hardware-Shared memory architecture with Bit-serial PEs

**UNIT IV** **9 Hours**

**ARITHMETIC ELEMENTS**

Conventional number system-Redundant Number System-Residue Number System-Bit-parallel and Bit-Serial Arithmetic-Minimum Number of Basic Operations-Bit Serial Squarers-Serial/Serial Multipliers-Digit Serial Arithmetic.

**UNIT V** **9 Hours**

**SIGNAL PROCESSING ELEMENTS**

CORDIC Algorithm-Distributed Arithmetic-Basic shift accumulator-Reducing the memory size-Complex Multipliers-Improved shift-accumulator-FFT Processor-DCT Processor

**Total: 45 Hours**

**Reference(s)**

1. Lars Wanhammer, DSP Integrated Circuits, Academic press, New York 1999.
2. Oppenheim A.V. Schafer, R.W., and Buck, J.R. Discrete-time Signal Processing, Pearson education, 2000
3. Emmanuel C. Ifeachor, Barrie W. Jervis, Digital signal processing-A Practical Approach, Second edition, Pearson education, Asia 2001
4. Keshab K. Parhi, VLSI digital Signal Processing Systems design and Implementation, John Wiley & Sons, 1999
5. John G. Proakis and Dimitris K. Manolakis, Digital Signal Processing, 4th edition, Pearson Education India, 2001

## 22EC018 VLSI VERIFICATION 3 0 0 3

**Course Objectives**

- To model the digital logic using Verilog HDL
- To understand object-oriented programming concepts
- To understand the System Verilog verification 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.

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. Design digital logic using advanced Verilog HDL
2. Carry-out object-oriented programming concepts for verification environment
3. Implement the different system Verilog constraints and arrays
4. Construct the system Verilog verification environment
5. Analyze the different coverage types

**Articulation Matrix**

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

**UNIT I** **9 Hours**

**BASICS OF SYSTEM VERILOG**

Importance of System Verilog (SV), Difference between Verilog and SV, SV Data types: 2 State Data types (bit, byte, int, long_int, short_int), 4 State Data types (integer, real, real, time, logic, reg), User defined data types (Struct, enum, string, typedef)

**UNIT II** **9 Hours**

**OBJECT ORIENTED PROGRAMMING AND METHODS**

OOPs, Encapsulation, Polymorphism, Inheritance, Built-in Methods: Randomization, Pre & Post Randomize, Object Creation (new), User-Defined Methods: print method, copy methods (copy by handle, Shallow copy, Deep Copy)

**UNIT III** **9 Hours**

**SV CONSTRAINTS AND ARRAYS**

Simple Constraints, Weighted Distributed Constraint, Implication Operator Based Constraint, Variable Order Based Constraint, Static Array and Dynamic Arrays (Dynamic, Associative, and Queue Array)

**UNIT IV** **9 Hours**

**INTER, PROCESS COMMUNICATION (IPC), INTERFACE AND COVERAGE**

IPC, Semaphore, Mailbox, Events, Interface, Virtual Interface, Modport, Clocking Block, Coverage, Functional Coverage, Code Coverage, Cross Coverage, Coverage option

**UNIT V** **9 Hours**

**SV VERIFICATION ENVIRONMENT**

SV Verification Blocks, Generator Block: Bus Functional Model (BFM) Block, Interface Block, Monitor Block, Assertion Block, Environment Block, Program Block

**Total: 45 Hours**

**Reference(s)**

1. S. Palnitkar, Verilog HDL: A Guide to Digital Design and Synthesis, Prentice Hall, 2nd edition, 2003
2. Chris Spear and Greg Tumbush, SystemVerilog for Verification, Third Edition, Springer US ,2012
3. Stuart Sutherland, Simon Davidmann, Peter Flake, SystemVerilog for Design, Second Edition, Springer New York, NY,2006
4. https://verificationguide.com/systemverilog/systemverilog,tutorial/
5. https://www.chipverify.com/systemverilog/systemverilog,tutorial/

## 22EC019 ADVANCED DIGITAL SIGNAL PROCESSING

**3 0 0 3**

**Course Objectives**

- To Learn fundamental concepts on Random variables and random process.
- To Analyze the concepts of multi rate signal processing and multi rate filters.
- To Design the optimum and adaptive filters for signal processing applications.

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

PSO2 Able to solve complex engineering problems using state-of-the-art hardware and software tools, along with analytical and managerial skills to arrive appropriate solutions

**Course Outcomes (COs)**

1. Apply the concept of random variables and random process in Discrete Time Signals
2. Apply the Multirate signal processing concepts in design of filter banks, subband coding
3. Analyze the design of LMS adaptive filters and its performance for non-stationary signals
4. Analyze the design of RLS adaptive filter and its variants.
5. Apply the concept of wiener filter in prediction and noise cancellation applications and analyze its performance.

**Articulation Matrix**

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

**UNIT I** **9 Hours**

**DISCRETE TIME RANDOM PROCESS**

Random variables- Ensemble Averages-Jointed distributed random variables- Independent, uncorrelated and orthogonal random Variables-Gaussian random variables- Random processes

**UNIT II** **9 Hours**

**MULTIRATE SIGNAL PROCESSING**

Introduction, decimation by a factor "D", Interpolation by a factor "I", sampling rate conversion by a factor "I/D", Implementation of sampling rate conversion, Multistage implementation of sampling rate conversion.

**UNIT III** **9 Hours**

**FIR ADAPTIVE FILTERS**

The steepest Descent Adaptive Filter, The LMS Algorithm- Convergence of the LMS algorithm, Normalized LMS algorithm, LMS based adaptive filters, Gradient Adaptive Lattice filter

**UNIT IV** **9 Hours**

**ADAPTIVE RECURSIVE FILTERS**

Adaptive Recursive filters, Recursive Least square algorithm, Exponentially Weighted RLS, Sliding window RLS, Lattice recursive least squares filter (LRLS)

**UNIT V** **9 Hours**

**WIENER FILTERS**

The FIR Wiener Filter, -Linear Prediction, Noise cancellation, Lattice representation for the FIR wiener filter. The IIR wiener filter- Non-causal IIR wiener filter, The causal IIR wiener filter

**Total: 45 Hours**

**Reference(s)**

1. Ramrez, David, Ignacio Santamara, and Louis Scharf. Coherence: In Signal Processing and Machine Learning. Springer Nature, 2023.
2. H. MonsonHayes, Statistical Digital Signal Processing and Modeling, John Wiley and Sons, Inc., 2008.
3. G. John Proakis and G. Dimitris Manolakis, Digital Signal Processing, Pearson Education,2006.
4. P.P. Vaidyanathan, Multirate Systems and Filter Banks, Pearson Education,2008.
5. N.J. Filege, Multirate Digital Signal Processing, John Wiley and Sons, 2000.
6. G. JohnProakis, Algorithms for Statistical Signal Processing, Pearson Education, 2002.

## 22EC020 SPEECH SIGNAL PROCESSING 3 0 0 3

**Course Objectives**

- To study the basics of speech signal, speech production mechanisms
- To explore time domain and frequency domain analysis of speech signal
- To focus on the applications of speech signal processing

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

PSO2 Able to solve complex engineering problems using state-of-the-art hardware and software tools, along with analytical and managerial skills to arrive appropriate solutions

**Course Outcomes (COs)**

1. Analyse the fundamentals and mechanism of speech signals
2. Apply time domain methods to extract the speech parameters
3. Apply and analyze frequency domain methods of speech processing
4. Apply and analyze the concepts of linear predictive analysis for speech processing
5. Apply the concepts of speech processing for various signal processing models

**Articulation Matrix**

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

**UNIT I** **9 Hours**

**MECHANICS OF SPEECH**

Speech production mechanism- Nature of Speech signal - Representation of Speech signals - Classification of Speech sounds - Phonetic and Phonemic alphabets - Articulatory features - Auditory perception

**UNIT II** **9 Hours**

**TIME DOMAIN METHODS FOR SPEECH PROCESSING**

Time domain parameters of Speech signal - Methods for extracting the parameters Energy- Average Magnitude - Zero crossing Rate - Silence Discrimination using ZCR and energy

**UNIT III** **9 Hours**

**FREQUENCY DOMAIN METHOD FOR SPEECH PROCESSING**

Short Time Fourier analysis - Filter bank analysis - Formant extraction - Pitch Extraction - Analysis by Synthesis- Phase vocoder - Channel vocoder -Formant and Pitch Estimation Speech enhancement

**UNIT IV** **9 Hours**

**LINEAR PREDICTIVE ANALYSIS OF SPEECH**

Formulation of Linear Prediction problem in Time Domain -Basic Principle - Auto correlation method - Covariance method - Solution of LPC equations - Durbin"s Recursive algorithm - Case study on analyzing customers" buying behavior in retail industries

**UNIT V** **9 Hours**

**APPLICATION OF SPEECH SIGNAL PROCESSING**

Algorithms: Spectral Estimation, dynamic time warping - Hidden Markov model - Pitch Detection - Feature analysis for recognition- Automatic Speech Recognition - Feature Extraction for ASR - Multi-language text-to-speech conversion

**Total: 45 Hours**

**Reference(s)**

1. Nilanjan Dey, Intelligent Speech Signal Processing, Elsevier Books Inc, 2019
2. Ben Gold and Nelson Morgan, Speech and Audio Signal Processing, John Wiley and Sons Inc., 2004
3. Quatieri, Discrete-time Speech Signal Processing, Prentice Hall, 2001
4. L.R. Rabiner and R.W. Schaffer., Digital Processing of Speech signals, Prentice Hall, 1978
5. I.H. Witten, Principles of Computer Speech, Academic Press, 1982

## 22EC021 DIGITAL IMAGE PROCESSING 3 0 0 3

**Course Objectives**

- To study the digital image processing fundamentals.
- To understand the working of mathematical transforms applied on digital images.
- To acquire the basic knowledge in filters, image enhancement, image restoration and compression techniques.

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

PSO2 Able to solve complex engineering problems using state-of-the-art hardware and software tools, along with analytical and managerial skills to arrive appropriate solutions

**Course Outcomes (COs)**

1. Analyse the fundamentals of digital images and application of mathematical transforms on images.
2. Apply different methodologies for smoothening and sharpening of images in spatial and frequency domain.
3. Implement the segmentation techniques for the detection of edges, lines, and thresholding techniques.
4. Analyze the methods for image restoration and reconstruction using different filtering and projections.
5. Analyze different lossy and lossless coding techniques for image compression.

**Articulation Matrix**

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

**UNIT I** **9 Hours**

**DIGITAL IMAGE FUNDAMENTALS**

Fundamentals of digital image processing, Elements of visual perception, Image sampling and quantization, Basic Relationships between pixels. Image Transforms: Discrete Fourier transform, Cosine, Hadamard, Haar, Walsh and Slant transform

**UNIT II** **9 Hours**

**IMAGE ANALYSIS**

Spatial domain: Histogram processing, Equalization, Basics of spatial filtering, smoothing spatial filters, sharpening spatial filters, Frequency Domain: Image smoothing and sharpening using frequency domain filters.

**UNIT III** **9 Hours**

**IMAGE SEGMENTATION**

Edge detection: Point, line and edge detection- Detection of isolated points, Line detection, Edge models, Edge linking and boundary detection. Thresholding, Region splitting and Region Merging.

**UNIT IV** **9 Hours**

**IMAGE RESTORATION AND RECONSTRUCTION**

Image Restoration: Image degradation/ restoration model, Noise models, Restoration-Spatial Filtering, Inverse filtering, Wiener Filtering, Geometric Mean Filter, Image reconstruction from projections.

**UNIT V** **9 Hours**

**IMAGE COMPRESSION**

Basic compression methods-Huffman coding, Golomb coding, Arithmetic coding, LZW coding, Run-length coding, Block transform coding, Wavelet coding.

**Total: 45 Hours**

**Reference(s)**

1. Rafael C Gonzalez, Richard E Woods, Digital Image Processing, 4th Edition, Pearson Education 2018.
2. Digital Image Processing, S. Jayaraman, S. Esakkirajan, T. Veerakumar, McGraw Hill Education, 2009. Pvt Ltd, NewDelhi.
3. S Sridhar, Digital Image Processing, 2nd ed., Oxford University Press, 2016.
4. Tinku Acharya and Ajoy K. Ray-Image Processing Principles and Applications, A John Wiley & Sons, Mc., Publication 2005.
5. Ardeshir Goshtasby, 2D and 3D Image registration for Medical, Remote Sensing and Industrial Applications, John Wiley and Sons, 2005.

## 22EC022 MULTIMEDIA COMPRESSION TECHNIQUES

**3 0 0 3**

**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

**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.

PO5 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 Able to apply the concepts of Electronics, Communication, Signal processing and VLSI in the design and implementation of application oriented engineering systems.

PSO2 Able to solve complex engineering problems using state-of-the-art hardware and software tools, along with analytical and managerial skills to arrive appropriate solutions

**Course Outcomes (COs)**

1. Apply the fundamental concepts of multimedia and compression techniques.
2. Implement different lossy and lossless coding techniques for text compression.
3. Analyze the various lossy and lossless coding techniques for audio compression.
4. Apply and analyze the compression techniques for images.
5. Analyze different video compression standards and techniques.

**Articulation Matrix**

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

**UNIT I** **9 Hours**

**INTRODUCTION**

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** **9 Hours**

**TEXT COMPRESSION**

Compression techniques - Huffmann coding - Adaptive Huffmann Coding - Arithmetic coding - Shannon- Fano coding - Dictionary techniques - LZ77, LZ78, LZW family algorithms.

**UNIT III** **9 Hours**

**AUDIO COMPRESSION**

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** **9 Hours**

**IMAGE COMPRESSION**

MMR coding - Transform Coding - JPEG Standard - Sub-band coding algorithms - Design of Filter banks - Wavelet based compression - Implementation using filters - EZW, SPIHT coders - JPEG 2000 standards - Run length coding.

**UNIT V** **9 Hours**

**VIDEO COMPRESSION**

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**

**Reference(s)**

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.

## 22EC023 COMPUTER VISION 3 0 0 3

**Course Objectives**

- To Learn the image fundamentals and mathematical transforms necessary for image processing
- To Understand the image enhancement and restoration methods
- To Study the concepts of optics and lens systems

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

PSO2 Able to solve complex engineering problems using state-of-the-art hardware and software tools, along with analytical and managerial skills to arrive appropriate solutions

**Course Outcomes (COs)**

1. Apply the various image enhancement and segmentation methods
2. Carry-out the different morphological operations and shape representations in digital images
3. Differentiate of different techniques in object recognition systems
4. Analyze the different camera systems for 3D vision tasks
5. Analyze the various motion methods in processing of machine vision images

**Articulation Matrix**

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

**UNIT I** **9 Hours**

**IMAGE SEGMENTATION**

Thresholding - Edge based segmentation - Region based segmentation - Matching - Evaluation issues in segmentation - Mean Shift segmentation - Active contour models - snakes - Geometric deformable models - level sets and geodesic active contours - Fuzzy Connectivity

**UNIT II** **9 Hours**

**MORPHOLOGY AND SHAPE REPRESENTATION**

Basic morphological concepts - Four morphological principles - Binary dilation and erosion-Gray scale dilation and erosion -Skeletons and object marking - Granulometry - Morphological segmentation and watersheds. Region identification

**UNIT III** **9 Hours**

**OBJECT RECOGNITION**

Knowledge representation - Statistical pattern recognition - Neural nets - Syntactic pattern recognition - Recognition as graph matching - Optimization techniques in recognition - Fuzzy systems - Boosting in pattern recognition

**UNIT IV** **9 Hours**

**3D VISION**

3D vision tasks - Basics of projective geometry - A single perspective camera-Scene reconstruction from multiple views -Two cameras, stereopsis - Three cameras and trifocal tensor- 3D information from radiometric measurements

**UNIT V** **9 Hours**

**MOTION ANALYSIS**

Differential motion analysis methods - Optical flow - Analysis based on correspondence of interest points - Detection of specific motion patterns - Video tracking - Motion models to aid tracking

**Total: 45 Hours**

**Reference(s)**

1. Ramesh Jain, Rangachar Kasturi and Brian G. Schunck, Machine Vision, McGraw Hill International Edition, 2012
2. Sonka, Hlavac, Boyle, Image Processing, Analysis and Machine Vision, CENGAGE Learning, 4th Edition, 2015
3. Rafael C. Gonzalez, Richard E. Woods, Digital Image Processing, Pearson India, 3rdEdition, 2013
4. W.K. Pratt, Digital Image Processing, John Wiley and Sons, 2001

## 22EC024 WAVELET TRANSFORMS AND APPLICATIONS

**3 0 0 3**

**Course Objectives**

- To understand the basic concept of wavelet transforms.
- To apply the wavelet transforms in the dynamic system models and classifiers.
- To apply wavelet signal processing techniques in domains of signal and image processing techniques.

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

PSO2 Able to solve complex engineering problems using state-of-the-art hardware and software tools, along with analytical and managerial skills to arrive appropriate solutions.

**Course Outcomes (COs)**

1. Apply the fundamentals of continuous and discrete wavelet transforms.
2. Implement the orthonormal basis and filter banks of wavelet transform.
3. Apply and analyze biorthogonal wavelet bases and 2D wavelet packets.
4. Apply and analyze wavelet transform in signal and image models.
5. Outline the recent advancements of wavelet transform in signal and image processing application.

**Articulation Matrix**

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

**UNIT I** **9 Hours**

**CONTINUOUS AND DISCRETE WAVELET TRANSFORM**

Concepts of continuous time wavelet transform, CWT as a correlation, Constant Q factor filtering-interpretation, time frequency resolution, CWT as an operator, inverse CWT, Discrete wavelet transform

**UNIT II** **9 Hours**

**ORTHONORMAL WAVELETS AND FILTER BANKS**

Definition of MRA, Construction of a general orthonormal MRA, Wavelet basis for MRA, Digital filtering, Examples of orthonormal basis, generating wavelets, Interpreting orthonormal MRA for discrete, time signals

**UNIT III** **9 Hours**

**ALTERNATIVE WAVELET TRANSFORMS**

Biorthogonal wavelet bases, Filtering relations for orthogonal filters, examples of biorthogonal scaling fuctions and wavelets, 2D Wavelets, non separable multidimensional wavelets, Wavelet packets, transform coding

**UNIT IV** **9 Hours**

**APPLICATION OF WAVELET TRANSFORMS**

Wavelet denoising, speckle removing, Edge detection and object isolation, image fusion, Object detection by wavelet transforms of projections, communication applications, Scaling functions as signaling pulses

**UNIT V** **9 Hours**

**ADVANCED TOPICS**

Parsevals identity for CWT, wavelet inner product as a projection operation, CWT with an orthonormal basis for generating wavelet, ATrous algorithm, regularity, convergence, Daubechies construction of orthonormal scaling functions, band limited biorthogonal decomposition.

**Total: 45 Hours**

**Reference(s)**

1. Lokenath Debnath, Firdous Ahmad Shah, Wavelet Transforms and Their Applications, BirkhÃƒÂ¤user Boston Inc, 2014
2. Mallat., Wavelet Tour of Signal Processing, Academic Press, 2008.
3. Raghuveer.M. Rao and Ajit.S. Bopardikar, Wavelet transforms Introduction to theory and Applications, Addison Wesley education Asia 2000.
4. C.Sidney burrus, Ramesh A. Gopinath, and Haitao Guo, Introduction to wavelets and wavelet transforms A Primer, PH International Editions,1998.
5. G. Strang and T. Nguyen, Wavelets and Filter Banks, Wellesley Cambridge Press, 1996

## 22EC025 UNDERWATER ACOUSTIC COMMUNICATIONS

**3 0 0 3**

**Course Objectives**

- Learn the characteristics of Underwater Acoustic environment.
- To be able to analyze and design the performance of underwater acoustic systems
- Detection of active signal, estimation of time of arrival and signal magnitude to asses geometric properties of underwater channel and to asses emission level and target strength.
- Design the Optimization techniques in Echo cancellation, Beam forming and Noise reduction methods.
- Understand the concepts of acoustic signal models.

**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 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 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. Find the characteristics of underwater acoustic channel environment.
2. Analyze the principles and characteristics of SONAR systems.
3. Analyze and develop acoustic an echo cancellation algorithm and beamforming techniques.
4. Analyze the challenges in noise reduction in underwater environment.
5. Analyze the acoustic MIMO system design for underwater scenario.

**Articulation Matrix**

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

**UNIT I** **7 Hours**

**FUNDAMENTAL OF UNDERWATER ACOUSTICS**

Speed of sound in seawater - Transmission Loss - Refraction - Deep sound channel and Reliable acoustic path - Surface Interference - Active and Passive UWSN - Noise and Bandwidth Considerations.

**UNIT II** **11 Hours**

**SONAR SYSTEMS**

SONAR equations: Active and Passive, Underwater sound systems: Generic Active SONAR systems and Generic Passive SONAR systems, SONAR Transducers, Receivers, Receiving arrays and sonobuoys - Signal processing functions.

**UNIT III** **10 Hours**

**ECHO CANCELLATION AND BEAM FORMING TECHNIQUES**

Acoustic echo cancellation (AEC) - Adaptive Beam Forming - Joint Acoustic echo cancellation and Adaptive Beamforming - Optimization Techniques: LCLSE, GSC, GSAEC, and RGSC Methods.

**UNIT IV** **10 Hours**

**NOISE REDUCTION**

Weiner Filter and spectral subtraction - Optimum Filter design in the digital domain - Weiner filter in the frequency domain - Weiner filter realizations - Spectral subtraction: Principles and realizations.

**UNIT V** **7 Hours**

**ACOUSTIC MIMO SYSTEMS**

Acoustic environment distraction - Signal Models: SISO, SIMO, MISO, and MIMO - Characteristics: Reverberation Time - Channel Invertibility and Minimum phase filter - Multichannel diversity and Common Zero problem - Spare Impulse response.

**Total: 45 Hours**

**Reference(s)**

1. Stergiopoulos, Stergios- Advanced signal processing handbook_theory and implementation for radar, sonar, and medical imaging real time systems-CR (2017).
2. David Havelock, Sonoko Kuwano, Michael Vorlander-Handbook of Signal Processing in Acoustics (2 vol set) - Springer (2009).
3. Jens Blauert, Ning Xiang-Acoustic MIMO Signal Processing-Springer (2006).
4. E. Hansler, G. Shmidt -Topics in Acoustic Echo and Noise Control-Springer (2006)
5. Hanzo L., Somerville F.S., Woodard J.-Acoustic Signal Processing for Telecommunication, (2002).
6. L.Kinsler, et al., Fundamentals of Acoustics, Wiley Publications, (2000) - Fourth edition.

## 22EC026 SATELLITE COMMUNICATION 3 0 0 3

**Course Objectives**

- To know the basics of satellite communication
- To understand the concepts of orbital mechanics, multiple access techniques and space links
- To gain knowledge on spacecraft subsystems, earth stations and satellite platform applications

**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.

PO7 Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

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

PSO2 Able to solve complex engineering problems using state-of-the-art hardware and software tools, along with analytical and managerial skills to arrive appropriate solutions

**Course Outcomes (COs)**

1. Apply Orbital effects in Communication System and analyze performance of Attitude control
2. Analyze the various subsystems of spacecraft
3. Design and analyze the characteristics of satellite links
4. Analyze various multiple access techniques in a satellite network
5. Compare different types of satellite services in broadcasting multimedia applications

**Articulation Matrix**

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

**UNIT I** **9 Hours**

**ORBITAL MECHANICS**

Kepler's laws of motion, Orbits, Orbit Equations, Orbit Description, Locating the Satellite in the Orbit and with Respect to Earth, Orbital Elements-Look Angle Determination and Visibility - Orbital Perturbations, Orbit Determination, Launch Vehicles, Spectrum allocations for satellite systems.

**UNIT II** **9 Hours**

**SPACECRAFT SUB SYSTEMS AND EARTH STATION**

Spacecraft Subsystems, Altitude and Orbit Control, Telemetry and Tracking, Power Systems, Communication Subsystems - Transponders, Antennas, Amplifier, Amplifier Noise Temperature, Equipment Reliability.

**UNIT III** **9 Hours**

**SPACE LINKS**

Satellite Link Design - Satellite uplink and down link power Budget, Basic Transmission Theory, System Noise Temp, G/T Ratio, Noise Figure, Interference between satellite circuits, Energy Dispersal, propagation characteristics of fixed and mobile satellite links.

**UNIT IV** **9 Hours**

**MULTIPLE ACCESS TECHNIQUES AND NETWORK ASPECTS**

Multiple access (MA). Classical MA techniques: FDMA, TDMA, CDMA, DAMA. Mobile satellite network design, ATM via satellite. TCP/IP via satellite - Call control, handover and call set up procedures. Hybrid satellite-terrestrial networks.

**UNIT V** **9 Hours**

**SERVICES AND APPLICATIONS**

INTELSAT series, INSAT, VSAT, Remote Sensing - Mobile satellite service: GSM, GPS, INMARSAT, LEO, MEO, Navigation System, Direct to Home service (DTH), Digital Audio Broadcast (DAB), Special Services-E-mail, Video conferencing and Internet connectivity.

**Total: 45 Hours**

**Reference(s)**

1. Dennis Roddy, Satellite Communications, Fourth Edition, Mc Graw Hill International Editions, 2006.
2. Bruce R. Elbert, The Satellite Communication Applications Hand Book, Artech House Boston, Second Edition, 2004.
3. Wilbur L. Pritchard, Hendri G. Suyderhood, Robert A. Nelson, Satellite Communication Systems Engineering, Second Edition, Prentice Hall, New Jersey, 1993.
4. Louis J. Ippolito, Jr., Satellite Communications Systems Engineering - Atmospheric Effects, Satellite Link Design and System Performance, First edition, John Wiley & Sons Ltd., 2008.
5. Tri T. Ha, Digital satellite communication, 2nd Edition, McGraw Hill, New York, 1990
6. Peter Teunissen, Springer Handbook of Global Navigation Satellite Systems, Springer Handbooks, ISBN: 9783030731724, July 25th, 2021.

## 22EC027 OPTICAL COMMUNICATION AND NETWORKS

**3 0 0 3**

**Course Objectives**

- Awareness on phenomena involved light propagation through various fiber configurations and the issues like attenuation mechanisms (losses) and signal degradation (dispersion effects)
- Characteristics of different components like transmitters, receivers, coupler etc., and their suitability to different types of optical communication links.
- Determination of choice of components for deployment of a given optical link based on link power (losses) & rise time (dispersive) budget and managing the optical network.

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

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. Implement the behavior of different optical medium (fibers) and performance of signal Propagation.
2. Demonstrate the issues in propagation of optical signals resulting from signal degradation mechanism of optical fiber media.
3. Analyze the performance of optical sources, detectors and the concept for choice of light sources, detectors for the given optical link
4. Demonstrate the working of optical components in the design of optical networks. optical links.
5. Analyse the power loss and signal dispersive nature of optical media and apply the result to identify appropriate transmitter, receiver, on line.

**Articulation Matrix**

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

**UNIT I** **9 Hours**

**INTRODUCTION TO OPTICAL FIBERS**

Evolution of fiber optic system- Element of an Optical Fiber Transmission link- Ray Optics-Optical Fiber Modes and Configurations. Mode theory of Circular Waveguides- Overview of Modes-Key Modal concepts- Linearly Polarized Modes Single-Mode Fibers

**UNIT II** **9 Hours**

**SIGNAL DEGRADATION OPTICAL FIBERS**

Attenuation, Absorption losses, scattering losses, Bending Losses, Core and Cladding losses, Signal Distortion in Optical Waveguides-Information Capacity determination. Group Delay-Material Dispersion, Waveguide Dispersion, Polarization Mode dispersion, Intermodal dispersion, Mode Coupling

**UNIT III** **9 Hours**

**FIBER OPTICAL SOURCES AND DETECTORS**

Direct and indirect Band gap materials -LED- lasers Diodes - Quantum efficiency-PIN and APD diodes-Photo detector noises, SNR, Detector Response time, Comparison of Photo detectors.

**UNIT IV** **9 Hours**

**OPTICAL NETWORK COMPONENTS**

Couplers, Isolators, Switches, Wavelength Converters, Circulators, Filters, Multiplexers, WDM, Optical Amplifiers-EDFA - Basic on concepts of SONET/SDH Network

**UNIT V** **9 Hours**

**SYSTEM DESIGN AND MANAGEMENT**

Point to Point links System considerations, Power budget, time budget- bandwidth budget calculations, Noise Effects on System Performance- OTDR -Attenuation and dispersion, Field Measurements. Network Management- Performance and fault management, Configuration Management.

**Total: 45 Hours**

**Reference(s)**

1. Optical Fiber Communication by Gerd Keiser, Springer Nature Singapore, March 2021
2. Optical Networks: A Practical Perspective by Rajiv Ramaswami and Kumar Sivarajan Morgan Kaufmann, 2010.
3. Optical Communication, Principles and Practice by J. Senior Prentice Hall of India, third edition published 2009.
4. Optical Communication-Components and Systems by J.H. Franz, V.K. Jain, Narosa Publishing House, 2000.
5. Optical Network Design and Implementation by Vivek Alwayn, Pearson Education, 2006.
6. Optical Networks: Architecture and Survivability by Hussein T. Mouftab and Pin-Han Ho, Springer US, 2003

## 22EC028 MIMO COMMUNICATION 3 0 0 3

**Course Objectives**

- To learn the concepts of MIMO channel propagation and MIMO channel model.
- To understand spatial diversity and MIMO channel capacity performance in wireless communication.
- To provide the fundamental knowledge on Space-Time Codes and MIMO detection techniques.

**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.

PO5 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 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 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. Analyze the channel models and power allocation in MIMO Systems.
2. Apply the mathematics concepts and Calculate the capacity of deterministic and random MIMO channels and fading channels
3. Analyze the implication of spatial diversity method and calculate the diversity order and channel variability.
4. Analyze the concept of different space time coding techniques like STBCs, STTCs and Space time turbo codes
5. Analyze the various algorithms used to detect the received signal in MIMO systems like Maximum likelihood, MMSE, ZFE

**Articulation Matrix**

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

**UNIT I** **9 Hours**

**INTRODUCTION TO MIMO CHANNEL MODELS**

Diversity-multiplexing trade-off, transmit diversity schemes, advantages and applications of MIMO systems, Fading Channel Models: Uncorrelated - fully correlated - separately correlated - keyhole MIMO fading models, parallel decomposition of MIMO channel, Power allocation in MIMO: Uniform - adaptive - near optimal power allocation

**UNIT II** **9 Hours**

**MIMO CHANNEL CAPACITY**

Capacity for deterministic MIMO Channels: SISO, SIMO, MISO, MIMO, Capacity of random MIMO channels: SISO, SIMO, MISO, MIMO (Unity Channel Matrix, Identity Channel Matrix), Capacity of independent identically distributed channels, Capacity of separately correlated Rayleigh fading MIMO channels, Capacity of keyhole Rayleigh fading MIMO channel

**UNIT III** **9 Hours**

**SPATIAL DIVERSITY**

Diversity gain, receive antenna diversity, transmit antenna diversity, Diversity order and channel variability, Diversity performance in extended channels, combined space and path diversity, Indirect transmit diversity, Diversity of a space, time, frequency selective fading channel.

**UNIT IV** **9 Hours**

**SPACE-TIME CODES**

Advantages, code design criteria, Alamouti space time codes, SER analysis of Alamouti space-time code over fading channels, Space time block codes, Space time trellis codes, Performance analysis of Space, time codes over separately correlated MIMO channel, Space-time turbo codes, BLAST Architectures: VBLAST, HBLAST, SCBLAST, DBLAST

**UNIT V** **9 Hours**

**MIMO DETECTION TECHNIQUES**

Maximum Likelihood, Zero Forcing, Minimum Mean Square Error, Zero Forcing Equalization with Successive Interference Cancellation, Minimum Mean Square Error Successive Interference Cancellation, Lattice Reduction based detection

**Total: 45 Hours**

**Reference(s)**

1. TolgaM.Duman and Ali Ghrayeb, Coding for MIMO Communication Systems, John Wiley & Sons Ltd.,2007
2. 2. EzioBiglieri, Robert Calderbank and Anthony Constantinides. MIMO Wireless Communications Cambridge University Press, 2007
3. R. S. Kshetrimayum, Fundamentals of MIMO Wireless Communications, Cambridge University Press, 2017.
4. B. Kumbhani and R. S. Kshetrimayum, MIMO Wireless Communications over Generalized Fading Channels, CRC Press, 2017
5. T. L. Marze_a, E. G. Larsson, H. Yang and H. Q. Ngo, Fundamentals of Massive MIMO, Cambridge University Press, 2016.

## 22EC029 SIGNAL PROCESSING FOR MM WAVE COMMUNICATION

**3 0 0 3**

**Course Objectives**

- To impart the knowledge and encompasses the complete mmWave communication from the signal processing point of view.
- To give an in-depth knowledge about the mmWave channel models.
- To analyze the MIMO-OFDM in mmWave channel models.
- To design and analyze the beamforming technology of the mmWave models.

**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 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 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. Analyze the ray tracing channel models in narrowband and wideband aspects.
2. Analyze the various time varying channel model
3. Analyze the mmWave channel model using Transmitter and receiver side multiple antennas
4. Design and analysis of various beamforming techniques in mmWave channel model.
5. Analyze the Precoder, Phase Shifter, Equalizer for better optimization of design parameters.

**Articulation Matrix**

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

**UNIT I** **9 Hours**

**AN INTRODUCTION TO WIRELESS CHANNELS**

Wireless Channel - A ray tracing model - Fundamentals and General Channel Model - RMS Delay, and Doppler effect of the channels, Understanding of various channel-related parameter statistics - Narrowband and broadband aspect.

**UNIT II** **9 Hours**

**TIME VARYING CHANNEL MODEL**

Time-varying model - Doppler impact of coherence Bandwidth - AR, ARMA and MA process - Doppler with AR process - Coherence Time and parameters

**UNIT III** **9 Hours**

**MMWAVE CHANNEL MODEL**

Basics of ISI channel - Channel estimation and Equalizer -Precoder and MIMO channel - mmWave Spectrum - 3D Concepts: AOA - AOD - mmWave Channel Model: mmWave channel model with Rx Beamforming - Channel Model: Tx with multiple antennas.

**UNIT IV** **9 Hours**

**BEAMFORMING TECHNIQUES**

Single antenna Beamforming - Different geometry of antenna from an electrical point of view - Basics of Beamforming pattern - SISO Beamforming - Concept of antenna many fold vector, beam parameters, efficiency of beams pattern.

**UNIT V** **9 Hours**

**HYBRID BEAMFORMING TECHNIQUES**

Hybrid Beamforming of mmWave MIMO systems: Precoder, Phase Shifter, Equalizer, Optimization of design parameters, MIMO-OFDM, parameter estimation using LMMSE - mmWave system impairments.

**Total: 45 Hours**

**Reference(s)**

1. Kao-Cheng Huang, Zhaocheng Wang, Millimeter Wave Communication Systems, 1st edition, Wiley-IEEE Press, 2011
2. David Tse, Pramod Viswanath, Fundamentals of wireless communication, Cambridge University Press, 2003.

## 22EC030 MACHINE LEARNING FOR WIRELESS COMMUNICATIONS

**3 0 0 3**

**Course Objectives**

- To understand the principles of machine learning and apply the fundamental principles for regression and classification.
- To apply the mathematical principles of probability, linear algebra and optimisation
- To apply machine learning principles in the design of some physical layer techniques in wireless communications

**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 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 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. Apply the principles of machine learning and apply the fundamental principles for regression and classification.
2. Apply the linear Modeling approach for estimation of the signal.
3. Apply the Bayesian Approach to Machine Learning for channel estimation.
4. Apply the machine learning concept for clustering and classification.
5. Analyze different Machine learning algorithms for wireless applications.

**Articulation Matrix**

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

**UNIT I** **9 Hours**

**FUNDAMENTALS OF MACHINE LEARNING**

Quick overview of Supervised, Unsupervised and Reinforcement Learning- Supervised Learning-Classification, Neural networks and Deep Learning, Unsupervised Learning-Clustering, Autoencoders, Reinforcement Learning-Markov Decision Processes, Q-Learning o Multi-armed Bandits

**UNIT II** **9 Hours**

**LINEAR MODELING**

A Least Squares Approach, Linear modelling, Generalization and over fitting, Regularized least squares A Maximum Likelihood Approach, Errors as noise, Maximum likelihood, Bias-variance trade-off, Effect of noise on parameter estimates.

**UNIT III** **9 Hours**

**BAYESIAN APPROACH**

Exact posterior, Marginal likelihood, Hyperparameters, Bayesian Inference- Non-conjugate models, Point estimate, MAP solution, Laplace approximation

**UNIT IV** **9 Hours**

**CLUSTERING AND CLASSIFICATION**

Classification: Probabilistic classifiers, Bayes classifier, logistic regression, Non Probabilistic classifiers, K-nearest neighbors, Discriminative and generative classifiers Clustering: General Problem, K-means clustering, Gaussian mixture models (GMM),EM algorithm , MAP estimates, Bayesian mixture models.

**UNIT V** **9 Hours**

**APPLICATION IN WIRELESS**

Physical layer communications, Use of autoencoders, Modulation, Channel coding, Modulation / Signal classification, Localization, Spectrum Sensing, Adaptive modulation and coding (AMC): classical AMC, using support vector machines, using k-nearest neighbors, using k-means, using reinforcement learning.

**Total: 45 Hours**

**Reference(s)**

1. M. Bishop Pattern Recognition and Machine Learning, Christopher, Springer 2009.
2. P Murphy, MIT Machine Learning a Probabilistic Perspective, Kevin Press 2012
3. Machine Learning and Wireless Communications, Yonina C. Eldar, Princeton University, New Jersey, Cambridge University Press, June 2022.

## 22EC031 MICROWAVE CIRCUITS AND SYSTEMS 3 0 0 3

**Course Objectives**

- To describe the basic principles and advanced applications of Microwave Engineering.
- To introduce the concept of transmission lines and waveguides.
- To illustrate the concepts of microwave network analysis and impedance matching.
- To learn about various types of resonators.
- To learn about Microwave Filters.
- To describe the procedures to design different amplifiers, oscillators and mixers.

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

PSO2 Able to solve complex engineering problems using state-of-the-art hardware and software tools, along with analytical and managerial skills to arrive appropriate solutions

**Course Outcomes (COs)**

1. Apply the concept and derive different characteristics of various transmission lines waveguides
2. Analyze various parameters of microwave networks.
3. Analyze and design microwave filters and resonators
4. Analyze the concept of amplifier stability, gain and noise figure
5. Analyze EMI/EMC for all microwave small signal and power amplifiers

**Articulation Matrix**

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

**UNIT I** **9 Hours**

**RF AND MICROWAVE PASSIVE COMPONENTS**

Resistor Inductor and Capacitor at High Frequency Directional Couplers Two-hole directional couplers Isolator Circulator S Matrix for microwave components

**UNIT II** **11 Hours**

**MICROWAVE NETWORK ANALYSIS AND TUNING**

Impedance and admittance matrices, scattering matrices, ABCD matrix, Signal flow graphs, discontinuities and modal analysis, Series and parallel resonance circuits, transmission line resonators rectangular waveguide cavity resonator, circular waveguide cavity resonator, dielectric resonator.

**UNIT III** **9 Hours**

**MICROWAVE FILTERS**

Periodic structures, filter design by: Image parameter method, insertion loss method, filter transformation, filter implementation, LPF, coupled line filters, filters using coupled resonators.

**UNIT IV** **9 Hours**

**MICROWAVE AMPLIFIER, OSCILLATOR AND MIXER DESIGN**

Two port power gains, single stage transistor amplifier design, broadband transistor amplifier design, power amplifier, RF oscillators Microwave Oscillator, oscillator phase noise, frequency multipliers, and mixers.

**UNIT V** **7 Hours**

**MODERN TRENDS IN MICROWAVES ENGINEERING**

Effect of Microwaves on human body. Medical and Civil applications of microwaves. Electromagnetic interference Electromagnetic Compatibility (EMI EMC).

**Total: 45 Hours**

**Reference(s)**

1. R.E. Collin, Foundations of Microwave Engineering, Wiley, 2nd edition 2007.
2. Ramo, Whinnery and Van Duzer, Fields and Waves in Communication Electronics, 3rd Edition, Wiley, 2007.
3. David. M Pozar, Microwave and RF System Design, Wiley 2001.
4. Wayne Tomasi, Advanced Microwave Communication Systems, PHI, 2nd Edition, 2002

## 22EC032 MICROWAVE INTEGRATED CIRCUITS 3 0 0 3

**Course Objectives**

- To acquire an insight view and knowledge to design different types of resonators, filters and advanced microwave structures.
- To gain proficiency regarding microwave integrated circuit concepts and relation between different parameters.
- To analyse and design microwave integrated circuit design using lumped elements and transmission lines.

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

PSO2 Able to solve complex engineering problems using state-of-the-art hardware and software tools, along with analytical and managerial skills to arrive appropriate solutions

**Course Outcomes (COs)**

1. Apply the concept of production methods, substrates, packaging and components in Monolithic MIC technology.
2. Analyze and design the different types of microwave integrated circuits by using transmission lines and lumped elements.
3. Analyze different types of resonators and filters to select frequencies in microwave communication circuit.
4. Analyze the various measurement techniques involved in Microwave Integrated Circuits.
5. Analyze the design and development of advanced microwave structures to enable the current MIC technologies in near future.

**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 | 2 | 3 | - | - | - | - | - | - | - | - | - | 2 | - |
| 3 | - | 2 | 3 | - | - | - | - | - | - | - | - | - | 2 | - |
| 4 | 1 | 2 | - | 2 | - | - | - | - | - | - | - | - | - | 1 |
| 5 | - | 1 | 3 | - | 2 | - | - | - | - | - | - | - | 2 | - |

**UNIT I** **9 Hours**

**MONOLITHIC MIC TECHNOLOGY**

Introduction to microwave communication and EM spectrum Characteristics of Microwave and Millimeter waves MMIC technology, Applications, Substrates, Production Methods, Packaging, and Electrical Connections, Components for Integrated Microwave Circuits.

**UNIT II** **9 Hours**

**TRANSMISSION LINES AND LUMPED ELEMENTS**

Characteristics of Planar Transmission lines Strip line, Microstrip, Suspended and Inverted Microstrip Lines, Coupled Lines and its Discontinuities Lumped elements: Design of Lumped elements, Inductors, Capacitors, and Resistors.

**UNIT III** **9 Hours**

**FILTERS AND RESONATORS**

Introduction Resonator parameters Planar Microstrip resonant structures Dielectric resonator. Filter Synthesis: Low pass filter, Special response filter, Filter transformations, Impedance and Admittance Inverters Filter Modelling: Narrowband approximation, Filter Realizations Dielectric Resonant Filters Practical considerations.

**UNIT IV** **9 Hours**

**MICROWAVE IC DESIGN AND MEASUREMENT TECHNIQUES**

Microwave Integrated Circuits MIC Materials Hybrid versus Monolithic MICs Multichip Module Technology Fabrication Techniques, Miniaturization techniques, Introduction to SOC, SOP, Test fixture measurements, probe station measurements.

**UNIT V** **9 Hours**

**ADVANCED MICROWAVE STRUCTURES**

Defect Ground Structure Introduction, Base structure, Circuit topologies, Characteristics, Modelling of DGS and Application of DGS Substrate Integrated Waveguides: Introduction Geometry Operation Principle Analysis Techniques of SIW Design Considerations.

**Total: 45 Hours**

**Reference(s)**

1. David M. Pozar, Microwave Engineering, John Wiley & Sons, 1998.
2. David M. Pozar, Microwave & RF Design of Wireless Systems, John Wiley & Sons, 1998.
3. Ramesh Garg, InderBahl, Maurizio Bozzi Microstrip Lines and Slotlines, Third Edition Artech House (2013).
4. Ulrich L. Rohde, Matthias Rudolph RF/Microwave Circuit Design for Wireless Applications Wiley (2012).
5. InderBahl, Prakash Bhartia Microwave Solid State Circuit Design-Wiley Interscience (2003).
6. Hoffman R.K, Handbook of Microwave Integrated Circuit, Artech House (1987).

## 22EC033 RF SYSTEM DESIGN 3 0 0 3

**Course Objectives**

- To identify the and realize the different specification parameters of a wireless system.
- To analyze the characteristics of noise and distortion in wireless RF systems.
- To design RF systems using behavior models of the subsystems present in the receiver chains.

**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 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 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. Analyze the characteristics of noise and distortion in the microwave systems due to temperature, mismatched terminations and inter-modulations.
2. Design and implement the Filters using image impedance, insertion loss and prototype techniques.
3. Analyze the performance of amplifier circuits in the receivers in different configuration modes.
4. Design the different mixer circuits using Schottky barrier diode, FETs and analyze its characteristics.
5. Analyze the devices for switches, oscillator circuits, frequency synthesizers and evaluate its performance at the receiver end.

**Articulation Matrix**

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

**UNIT I** **9 Hours**

**NOISE AND DISTORTION IN RF SYSTEMS**

Noise temperature and noise figure, noise figure of a lossy transmission line; Noise figure of cascade systems: Noise figure of passive networks, mismatched transmission lines and Wilkinson power dividers; Dynamic range and inter-modulation distortion.

**UNIT II** **9 Hours**

**RF FILTER DESIGN**

RF filter design-constant K prototype filter design-derived prototype filter design. Insertion loss method- Maximally flat low pass prototype, Equal ripple low pass prototype, Filter transformation and filter implementation.

**UNIT III** **9 Hours**

**RF AMPLIFIER DESIGN**

Circuit models for FETs and BJTs; Amplifier design using S-parameters: Design for maximum gain, maximum stable gain, design for specified gain, low-noise amplifier design, design of class-A power amplifiers.

**UNIT IV** **9 Hours**

**MIXERS**

Mixer characteristics: Image frequency, conversion loss, noise figure; Diode mixers: Small-signal characteristics of diode, single-ended mixer, large-signal model, switching model; FET Mixers: Single-ended mixer, other FET mixers; Balanced mixers; Image reject mixers.

**UNIT V** **9 Hours**

**SWITCHES**

Devices for microwave switches: PIN diode, BJT, FET; Device models; Types of switches; Switch configurations; Basic theory of switches; Multi-port, broad-band and isolation switches.

**Total: 45 Hours**

**Reference(s)**

1. Pozar, D.M. Microwave and RF Design of Wireless Systems, John Wiley & Sons.
2. Gonzalez, G., Microwave Transistor Amplifiers: Analysis and Design, 2nd Ed., Prentice-Hall. 1997.
3. Bahl, I. and Bhartia, P., Microwave Solid State Circuit Design, 2nd Ed., John Wiley & Sons. 2003.
4. Chang, K., Bahl, I. and Nair, V., RF and Microwave Circuit and Component Design for Wireless Systems, Wiley Interscience. 2002.
5. Rohde, U.L. and Newkirk, D.P., RF/Microwave Circuit Design for Wireless Applications, John Wiley & Sons. 2000.
6. Larson, L.E., RF and Microwave Circuit Design for Wireless Applications, Artech House. 1996.

## 22EC034 ELECTROMAGNETIC INTERFERENCE AND COMPATIBILITY

**3 0 0 3**

**Course Objectives**

- To apply, identify and understand the basic sources of EMI & EMC.
- To formulate and analyze different EMI measurements.
- To understand the concepts of EMI control mechanisms which meets the specific needs with appropriate techniques.
- To select, apply and differentiate appropriate standards for EMI/EMC
- To design, analyze and understand the process of creating EMC PCBs

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

PSO2 Able to solve complex engineering problems using state-of-the-art hardware and software tools, along with analytical and managerial skills to arrive appropriate solutions

**Course Outcomes (COs)**

1. Analyze the effects of EMI-EMC and their sources of origination
2. Design and implement the EMI rejection filters for a particular application.
3. Apply EMI control mechanisms for specific needs with appropriate techniques
4. Compare and discuss about different standards for EMI/EMC.
5. Design and analyze the process of creating EMC PCBs

**Articulation Matrix**

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

**UNIT I** **9 Hours**

**EMI ENVIRONMENT**

Concepts of EMI and EMC and definitions Sources of EMI Celestial Electromagnetic noise Lightning Discharge-Electrostatic Discharge Electromagnetic Pulse Electromagnetic emissions Noise from relays and Switches Nonlinearities in Circuits.

**UNIT II** **9 Hours**

**EMI COUPLING PRINCIPLES**

Capacitive coupling Inductive coupling Common impedance ground coupling- Ground loop coupling Transients in power supply lines Radiation coupling, Conduction coupling Common mode and Differential mode interferences Conducted EM noise on power supply lines.

**UNIT III** **9 Hours**

**EMI MEASUREMENTS**

Open area test site measurements Measurement precautions Open -area test site Anechoic Chamber TEM Reverberating TEM GTEM cell Comparisons

**UNIT IV** **9 Hours**

**EMI CONTROL TECHNIQUES**

EMC Technology Grounding-Shielding Electrical Bonding Power line filter CM filter DM filter EMI suppression Cables EMC Connectors Isolation transformer.

**UNIT V** **9 Hours**

**EMI/EMC STANDARDS**

Introduction Standards for EMI/EMC MIL STD 461/462-IEEE/ANSI standard CISPR/IEC standard FCC regulations British standards VDE standards Euro norms Performance standards Comparisons.

**Total: 45 Hours**

**Reference(s)**

1. V.P. Kodali, Engineering EMC Principles, Measurements and Technologies, IEEE Press, 2 nd edition 2011.
2. C.R. Paul, Introduction to Electromagnetic Compatibility, John Wiley and Sons, Inc, 2 nd edition 2010.
3. Henry W. Ott, Electromagnetic Compatibility Engineering, John Wiley and Sons, New York, 2009.
4. Clayton R. Paul, Introduction to Electromagnetic Compatibility, 2nd Edition, wiley publishers, 2006.

## 22EC035 ANTENNA TECHNOLOGIES FOR WIRELESS APPLICATIONS

**3 0 0 3**

**Course Objectives**

- To understand the fundamental knowledge on evolution of wireless communications
- To analyze the performance of the antenna for nearfield and indoor Applications
- To design the antenna for cellular applications

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

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. Analyze the requirements of an antenna for wireless applications with respect to its parameters
2. Analyze the radiation pattern of antennas using EM CAD simulator software-ADS
3. Design the antennas for typical applications including RFID, Zigbee, cellular, wearable devices and UWB communication
4. Design an electrically small antennas using design principles
5. Analyze the challenges associated with the deployment and implementation of 5G networks

**Articulation Matrix**

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

**UNIT I** **9 Hours**

**INTRODUCTION TO WIRELESS SYSTEMS AND STANDARDS**

Wireless systems and standards – Applications, Air interface- Near field, Indoor, Outdoor, Requirements of antenna for above applications, Base station (BS) and User equipment (UE) antennas

**UNIT II** **9 Hours**

**NEAR FIELD APPLICATIONS**

Reader antennas- Specifications- gain, bandwidth and polarization, pillar antennas and design. RFID Tag Antennas: Tag architecture- Tag, clip type, Types of Tag, Radio Link, Parameters, Effect of Environment on RFID Tag Antennas. Design of reader and tag antennas.

**UNIT III** **9 Hours**

**ANTENNAS FOR INDOOR APPLICATIONS**

Zigbee and WLAN: air interface, frequency, Bandwidth and data rate requirement. Specification & topologies, Antennas for Zigbee/WLAN Access points- whip antennas, diversity. Antennas for user equipment- design challenges- gain, efficiency, SAR and size constraints.

**UNIT IV** **9 Hours**

**CELLULAR ANTENNAS**

Cellular applications, Performance Requirements, Mode of operation, Base station antenna-specifications and challenges, topologies, Electrically Small Antennas, Topologies- Patch arrays, Beam tilting, null fill.

**UNIT V** **9 Hours**

**ANTENNAS FOR NEXT GENERATION WIRELESS APPLICATIONS**

4G & 5G communication, challenges, form factor and broadband performance, Conformal, wearable antennas for body area network and UWB antennas.

**Total: 45 Hours**

**Reference(s)**

1. Zhi Ning Chen, Antennas for Portable devices Wiley Publishers, 2007
2. R. Waterhouse Printed antennas for wireless communications John Wiley Publishers
3. Peter S. Hall, Yang Hao Antennas and propagation for body-centric wireless communications
4. J.C. Liberti, JR and Theodore Rappaport, Smart Antennas for Wireless communication, Prentice Hall of India, 1999.
5. Grishkumar and K.P. Ray, Broadband microstrip antennas Artech House, 2003
6. John D.Kraus, Ronald J.Marhefka Antennas for all Applications Fourth Edition, Tata McGraw-Hill, 2006.

## 22EC036 SMART ANTENNAS 3 0 0 3

**Course Objectives**

- To Understand the fundamental knowledge on smart antenna systems and its configuration
- To estimate the Direction of arrival and using appropriate techniques.
- To simulate and measure the performance of the antenna structures using software tools

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

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. Analyze the architecture of smart antenna systems and its configuration to meet the requirements of real time applications
2. Apply the adaptive antenna systems and digital radio receiver techniques for smart antennas.
3. Analyze and evaluate the range and capacity of wireless systems equipped with smart antennas
4. Analyze the direction of arrival of the signal from the smart antenna array using appropriate methodologies
5. Design the smart antennas using simulation tools and to evaluate its performance with vector network analyser

**Articulation Matrix**

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

**UNIT I** **9 Hours**

**SMART ANTENNAS**

Spatial Processing for Wireless Systems, Key Benefits of Smart Antennas, smart antenna configuration, SDMA, architecture of smart antenna systems.

**UNIT II** **9 Hours**

**SMART ANTENNA SYSTEMS AND SPATIAL SIGNAL PROCESSING**

The Vector Channel Impulse Response and the Spatial Signature, Spatial Processing Receivers, Fixed Beam forming Networks, Switched Beam Systems, Adaptive Antenna Systems, Digital Radio Receiver Techniques and Software Radios for Smart Antennas

**UNIT III** **9 Hours**

**MULTI-USER SPATIAL PROCESSING TECHNIQUES**

Multi user spatial Processing, Dynamic resectoring- Range and capacity extension Range and Capacity analysis using smart antennas. Spatio temporal channel models. Spatial Channel Measurements, Application of Spatial Channel Models, Environment and signal parameters.

**UNIT IV** **9 Hours**

**DOA ESTIMATION**

DOA estimation, conventional and subspace methods. ML estimation techniques. Estimation of the number of sources using Eigen decomposition. DOA Estimation under Coherent Signal Conditions, The Integrated Approach to DOA Estimation, Direction finding and true ranging PL systems.

**UNIT V** **9 Hours**

**ANTENNA MEASUREMENT**

Introduction to Simulation tools for smart antenna design- ADS, HFSS. Introduction to Vector Network Analyzer, Antenna test range Design.

**Total: 45 Hours**

**Reference(s)**

1. T.S. Rappaport and J.C. Liberti, Smart Antennas for Wireless Communications, Prentice Hall, 2007.
2. Tapan K Sarkar, Smart Antennas, IEEE Press, John Wiley & Sons Publications,2004.
3. L.C. Godara, Applications of antenna arrays to mobile communications, Part I: Performance improvement, feasibility, and system considerations, Proc. IEEE, vol. 85, no.7, pp.1031-1060, 2003.

## 22EC037 SOFT COMPUTING TECHNIQUES 3 0 0 3

**Course Objectives**

- To understand Fuzzy logic and Neural Network concepts
- To acquire the basic knowledge of Genetic algorithms
- To equip the students with the latest application of soft computing

**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.

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.

PO11 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 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 Able to solve complex engineering problems using state-of-the-art hardware and software tools, along with analytical and managerial skills to arrive appropriate solutions.

**Course Outcomes (COs)**

1. Analyze the various types of Classical sets, Fuzzy sets with its properties
2. Analyze the basics of artificial neural networks
3. Analyze the key concepts of Neuro Fuzzy systems
4. Analyze the various operations involved in the genetic algorithms
5. Analyze the concepts of soft computing for various Applications

**Articulation Matrix**

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

**UNIT I** **9 Hours**

**FUZZY SYSTEMS**

Fuzzy Sets, operations on Fuzzy Sets, Fuzzy Relations, Membership Functions: Fuzzy Rules and Fuzzy Reasoning, Fuzzy Inference Systems, Fuzzy Expert Systems, Fuzzy Decision Making.

**UNIT II** **9 Hours**

**NEURAL NETWORKS**

Basic concepts-knowledge based processing-single layer perceptron-multilayer perceptron-supervised band unsupervised learning-feed forward and back propagation and counter propagation networks-kohens self organizing networks.

**UNIT III** **9 Hours**

**NEURO-FUZZY MODELING**

Adaptive neuro fuzzy inference systems-classification and regression trees- data clustering-rule base structure identification.

**UNIT IV** **9 Hours**

**GENETIC ALGORITHMS**

Basic Concepts-Working Principles -Encoding- Fitness Function - Reproduction - Inheritance Operators - CrossOver -Inversion and Deletion -Mutation Operator -Bit-wise Operators-Convergence of Genetic Algorithms.

**UNIT V** **9 Hours**

**APPLICATIONS OF SOFT COMPUTING**

Fuzzy techniques for inverted pendulum case-SIRM fuzzy systems-MCDM for weather forecasting and financial marketing-Neural networks for pattern recognition-TS problems-Routers. GA application to metabolic modelling.

**Total: 45 Hours**

**Reference(s)**

1. Samarjeet Borah, Ranjit Panigrahi, Applied Soft computing: Techniques and Applications,2022.
2. Timothy J. Ross, McGraw Hill Inc, Fuzzy Logic with Engineering Applications,2000.
3. Madan M Gupta, Naresh K Sinha, Soft Computing and Intelligent Systems: Theory and Applications, Academic Press,1999.
4. Rajasekaran, G A Vijayalakshmi Pai, Neural Networks, Fuzzy Logic and Genetic Algorithms Synthesis and Applications, Prentice Hall India, 2003.
5. S N Sivanandam, S Sumathi, S N Deepa,5. Neural Networks using MATLAB, Tata McGraw Hill, 2005.
6. David E Goldberg, Genetic Algorithms in Search, Optimization, and Machine Learning, Pearson Education, 1996.

## 22EC038 OPTIMIZATION TECHNIQUES 3 0 0 3

**Course Objectives**

- To familiarize with the basic concepts and models of the operations research.
- To use transportation and assignment model techniques for effective decisions making.
- To optimization that are tailored to large-scale statistics and machine learning problems.

**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.

PSO2 Able to solve complex engineering problems using state-of-the-art hardware and software tools, along with analytical and managerial skills to arrive appropriate solutions.

**Course Outcomes (COs)**

1. Analyze the basics of convex optimization in linear programming
2. Apply the suitable method to predict the optimum solution for nonconvex problems.
3. Analyze the modern optimization techniques in Genetic Algorithm.
4. Analyze the methodology to reduce optimization problems using fuzzy logic and genetic algorithms.
5. Analyze the various optimization techniques involved in PSO.

**Articulation Matrix**

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

**UNIT I** **9 Hours**

**BASICS OF CONVEX OPTIMIZATION**

Convex sets, convexity-preserving operations, examples of convex programs (linear programming (LP), second-order cone programming (SOCP), semidefinite programming (SDP)), convex relaxation, KKT conditions, duality

**UNIT II** **9 Hours**

**STOCHASTIC AND NONCONVEX OPTIMIZATION**

Dual averaging, Polyak Juditsky averaging, stochastic variance reduced gradient (SVRG), Langevin dynamics, escaping saddle points, landscape of nonconvex problems, deep learning.

**UNIT III** **9 Hours**

**MODERN OPTIMIZATION IN GA**

Genetic algorithm: Introduction, biological background, traditional optimization and search techniques, Genetic basic concepts, operators, Encoding scheme, Fitness evaluation, crossover, mutation, genetic programming, multilevel optimization, real life problem, advances in GA.

**UNIT IV** **9 Hours**

**GENETIC PROGRAMMING**

Principles of genetic programming, terminal sets, functional sets, differences between GA & GP, Random population generation. Fuzzy Systems: Fuzzy set Theory, Optimization of Fuzzy systems.

**UNIT V** **9 Hours**

**PARTICLE SWARM OPTIMIZATION**

Swarm Intelligence Swarm intelligence, Particle Swarm Optimization (PSO) Algorithm- Formulations, Pseudo-code, parameters, premature convergence, topology, biases, Real valued and binary PSO, Ant colony optimization (ACO)- Formulations, Pseudo-code. Applications of PSO and ACO.

**Total: 45 Hours**

**Reference(s)**

1. Stephen Boyd, Convex Optimization, Lieven Vandenberghe book.
2. Introductory Lectures on Convex Optimization, Nesterov old book.
3. Kalyanmoy Deb, Optimization for Engineering Design, PHI Publishers
4. D.E. Goldberg, Addison, Genetic algorithms in Search, Optimization, and Machine learning, Wesley Publishers.

## 22EC039 MACHINE LEARNING TECHNIQUES 3 0 0 3

**Course Objectives**

- To apply Machine learning concepts for real-time problems.
- To implement machine learning techniques and computing environments that are suitable for the applications under consideration.
- To apply scaling up machine learning techniques and associated computing techniques and technologies.

**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 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 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. Analyze the basics concepts of machine learning.
2. Implement probabilistic discriminative and generative algorithms for regression and classification problems and analyze the results.
3. Design an unsupervised algorithm to predict the continuous and categorical data and analyze the results.
4. Implement machine learning algorithms and solve real-world problems.
5. Analyze machine learning models for regression and classification problems.

**Articulation Matrix**

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

**UNIT I** **7 Hours**

**INTRODUCTION**

Introduction-Definitions, types of learning, designing learning systems, issues in machine learning, - hypothesis space and inductive bias, evaluation, cross-validation.

**UNIT II** **10 Hours**

**SUPERVISED LEARNING**

Regression-Linear and multilinear regression, polynomial, decision trees, random forest, support vector machine(svm). Classification- k-nearest neighbour algorithm, Classification and Regression Tree, logistic regression, SVM

**UNIT III** **10 Hours**

**UNSUPERVISED LEARNING**

Clustering- k-means clustering and dimensionality reduction-singular value decomposition, principal component analysis, Categorical-Association analysis, Apriori, Frequent pattern growth, Hidden Markov model.

**UNIT IV** **9 Hours**

**NEURAL NETWORKS**

Biological Motivation- McCulloch Pitts Neuron, Thresholding Logic, Perceptron, Perceptron Learning Algorithm, Multilayer Perceptron-Back propagation algorithm, Sigmoid Neurons, neural network representation, Gradient Descent, bagging and boosting.

**UNIT V** **9 Hours**

**APPLICATION**

Machine Learning Frameworks- Scikit Learn, Tensor flow, Azure, Theano. Applications-Boston house price prediction, Face recognition, Iris Classification.

**Total: 45 Hours**

**Reference(s)**

1. John Paul Mueller, Luca Massaron, Machine Learning for Dummies, second edition, Wiley, 2021
2. Stuart Jonathan Russell, Peter Norvig, John Canny, Artificial Intelligence a Modern Approach, Prentice Hall, Fourth edition, 2020
3. Ameet V Joshi, Machine Learning and Artificial Intelligence, Springer Publications, 2020
4. T.M. Mitchell, Machine Learning, McGraw-Hill 2017
5. Stephen Marsland, Machine Learning an Algorithmic Perspective, Second Edition, Chapman and Hall/CRC Machine Learning and Pattern Recognition Series, 2014

**22EC040PYTHON PROGRAMMING FOR AI AND ML** **3 0 0 3**

**Course Objectives**

- To understand the basics of algorithmic problem-solving.
- To learn to solve problems using Python conditionals and loops.
- To define Python functions and use function calls to solve problems.
- To use Python data structures - lists, tuples, and dictionaries to represent complex data.
- To utilize the Python libraries for interpreting data and visualization of data.

**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 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 Able to solve complex engineering problems using state-of-the-art hardware and software tools, along with analytical and managerial skills to arrive appropriate solutions.

**Course Outcomes (COs)**

1. Use an algorithmic solution to design a simple computational problem.
2. Develop and execute simple Python programs.
3. Execute simple Python programs using conditional and loop statements.
4. Analyze compound data using Python lists, tuples, dictionaries etc.
5. Use the Python Libraries to interpret and explore data.

**Articulation Matrix**

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

**UNIT I** **9 Hours**

**COMPUTATIONAL THINKING AND PROBLEM SOLVING**

Fundamentals of Computing - Identification of Computational Problems - Algorithms, building blocks of algorithms (statements, state, control flow, functions), notation (pseudo code, flow chart, programming language), algorithmic problem solving, simple strategies for developing algorithms (iteration, recursion). Illustrative problems: find minimum in a list, insert a card in a list of sorted cards, guess an integer number in a range, Towers of Hanoi.

**UNIT II** **9 Hours**

**DATA TYPES, EXPRESSIONS, STATEMENTS**

Python interpreter and interactive mode, debugging; values and types: int, float, boolean, string, and list; variables, expressions, statements, tuple assignment, precedence of operators, comments; Illustrative programs: exchange the values of two variables, circulate the values of n variables, distance between two points.

**UNIT III** **9 Hours**

**CONTROL FLOW, FUNCTIONS, STRINGS**

Conditionals: Boolean values and operators, conditional (if), alternative (if-else), chained conditional (if-elif-else); Iteration: state, while, for, break, continue, pass; Fruitful functions: return values, parameters, local and global scope, function composition, recursion; Strings: string slices, immutability, string functions and methods, string module; Lists as arrays. Illustrative programs: square root, gcd, exponentiation, sum an array of numbers, linear search, binary search.

**UNIT IV** **9 Hours**

**LISTS, TUPLES, DICTIONARIES**

Lists: list operations, list slices, list methods, list loop, mutability, aliasing, cloning lists, list parameters; Tuples: tuple assignment, tuple as a return value; Dictionaries: operations and methods; advanced list processing - list comprehension; Illustrative programs: simple sorting, histogram, Students marks statement, Retail bill preparation.

**UNIT V** **9 Hours**

**PYTHON LIBRARIES AND DATA VISUALIZATION**

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 - pivot tables-Importing Matplotlib - Line plots - Scatter plots - visualizing errors - density and contour plots - Histograms - legends - colors - subplots - Visualization with Seaborn.

**Total: 45 Hours**

**Reference(s)**

1. Python for Programmers, by Paul Deitel and Harvey Deitel Pearson Education, 1st Edition, 2021
2. Computational Thinking: A Primer for Programmers and Data Scientists by G Venkatesh and Madhavan Mukund, 1st Edition, Notion Press, 2021
3. Introduction to Computation and Programming Using Python: With Applications to Computational Modeling and Understanding Data by John V Guttag, Third Edition, MIT Press, 2021
4. Computational Thinking: A Beginner""s Guide to Problem Solving and Programming, by Karl Beecher, 1st Edition, BCS Learning & Development Limited, 2017.
5. Think Python: How to Think like a Computer Scientist by Allen B. Downey, 2nd Edition, O Reilly Publishers, 2016.

## 22EC041 DEEP LEARNING TECHNIQUES 3 0 0 3

**Course Objectives**

- To understand the operations of Deep Learning Neural Networks
- To apply the Deep Learning concepts to the real world applications
- To analyze the performance of deep learning architectures for real time applications

**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 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 Able to solve complex engineering problems using state-of-the-art hardware and software tools, along with analytical and managerial skills to arrive appropriate solutions.

**Course Outcomes (COs)**

1. Analyze the mathematical background and significance of Machine Learning Principles.
2. Apply the mathematical background and significance of Artificial Neural Networks in Deep Learning.
3. Apply deep learning concepts in the text and image processing.
4. Implement deep generative models for real time applications.
5. Analyze the recent developments and real world examples of Deep Learning architectures.

**Articulation Matrix**

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

**UNIT I** **7 Hours**

**INTRODUCTION TO MACHINE LEARNING**

Overview of machine learning, linear classifiers, loss functions, Stochastic gradient descent, back-propagation

**UNIT II** **9 Hours**

**INTRODUCTION TO DEEP NEURAL NETWORKS**

Activation functions, initialization, regularization, batch normalization, model selection, CNN architectures, pooling, visualization

**UNIT III** **11 Hours**

**DEEP NEURAL NETWORK FOR TEXT AND IMAGE PROCESSING**

Transposed convolution, object detection, semantic segmentation, Recurrent neural networks (RNN), long-short term memory (LSTM), language models, machine translation, image captioning, video processing, visual question answering

**UNIT IV** **11 Hours**

**DEEP GENERATIVE MODELS**

Auto-encoders, variational auto-encoders, generative adversarial networks, autoregressive models, generative image models, unsupervised and self-supervised representation learning

**UNIT V** **7 Hours**

**DEEP REINFORCEMENT LEARNING**

Policy gradient methods, Q-Learning, Real World Applications of Deep Learning Techniques

**Total: 45 Hours**

**Reference(s)**

1. Magnus Ekman, Addison-Wesley, Learning Deep Learning, 2021
2. I. Goodfellow, Y. Bengio, A. Courville, Deep Learning, MIT Press, 2016
3. K. P. Murphy, Machine Learning: A Probabilistic Perspective, MIT Press, 2012
4. C. M. Bishop, Pattern Recognition and Machine Learning, Springer, 2006

## 22EC042 NATURAL LANGUAGE PROCESSING 3 0 0 3

**Course Objectives**

- To understand the theory and methodology of natural language understanding and generation.
- To analyze topics include stemming, lemmatization, parts of speech tagging, parsing, and machine translation.
- To design employing specialized libraries, students develop applications for topic modelling, sentiment analysis, and text summarization.

**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 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 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. Analyze Extract information from text automatically using concepts and methods from natural language processing (NLP) including stemming, n-grams, POS tagging, and parsing.
2. Analyze the syntax, semantics, and pragmatics of a statement written in a natural language.
3. Develop a conversational agent that uses natural language understanding and generation.
4. Apply machine learning algorithms to natural language processing.
5. Develop scripts and applications in Python to carry out natural language processing using libraries such as NLTK, Gensim, and spaCY.

**Articulation Matrix**

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

**UNIT I** **9 Hours**

**INTRODUCTION TO NLP PHASES AND PYTHON**

Introduction, Natural Language Processing, History, Advantages and Disadvantages of NLP, Components and Applications of NLP, Difference between NLP and Computer Language, NLTK-Natural language Toolkit, Python3, and Jupyter Notebook, Introduction to HPC High Performance Computing,

**UNIT II** **9 Hours**

**NLP IN ARTIFICIAL INTELLIGENCE**

To build an NLP Pipeline, Phases of NLP, Lexical Analysis, Syntactic Analysis, Semantic Analysis, Discourse Integration, Pragmatic Analysis, Textual Sources, and formatting, Web Scraping, Building the Corpus, Tokenization the corpus, N-Grams, Stemming and Lemmatization, Synsets and Hypernyms.

**UNIT III** **9 Hours**

**NLP APIS AND LIBRARIES**

IBM Watson API, Chatbot API, Speech to text API, Sentiment Analysis API, Translation API, Text Analysis API, Cloud NLP API, Google Cloud Natural API, Scikit Learn, NLTK Natural Language toolkit, Pattern, Text blob, Quepy, SpaCY, Gensim.

**UNIT IV** **9 Hours**

**NLP IN MACHINE LEARNING**

Machine Learning for Natural Language Processing, Supervised Machine Learning for Natural Language Processing and Text Analytics, Unsupervised Machine Learning for Natural Language Processing and Text Analytics, ML vs NLP and Using Machine Learning on Natural Language Sentences, Hybrid Machine Learning Systems for NLP.

**UNIT V** **9 Hours**

**NLP IN DEEP LEARNING**

Dependency Parsing, Neural Machine Translation and attention, Neural Networks, RNNs and Language models, Transformers and Pretaining, Using PyTorch from scratch, Word vectors.

**Total: 45 Hours**

**Reference(s)**

1. Natural Language Processing: A Machine Learning Perspective by Yue Zhang, Zhiyang Teng, 2021.
2. Natural Language Processing Succinctly by Joseph D Booth, 2018.
3. Deep Learning for NLP and Speech Recognition by Uday Kamath, John Liu, James Whitaker, First Edition, 2019.
4. Natural Language Processing with Python by Steven Bird, Ewan Klein, Edward Loper, 2009.
5. Neural Network Methods for Natural Language Processing by Yoav Goldberg, 2017.

## 22EC043 MEDICAL ELECTRONICS AND INSTRUMENTATION

**3 0 0 3**

**Course Objectives**

- To study the generation of bio-potentials, its representation recording
- To understand electrical and non-electrical parameter measurements
- To study the various diagnostic and therapeutic equipment

**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.

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. Analyze the concepts of Electro-Physiology and Bio-Potential Recording.
2. Analyze Bio medical and non-electrical parameter measurements.
3. Analyze the concepts of Assist Devices and Bio-Telemetry
4. Analyze the various operations involved in Radiological Equipment
5. Analyze recent trends in Medical Instrumentation

**Articulation Matrix**

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

**UNIT I** **9 Hours**

**ELECTRO-PHYSIOLOGY AND BIO-POTENTIAL RECORDING**

The Origin of Bio-potentials; bio potential electrodes, biological amplifiers, ECG, EEG, EMG, PCG, EOG, lead systems and recording methods-typical waveform and signal characteristics.

**UNIT II** **9 Hours**

**BIO- CHEMICAL AND NON ELECTRICAL PARAMETER MEASUREMENT**

PH, PO2, PCO2, PHCO3, Electrophoresis, colorimeter, photometer, Autoanalyzer, Blood flow meter, cardiac output, respiratory measurement, Blood pressure, temperature, pulse, Blood cell counters

**UNIT III** **9 Hours**

**ASSIST DEVICES AND BIO-TELEMETRY**

Cardiac pacemakers, DC Defibrillator, Telemetry principles, frequency selection, Bio-telemetry, radio-pill and tele-stimulation, Signal sources for Analog I/O, Digital I/O waveform generation for testing and calibration

**UNIT IV** **9 Hours**

**RADIOLOGICAL EQUIPMENTS**

Ionizing radiation, Diagnostic x-ray equipment, use of Radio Isotope in diagnosis, Multi section Radiography, plane of movement-Radiation Therapy

**UNIT V** **9 Hours**

**RECENT TRENDS IN MEDICAL INSTRUMENTATION**

Thermograph, endoscopy unit, Lasers in medicine, Diathermy units, Electrical safety in medical equipment Patient monitoring system.

**Total: 45 Hours**

**Reference(s)**

1. Leislie Cromwell, Bio medical Instrumentation and Measurement, PHI,2007
2. David Prutchi and Michael Norris, Design and Development of Medical Electronic Instrumentation: A Practical perspective of the design construction and test of Medical Device,2004.
3. RS Khandpur, Hand book of Bio medical Instrumentation, Tata McGraw-Hill,2005.
4. Joseph J. Carr and John M. Brown, Introduction to Bio medical equipment Technology, John Wiley, 2004.
5. David Prutchi and Michael Norris, Design and Development of Medical Electronic Instrumentation :A Practical perspective of the design construction and test of Medical Device, 2004.

## 22EC044 CONSUMER ELECTRONICS 3 0 0 3

**Course Objectives**

- Understand the basics of audio and video technology.
- Understand the electronic gadgets and telecommunication systems.
- Explain the working concepts of consumer appliances.

**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.

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

PSO2 Able to solve complex engineering problems using state-of-the-art hardware and software tools, along with analytical and managerial skills to arrive appropriate solutions.

**Course Outcomes (COs)**

1. Analyze the various Microphones and Loudspeakers used in real time applications.
2. Analyse different techniques involved in audio processing.
3. Analyse the various video standards and systems.
4. Analyze the various technologies involved in communication and consumer gadgets.
5. Analyze the evolution and development of Modern Consumer applications.

**Articulation Matrix**

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

**UNIT I** **9 Hours**

**AUDIO SYSTEM COMPONENTS**

Introduction to wave motion -Interference and superposition of waves- Beats, Resonance, Echos-characteristics of microphones- types of microphones- wireless microphones-types of headphones-Types of loudspeakers- Multispeaker Systems-Acoustic Insulation and acoustic design. Stereo systems and multiway systems

**UNIT II** **9 Hours**

**AUDIO PROCESSING**

Audio Filters, Types of AGC -Loudspeaker Impedance matching- Pre-emphasis and De-emphasis noise reduction- Optical recording and reproduction- stereophony, Quadraphony-Stereo controls- Active tone control, filtering, bass and treble control-Integrated Stereo amplifier- Equalizers- Codecs -LPC, Sub-band Coding, CELP. MPEG-1, MPEG-2, MPEG-4 and Dolby Digital.

**UNIT III** **9 Hours**

**VIDEO STANDARDS AND SYSTEMS**

Elements of a TV system, scanning process- resolution, interlacing, composite signal- Types of TV camera-compatibility between monochrome and colour TV - TV standards- NTSC, PAL, SECAM, CCIR-B.

**UNIT IV** **9 Hours**

**COMMUNICATION AND CONSUMER GADGETS**

Radio system- VHF and UHF- Types of mobile phones-Facsimile machine- electronic calculators-digital clocks- Automobile computers- Antilocking Breaking Systems, Electronically Controlled Suspension, Safety Belt System, Navigation System- Microwave Ovens. Dish washers and TV Remote.

**UNIT V** **9 Hours**

**CONSUMER APPLICATIONS**

Washing Machines- electronic controller, fuzzy logic, Hardware and Software development- Air Conditioners- Components, Remote Controls, Bar Coders- Bar codes, scanner and decoder- Set Top Box- Types, firmware development, Interactive program guides. Video on demand.

**Total: 45 Hours**

**Reference(s)**

1. S.P. Bali, Consumer Electronics, Pearson Education, 2005.
2. C.A. Schuler and W.L. Mc Namee, Modern Industrial Electronics, McGraw Hill, 2002.
3. D.J. Shanefield, Industrial Electronics for Engineers, Chemists and Technicians, Jaico Publishing House, 2007.

## 22EC045 NANO ELECTRONICS 3 0 0 3

**Course Objectives**

- To study the channel and gate effect of MOS system
- To understand nanotube FETs and MOSFETs
- To study the recent trends of nano devices in the industry

**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.

PO7 Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

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

PSO2 Able to solve complex engineering problems using state-of-the-art hardware and software tools, along with analytical and managerial skills to arrive appropriate solutions.

**Course Outcomes (COs)**

1. Analyze the basic concepts of nanotechnology
2. Analyze the concepts of nanoelectronics
3. Demonstrate the concept of Silicon MOSFET and quantum transport devices
4. Analyse the process involved in carbon nanotubes
5. Analyze the concept of molecular electronics.

**Articulation Matrix**

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

**UNIT I** **9 Hours**

**INTRODUCTION TO NANOTECHNOLOGY**

Background to nanotechnology: Types of nanotechnology and nano machines; MolecularNanotechnology: Electron microscope-scanning electron microscope-atomic force microscope-scanning tunnelling microscope-nano manipulator-nano tweezers-atom manipulation-nanodots; Top down and bottom-up approaches: self assembly-dip pen nano lithography. Nanomaterials: preparation-plasma arcing-chemical vapor deposition-sol-gels-electrodeposition ballmilling

**UNIT II** **9 Hours**

**FUNDAMENTALS OF NANOELECTRONICS**

Fundamentals of logic devices: -Requirements-dynamic properties-threshold gates; physicallimits to computations; concepts of logic devices: -classifications-two terminal devices-fieldeffect devices-coulomb blockade devices-spintronics-quantum dot cellular automata-quantum computing-DNA computer, Ultimate computation: -power dissipation limit-dissipation in reversible computation.

**UNIT III** **9 Hours**

**SILICON MOSFETS**

Silicon MOSFETS-Novel materials and alternate concepts:-fundamentals of MOSFETDevices-scaling rules-silicon-dioxide based gate dielectrics-metal gates-junctions & contacts-advanced MOSFET concepts. Quantum transport devices based on resonant tunneling: -Electrontunneling-resonant tunneling diodesresonant tunneling devices; Single electron devices forlogic applications: -Single electron devices

**UNIT IV** **9 Hours**

**CARBON NANOTUBES**

Carbon Nanotube: Fullerenes-types of nanotubes-formation of nanotubes-assemblies-purification of carbon nanotubes-electronic propertics-synthesis of carbon nanotubes-carbonnanotube interconnects carbon nanotube FETs-Nanotube for memory applications.

**UNIT V** **9 Hours**

**MOLECULAR ELECTRONICS**

Electrodes & contacts-functions-molecular electronic devices-first test systems-simulation and circuit design-fabrication; Future applications.

**Total: 45 Hours**

**Reference(s)**

1. Michael Wilson, Kamali Kannangara, Geoff Smith, Michelle Simmons and BurkhardRaguse, Nanotechnology: Basic Science and Emerging Technologies, Chapman & Hall /CRC, 2002
2. T. Pradeep, NANO: The Essentials-Understanding Nanoscience and Nanotechnology, TMH, 2007
3. Rainer Waser (Ed.), Nanoelectronics and Information Technology: Advanced Electronic Materials and Novel Devices, Wiley-VCH, 2012
4. Saito, S., Carbon Nanotubes for Next-Generation Electronics Device, Science 278(5335): 77-78. doi:10.1126/science.278.5335.77
5. George W. Hanson, Fundamentals of nano electronics, Prentice Hall, 2008

## 22EC046 AUTOMOTIVE ELECTRONICS AND NETWORKING

**3 0 0 3**

**Course Objectives**

- To gain the basic knowledge about automotive systems.
- To study the characteristics of automotive sensors and actuators.
- To understand the fundamentals of automotive networking in new generation vehicles.

**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.

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

PSO2 Able to solve complex engineering problems using state-of-the-art hardware and software tools, along with analytical and managerial skills to arrive appropriate solutions.

**Course Outcomes (COs)**

1. Apply the fundamentals and concept of electronics in automotive industry.
2. Analyze the functionalities of automotive sensors.
3. Analyze the concepts of automotive actuators in modern vehicles.
4. Apply the basic knowledge of electronics in vehicular architecture.
5. Asses the most suitable networking topologies for a new generation automotive system.

**Articulation Matrix**

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

**UNIT I** **8 Hours**

**FUNDAMENTALS OF AUTOMOTIVE ELECTRONICS**

Automobile systems: Engine and its control - Ignition systems - Steering systems - Control systems: proportion controller, Proportional Integral controller and Proportional Integral differential controller.

**UNIT II** **10 Hours**

**AUTOMOTIVE SENSORS**

Sensor basics &its Functions - Air mass flow sensor- Crankshaft angular position sensor - Throttle valve sensor – Eddy current sensors -Hall sensors -Exhaust gas oxygen sensors- Ultrasound sensor - GPS and distance travelled measurement.

**UNIT III** **9 Hours**

**AUTOMOTIVE ACTUATORS**

Fuel Injectors - Exhaust gas recirculation Actuator - Electronic Ignition sub-systems - Digital Engine control systems: Speed density method - Idle speed control method- EGR control - Distributor-less Ignition control.

**UNIT IV** **9 Hours**

**VEHICULAR ELECTRONICS ARCHITECTURE**

Intelligent Power distribution module - Supplemental restraint systems - Body control module - Engine control modules - Automatic drive positioned control unit - Driver seat control module - Front air control unit and transmission control unit.

**UNIT V** **9 Hours**

**AUTOMOTIVE NETWORKING**

Networking basics topologies - Addressing - Control mechanisms: Event control & Timer control - Network topologies for new generation vehicles - Bus systems: CAN Bus, High speed CAN, LIN bus, MOST bus, Bluetooth: Piconet and scatternet.

**Total: 45 Hours**

**Reference(s)**

1. Konrad Reif -Automotive Mechatronics Automotive Networking, Driving Stability Systems, Electronics-Vieweg-Teubner Verlag 2015.
2. Najamuz Zaman, Automotive Electronics Design Fundamentals-Springer International Publishing 2015.
3. Robert Bosch GmbH, Bosch Automotive Electrics and Automotive Electronics Systems and Components, Networking and Hybrid Drive-Springer Vieweg 2014.
4. William Ribbens-Understanding Automotive Electronics, Fifth Edition-Newnes 1998.
5. W.H. Crouse, Automobile Electrical Equipment, McGraw-Hill, 1996.
6. P.L. Kholi, Automotive Electrical Equipment, Tata McGraw-Hill, 1995.

## 22EC047 PCB DESIGN AND FABRICATION 3 0 0 3

**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

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

PSO2 Able to solve complex engineering problems using state-of-the-art hardware and software tools, along with analytical and managerial skills to arrive appropriate solutions.

**Course Outcomes (COs)**

1. Analyze the basic concepts involved in the PCB design
2. Design a circuit schematic using electronic components
3. Design a PCB layout and realize the manufacturing data
4. Design a PCB for High Speed Circuits
5. 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 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
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| 2 | 2 | 1 | 2 | 2 | 2 | - | - | - | - | - | - | - | 2 | 1 |
| 3 | 2 | 1 | 2 | 2 | 2 | - | - | - | - | - | - | - | 1 | 2 |
| 4 | - | - | 2 | 3 | 2 | - | - | - | - | - | - | - | 2 | 2 |
| 5 | 1 | 2 | 2 | 3 | 2 | - | - | - | - | - | - | - | 2 | 2 |

**UNIT I** **9 Hours**

**BASICS OF PCB**

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** **9 Hours**

**SCHEMATIC DESIGN AND FOOTPRINT CREATION**

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** **9 Hours**

**LAYOUT PLANNING AND DESIGN**

General PCB Consideration - Mechanical and Electrical Design Consideration - PCB Stack up - Component Placement Rules - Conductor Orientation, Routing and spacing - Current and Impedance 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** **9 Hours**

**HIGH SPEED PCB DESIGN**

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** **9 Hours**

**PCB FABRICATION**

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**

**Reference(s)**

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.
6. Bosshart Walter C, Printed Circuit Boards, Tata Mcgraw Hill Publishing Company Limited, 1984.

## 22EC048 CRYPTOGRAPHY AND NETWORK SECURITY

**3 0 0 3**

**Course Objectives**

- Understand the basic concept of Cryptography and Network Security, their mathematical models.
- To understand the necessity of network security, threats/vulnerabilities to networks and counter measures.
- To understand Authentication functions with Message Authentication Codes and Hash Functions.
- To provide familiarity in Intrusion detection and Firewall Design Principles.

**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.

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. Analyze the network security fundamental concepts and principles.
2. Apply various models for Encrypt and decrypt messages using block ciphers and network security technology and Protocols.
3. Analyze key agreement algorithms to identify their weaknesses.
4. Analyze the different types of Message Authentication and Hash functions.
5. Assess different types of threats, malware, spyware, viruses, vulnerabilities.

**Articulation Matrix**

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

**UNIT I** **9 Hours**

**INTRODUCTION TO CONVENTIONAL ENCRYPTION MODELS**

Security Services, Mechanisms, and Attacks, A Model for Internetwork security, Classical Techniques: Conventional Encryption model, Steganography, Classical Encryption Techniques. Modern Techniques: Simplified DES, Block Cipher Principles, Data Encryption standard, Strength of DES, Block Cipher Design Principles.

**UNIT II** **9 Hours**

**ENCRYPTION TECHNIQUES**

Triple DES, International Data Encryption algorithm, Blowfish, RC5, Characteristics of Advanced Symmetric Block Ciphers. Placement of Encryption function, Traffic confidentiality, Key distribution, Random Number Generation.

**UNIT III** **9 Hours**

**PUBLIC KEY CRYPTOGRAPHY**

Principles, RSA Algorithm, Key Management, Diffie Hellman Key exchange, Elliptic Curve Cryptography.

Number Theory: Prime and Relatively prime numbers, Modular arithmetic, Fermat and Euler"s theorems, Testing for primality, Euclid Algorithm, the Chinese remainder theorem, Discrete logarithms.

**UNIT IV** **9 Hours**

**MESSAGE AUTHENTICATION AND HASH FUNCTIONS**

Authentication requirements and functions, Message Authentication, Hash functions, Security of Hash functions, and MACs. Hash and Mac Algorithms: MD-5, Message Digest Algorithm, Secure Hash Algorithm. Digital signatures and Authentication protocols: Digital signatures, Authentication Protocols, Digital signature standards. Authentication Applications: Kerberos, Electronic Mail Security: Pretty Good Privacy, SIME/MIME.

**UNIT V** **9 Hours**

**IP AND WEB SECURITY**

IP security: Overview, Architecture, Authentication, Encapsulating Security Payload, Key Management. Web Security: Web Security requirements, Secure sockets layer and Transport layer security, Secure Electronic Transaction. Intruders, Viruses, and Worms: Intruders, Viruses and Related threats. Fire Walls: Fire wall Design Principles, Trusted systems.

**Total: 45 Hours**

**Reference(s)**

1. Atul Kahate, Cryptography and Network Security, Mc Graw Hill, 4th Edition, 2017.
2. William Stallings, Cryptography and Network Security - Principles and Practice, Pearson Education, 6th Edition, 2013.
3. BehrouzA.Foruzan, Cryptography and Network Security, Tata McGraw Hill 2007.

## 22EC049 SCRIPTING LANGUAGES FOR VLSI DESIGN AUTOMATION

**3 0 0 3**

**Course Objectives**

- Analyze requirements of software systems to determine the suitability of implementing in scripting languages.
- Apply effective knowledge of Perl and Python to new situations and learn from the experience.
- Analyze problems and synthesize suitable solutions.

**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 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 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. Apply basic commands of Linux to work in Linux environment.
2. Apply basic commands of PERL in designing basic systems.
3. Apply PERL in writing scripts for building CMOS designs.
4. Design and run scripts using TCL in IC design flow.
5. Apply basics of JAVA and PYTHON scripting for designs.

**Articulation Matrix**

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

**UNIT I** **9 Hours**

**LINUX BASICS**

Introduction to Linux, File System of the Linux, General usage of Linux kernel 7 basic commands, Linux users and group, Permissions for file, directory and users, Searching a file & directory, Zipping and unzipping concepts.

**UNIT II** **9 Hours**

**INTRODUCTION TO SCRIPTS AND PERL LANGUAGE**

Characteristics and uses of scripting languages, Introduction to PERL, Names and values, Variables and assignment, Scalar expressions, File handles, Operators, Control structures, Regular expressions, Built in data types, Statements and declarations- simple, Compound, Loop statements, Global and scoped declarations.

**UNIT III** **9 Hours**

**PERL SCRIPTING**

PERL built-in functions, Collections of Data, Working with arrays, Lists and hashes, Simple input and output, Strings, Patterns and regular expressions, Subroutines, Scripts with arguments.

**UNIT IV** **9 Hours**

**TCL FUNDAMENTALS**

TCL Fundamentals, String and Pattern Matching, Structure, Syntax, Parser, Variables and data in TCL, Control flow, Data structures, Simple input/output, Procedures and Scope, Working with Strings, Patterns, Files and Pipes, Example code.

**UNIT V** **9 Hours**

**OTHER LANGUAGES**

JavaScript - Object models, Design Philosophy, Versions of JavaScript, The Java Script core language, Introduction to Python, Using the Python Interpreter, More Control Flow Tools, Data Structures, Modules, Input and Output, Errors and Exceptions, Classes, Brief Tour of the Standard Library.

**Total: 45 Hours**

**Reference(s)**

1. David Barron, "The World of Scripting Languages", Wiley Student Edition, 2010.
2. Randal L, Schwartz Tom Phoenix, "Learning PERL", Oreilly Publications, 3rd Edn., 2000.
3. Igor Markov and Michael L. Bushnell "Scripting in VLSI CAD" Springer Publications, 2000.
4. Kurt Keutzer, Sharad Malik, and Rob M. A. (Bob) van der Geijn “Scripting for VLSI Design Automation” Kluwer Academic Publishers 1998.

## 22EC050 5G MOBILE AND WIRELESS COMMUNICATION

**3 0 0 3**

**Course Objectives**

- Students will gain a foundational knowledge of 5G channel modelling, network architecture, radio access technologies, and key enabling technologies.
- Students will be able to analyse the strengths and weaknesses of different functional splits in the 5G architecture for specific applications.
- Students will apply their understanding to propose solutions or design considerations for integrating D2D communication into existing network architectures.

**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.

PO5 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 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 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. Analyze the spectrum requirements for 5G, different channel modeling scenarios, and propagation characteristics.
2. Design a basic 5G network architecture considering functional splits and specific application requirements.
3. Analyze the impact of diversity techniques on channel variability and performance in D2D scenarios.
4. Assess the performance of different access technologies for massive machine-type communication in terms of capacity and efficiency.
5. Design interference management techniques for specific network scenarios like ultra-dense networks or moving relay nodes.

**Articulation Matrix**

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

**UNIT I** **9 Hours**

**5G CHANNEL MODELLING AND USE CASES**

Spectrum for 5G, Modeling requirements and scenarios, Channel model requirements, Propagation scenarios, Relaying multi-hop and cooperative communications: Principles of relaying, fundamentals of relaying.

**UNIT II** **9 Hours**

**THE 5G ARCHITECTURE**

Cognitive radio: Architecture, spectrum sensing, Software Defined Radio (SDR), NFV and SDN, Basics about RAN architecture, High-level requirements for the 5G architecture, Functional architecture and 5G flexibility, Functional split criteria, Functional split alternatives, Functional optimization for specific applications.

**UNIT III** **9 Hours**

**DEVICE-TO-DEVICE (D2D) COMMUNICATIONS**

Diversity gain, receive antenna diversity, transmit antenna diversity, Diversity order and channel variability, Diversity performance in extended channels, combined space and path diversity, Indirect transmit diversity, Diversity of a space, time, frequency selective fading channel.

**UNIT IV** **9 Hours**

**The 5G RADIO-ACCESS TECHNOLOGIES**

Access design principles for multi-user communications, Orthogonal multiple-access systems, spread spectrum multiple access systems, Capacity limits of multiple-access methods, Sparse code multiple access (SCMA), Interleave division multiple access (IDMA), Radio access for dense deployments, Radio access for V2X communication, Radio access for massive machine-type communication.

**UNIT V** **9 Hours**

**INTERFERENCE MANAGEMENT, MOBILITY MANAGEMENT, AND SECURITY FOR 5G**

Network deployment types, Ultra-dense network or densification, Heterogeneous networks, Interference management in 5G, Interference management in UDN, Mobility management in 5G, User equipment controlled versus network-controlled handover, Mobility management in heterogeneous 5G networks.

**Total: 45 Hours**

**Reference(s)**

1. Afif Osseiran, Jose F. Monserrat, Patrick Marsch, 5G Mobile and Wireless Communications Technology, Cambridge University Press, 2011
2. Erik Dahlman, Stefan Parkvall, Johan Sko¨ld 5G NR: The Next Generation Wireless Access Technology, Elsevier, First Edition, 2016
3. Jonathan Rodriguez, Fundamentals of 5G Mobile Networks, Wiley, 2010
4. https://nptel.ac.in/courses/108/105/108105134/
5. https://www.udemy.com/course/5g-mobile-networks-modern-wireless-communication-technology/

## 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

**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.

PO7 Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

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. Classify and characterize the energy resources.
2. Illustrate the concept of green building.
3. Outline the sustainable construction practices.
4. Understand the hydropower production and conservation of water.
5. Emphasis the significance of energy and resource recovery from waste materials.

**Articulation Matrix**

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

**UNIT I** **9 Hours**

**INTRODUCTION TO ENERGY SCIENCE**

Introduction to energy systems and resources; Introduction to Energy, sustainability & the environment. Energy - Past & Present scenario of World; Renewable and Nonrenewable energy resources

**UNIT II** **9 Hours**

**ENERGY CONSERVATION IN BUILDINGS**

Principles of Planning of buildings: orientation, energy efficiency, utility. Components of building-classification of buildings. Green building - LEED building assessment standard – LEED certification process - Building rating system - Building energy issues – Building energy design strategies – Energy Auditing

**UNIT III** **9 Hours**

**SUSTAINABLE CONSTRUCTION**

Equipment use in excavations, foundation, concreting. Advanced Techniques in tunneling, under water construction, piling techniques, Innovations & efficiency in Highways, Railways & Harbours - linkages between economic and environmental outcomes

**UNIT IV** **9 Hours**

**WATER CONSERVATION & SUSTAINABILITY**

Types of reservoirs and its functions – Hydropower production – Types of Turbines & selections of turbines & Energy calculations. Water losses from reservoirs and channels – Canal lining & its economic aspects. Water supply systems & Irrigation methods - Rain Water Harvesting methods & benefits.

**UNIT V** **9 Hours**

**ENERGY RECOVERY FROM WASTE**

Classification and sources of wastes- Factors affecting MSW generation – Waste management hierarchy - Energy recovery from wastes: Thermochemical methods for energy production - Details of incineration, gasification and pyrolysis & biochemical conversions - Landfill gas recovery system - Principles of fermentation - Concept of MFC - Trans-esterification process - Biofuel processing - Biomass gasification - Organic waste for hydrogen production.

**Total: 45 Hours**

**Reference(s)**

1. Boyle, Godfrey, Bob Everett, and Janet Ramage (Eds.) (2004), Energy Systems and Sustainability: Power for a Sustainable Future. Oxford University Press.
2. Charles. J. Kibert, Sustainable Construction: Green Building Design and Delivery, John Wiley & Sons, Inc., New Jersey, 2008.
3. H. M. Raghunath, Irrigation Engieering, Wiley India (P) Ltd, 2011.
4. E H Thorndike (1976), Energy & Environment: A Primer for Scientists and Engineers, Addison-Wesley Publishing Company.
5. M. Datta, Waste Disposal in Engineered Landfills, Narosa Publishing House, ISBN-10: 8173191409,1997.
6. Lal, P.M. Sarma, Priyangshu M, Wealth from Waste: Trends and Technologies, 3rd Edition, The Energy and Resources Institute, New Delhi, ISBN: 9788179934241, 2011.
7. W. McDonough, M. Braungart, Cradle to Cradle: Remaking the Way We Make Things, United States: North Point Press, ISBN-10: 0865475873, 2002.

## 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 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.

PO5 Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

**Course Outcomes (COs)**

1. Identify the characteristics and data types of C++ language.
2. Develop programs using objects and classes for real world applications
3. Construct programs to implement operator overloading and inheritance techniques
4. Apply Polymorphism and File streams concepts to develop C++ program
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 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 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** **9 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** **9 Hours**

**OBJECTS AND CLASSES**

Objects and Classes Simple Class - C++ Objects as Physical Objects - C++ Object as Data types-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 Overloading and Inheritance Need of operator overloading- Overloading Unary Operators-Overloading binary Operators - Overloading Special Operators - Data Conversion Inheritance: Derived Class and Base Class - Derived Class Constructors-Overriding Member Functions-Class Hierarchies- Public and Private Inheritance-Levels of Inheritance-Multiple Inheritance.

**UNIT IV**

**POLYMORPHISM AND FILE STREAMS** **9 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** **9 Hours**

**TEMPLATES AND EXCEPTION HANDLING**

Templates: Introduction - Function Templates - Overloading Function Templates-, user defined template arguments(sona) - Class Templates - Exception Handling - Syntax, multiple exceptions, exceptions with 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 New Delhi, 2006.

## 22OCS02 JAVA 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 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.

PO5 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. Demonstrate applications based on core Java Concepts with examples
2. Construct application using inheritance, packages and exception handling for real time problem
3. Explain the Java I/O concepts to handle input and output operations.
4. Develop 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 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 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 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. Explain the concepts of Data Warehousing architecture and business analysis process.
2. Illustrate the process of Data Mining and preprocessing techniques for data cleansing.
3. Apply the association rules for mining the various kinds of data
4. Analyze Classification and Clustering algorithms for various problems with high dimensional data.
5. Illustrate 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 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 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**

Data warehousing Components -Building a Data warehouse -Data Warehouse and DBMS-Metadata-Multidimensional 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** **9 Hours**

**INTRODUCTION TO DATA MINING**

Introduction - Steps in knowledge discovery from databases process - Architecture of a Typical Data Mining Systems - Data Mining Functionalities - Classification of Data Mining Systems - Data mining on different kinds of data - Different kinds of pattern - Task Primitives - 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: Apriori 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** **9 Hours**

**DATA MINING APPLICATIONS**

Mining complex data objects - Text Mining - Graph mining - Web mining - Spatial Data mining -Application and trends in data mining - Social impacts of Data mining.

**Total: 45 Hours**

## Reference(s)

1 Jiawei Han, Micheline Kamber and Jian Pai , Data Mining: Concepts and Techniques, Morgan Kauffman, 3rd Edition, 2013.
2 Alex Berson and Stephen J Smith, Data Warehousing, Data Mining, and OLAP, Tata Mcgraw- Hill, 1997.
3 David Hand, Heikki Manila, Padhraic Symth, Principles of Data Mining, MIT Press, 2001.
4 Margaret H.Dunham, Data Mining: Introductory and Advanced Topics, Pearson Education 2003.

**22OCS04 E-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 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.

**Course Outcomes (COs)**

1. Acquire knowledge about the basic concepts of e-learning.
2. Explain the technology mediated communication in e-learning
3. Exemplify of e-learning and content the process management.
4. Analyze the teaching and learning processes in 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 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 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 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 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. Demonstrate the concepts and applications of text mining
2. Explain Content analysis and Sentiment analysis
3. Illustrate web analytics with a suitable model
4. Illustrate social network analytics with suitable example.
5. Illustrate social media analytics with suitable example.

**Articulation Matrix**

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

## 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 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

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 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 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. Execute the suitable PLC Programming languages
4. Attribute the various functions and instruction sets of PLC
5. Generate 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 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 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 FUNCTIONS**

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.

## 22OEI04 OPTOELECTRONICS AND LASER INSTRUMENTATION 3 0 0 3

**Course Objectives**

- To enhance the student knowledge in fiber optics fundamentals and fabrication
- To be recognized with industrial applications of fibers
- To understand the fundamental concepts about lasers
- To identify and describe various fiber optic imaging and optoelectronic sensor applications

**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.

**Course Outcomes (COs)**

1. Attribute the properties of optical fibers, their light sources and detectors.
2. Implement the fiber-optic sensor for the measurement of various physical quantities.
3. Conclude the fundamentals of laser, types of laser and its working.
4. Outline the applications of laser for industrial applications.
5. Differentiate the use of laser instruments for various medical applications.

**Articulation Matrix**

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

**UNIT I** **9 Hours**

**OPTICAL FIBERS AND THEIR PROPERTIES**

Introduction to optical fibers - Light guidance - Numerical aperture - Dispersion - Different types of fibers and their properties - Light Sources for fiber optics, Photo detectors, source coupling, splicing and connectors.

**UNIT II** **9 Hours**

**INDUSTRIAL APPLICATION OF OPTICAL FIBERS**

Fiber optics instrumentation system - optical fiber sensors, Measurement of pressure, temperature, current, voltage and liquid level - fiber optic communication set up - different types of modulators - detectors.

**UNIT III** **9 Hours**

**LASER FUNDAMENTALS**

Fundamental characteristics of lasers: laser rate equation - three level system - four level system - properties of laser beams - laser modes - resonator configuration - Q- switching and mode locking - cavity dumping - types of lasers: gas lasers, solid state lasers, liquid lasers and semiconductor lasers.

**UNIT IV** **9 Hours**

**INDUSTRIAL APPLICATION OF LASERS**

Lasers for measurement of distance and length, velocity, acceleration, atmospheric effects, sonic boom, pollutants - material processing: laser heating, melting, welding and trimming of materials - removal and vaporization - calculation of power requirements of laser for material processing.

**UNIT V** **9 Hours**

**HOLOGRAM AND MEDICAL APPLICATIONS**

Holography: basic principle, methods - holographic interferometry and application, holography for non-destructive - medical applications of lasers, laser and tissue interactive - laser instruments for surgery, removal of tumors of vocal cards, brain surgery, plastic surgery, gynaecology and oncology.

**Total: 45 Hours**

**Reference(s)**

1. John M. Senior, Optical Fiber Communications - Principles and Practice, Prentice Hall of India,2010.
2. John F. Ready, Industrial Applications of Lasers, Academic Press, 2012.
3. Gerd Keiser, Optical Fiber Communication, Mc Graw Hill, New York, 2013.
4. S.C. Gupta, Textbook on Fiber Optics Communications and its application, Prentice Hall of India, 2012.
5. John Wilson and J.F.B. Hawkes, Introduction to Opto Electronics, Prentice Hall of India, 2011.
6. R. P. Khare, Fiber Optics and Optoelectronics, Oxford University Press, 2011.

## 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 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 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. Select 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 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 2 | 2 | 2 | 2 | - | - | - | - | - | - | - | - | - |
| 2 | 2 | 2 | 2 | 2 | 2 | - | - | - | - | - | - | - | - | - |
| 3 | 2 | 2 | 2 | 2 | 2 | - | - | - | - | - | - | - | - | - |
| 4 | 2 | 2 | 2 | 2 | 2 | - | - | - | - | - | - | - | - | - |
| 5 | 2 | 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
6. http://www.springer.com/978-1-4939-2112-6
7. 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 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.

PO5 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.

PO11 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. Select proper plant layout for the required production system
2. Plan the resources required for the production and to perform the control methods
3. Apply work study method, prepare charts to outline the process and develop ergonomic condition suitable for the processes.
4. Analyze 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 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 1 | - | 1 | - | - | - | - | - | - | - | - | - |
| 2 | 3 | 3 | 1 | - | 2 | - | - | - | - | - | 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 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.

PO5 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 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 Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

**Course Outcomes (COs)**

1. Explain the principles, objectives and importance of maintenance adopted in industry.
2. Select the suitable maintenance category and lubrication type.
3. Apply the appropriate methods and instruments for condition monitoring.
4. Analyze the failures of mechanical systems and select suitable repair methods.
5. Utilize computers in maintenance and inventory management.

**Articulation Matrix**

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

**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.

**22OME04 SAFETY ENGINEERING 3 0 0 3**

**Course Objectives**

- To study the principles of safety management system.
- To introduce the provisions contained in the industrial laws.
- To provide knowledge on safety requirements for engineering industry.
- To learn safety requirement for chemical industry.
- To study the various safety measures adopted in construction industries.

## 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

PO5 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 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 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 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. Explain safety management system of an industry.
2. Implement the provisions of acts and rules in industries.
3. Implement and review the safety performance followed in various industries
4. Evaluate safety appraisal in chemical industries.
5. Generate safety reports on construction industries.

**Articulation Matrix**

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

**UNIT I** **9 Hours**

**SAFETY MANAGEMENT**

Concepts - Evolution, International Labour Organization (ILO), National Safety Council, Techniques - Job Safety Analysis (JSA), Safety survey, Safety inspection, Safety Sampling, Accident Reporting and Investigation - Concept of an accident, Accident causation models, cost of accident, investigation, Safety Performance Monitoring - Safety indices.

**UNIT II** **9 Hours**

**SAFETY AND LAW**

Factory Act 1948-Safety and Health chapters, Tamil Nadu Factories Rules- Safety and Health chapters, Environment and Pollution Laws, Building and other construction works act 1996, Electricity Rules.

**UNIT III** **9 Hours**

**SAFETY IN ENGINEERING INDUSTRIES**

Safety in machine shop - Principles of machine guarding - Personal protective equipment- Safety in handling industrial gases - Safety in cold forming and hot working of metals- Safety in finishing, inspection and testing, heat treatment, electro plating, leak test, radiography.

**UNIT IV** **9 Hours**

**SAFETY IN CHEMICAL INDUSTRIES**

Safety in process design, unit operations, pressure vessel, heat exchanger, safety valves -Plant commissioning and inspection, pressure vessel, Plant maintenance and emergency planning, management of maintenance HAZOP study.

**UNIT V** **9 Hours**

**SAFETY IN CONSTRUCTION INDUSTRY**

Construction regulations, contractual clauses, permit to work, - Education and training-Hazards of construction and prevention- excavation, scaffolding, dismantling, road works, construction of high-rise buildings - Working at heights-Working on fragile roofs, work permit systems-Construction machinery, cranes, chain pulley blocks, earth moving equipment, conveyors- Manual handling, Safety in demolition work, - Safety in confined spaces.

**Total: 45 Hours**

**Reference(s)**

1. Blake R.B., Industrial Safety, Prentice Hall, Incorporated, New Jersey,1973.
2. National Safety Council, Accident Prevention Manual for Industrial Operations, Chicago, 1988
3. Subramanian V., The Factories Act, 1948, with Tamil Nadu Factories Rules, 1950, Madras
4. Environmental Pollution Control Act, 1986
5. BOCW Act,1996, Madras Book agency, Chennai-1
6. Explosive Act, 1884, Eastern Book Company, Lucknow -266 001.

**22OBT01 BIOFUELS** **3 0 0 3**

**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 in order to surrogate the existing conventional fuels and hence strives towards sustainabledevelopment
- To give way to the bolster green technology and incline towards more ecofriendly options.

**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.

PO6 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 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 thee bio resources that can be used for the production of biofuels.
2. Analyze the physical and chemical properties of the biodiesel.
3. Analyze the mechanisms of improvising the quality and performance of engines using biofuels
4. Analyze the bio-fuel conversion technologies and their environmental attributes
5. Evaluate 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 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1 | 1 | 2 | - | - | - | 3 | - | - | - | - | - | - | - |
| 2 | 2 | 1 | - | 3 | - | - | 1 | - | - | - | - | - | - | - |
| 3 | 1 | 2 | - | 2 | - | 2 | 3 | - | - | - | - | - | - | - |
| 4 | 2 | 3 | - | - | - | 2 | 3 | - | - | - | - | - | - | - |
| 5 | 1 | 2 | 3 | 3 | - | - | 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 biodiesel 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 andthermal 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, wheat starch, 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 biorefineries, co-products of biorefineries-oil cake and glycerol, purification of glycerol obtained in biodiesel plant; anaerobic and thermal gasification of biomass, economics of biorefineries.

**Total: 45 Hours**

**Reference(s)**

1. Caye Drapcho, John Nghiem and Terry Walker, Biofuels Engineering process technology,McGraw Hill Professional, 2008.
2. Mousdale, Biofuels, CRC Press, 2008
3. Ahindra Nag, Biofuels Refining and Performance, McGraw-Hill Professional, 2007.
4. Lisbeth Olsson, Biofuels (Advances in Biochemical Engineering/ Biotechnology), Springer,2007

## 22OFD01 TRADITIONAL FOODS 3 0 0 3

**Course Objectives**

- To understand the importance of traditional foods and food habits
- To know the traditional processing of snack, sweet and dairy food products
- To infer the wide diversity and common features of traditional Indian foods and meal patterns.

**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.

PO8 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 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 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**

- To introduce the concept of food hygiene, importance of safe food and laws governing it
- To learn common causes of food borne illness - viz. physical, chemical and biological and identification through food analysis
- To understand food inspection procedures employed in maintaining food quality

**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.

PO6 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 Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

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

**Course Outcomes (COs)**

1. Analyse the food safety strategies and nutritional quality of the food
2. Check the food regulatory mechanism and mandatory laws for food products
3. Determine the national and international regulatory agencies
4. Understand 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 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 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 claim.

**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 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.

PO7 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. Analyze the suitable preservation method (sugar, salt or dehydration) to produce value added products from fruits and vegetables
3. Evaluate 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 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
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| 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**

- To understand the application of scientific principles in the processing technologies specific to the materials
- To understand the storage methods and handling techniques followed for cereals, pulses and oil seeds
- To develop the knowledge in the area of Cereals, pulses and oil seed processing and technology

## 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

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

**Course Outcomes (COs)**

1. Identify the specific processing technologies employed for cereals
2. Analyse the composition of millets and their nutritional importance
3. Relate the compositional changes and processing methods of pulses and legumes
4. Create the competence in processing of oilseeds technology
5. Relate 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 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 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.

**3 0 0 3**

## 22OFT01 FASHION CRAFTSMANSHIP

**Course Objectives**

- To impart theoretical and practical knowledge about various handi-craft techniques
- To enhance innovative skills on hand crafts.
- To build confidence on doing handicrafts.

**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.

PO7 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 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. 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. Design and construct head accessories, home furnishings and paintings
5. Design and construct 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 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 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 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.

PO5 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 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 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 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 3 | 2 | 3 | - | - | 1 | - | - | - | - | - | - | - | - |
| 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 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.

PO5 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 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 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. Apply the machine and computerized embroidery stitches
4. Analyze 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 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 2 | - | - | - | - | 1 | - | - | - | - | - | - |
| 2 | 2 | 3 | 2 | - | - | - | - | - | 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

## 22OPH03 APPLIED LASER SCIENCE 3 0 0 3

**Course Objectives**

- Impart knowledge on laser science
- Explore different strategies for producing lasers
- Create expertise on the applications of lasers in various fields

**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.

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. Analyze the role of energy levels and excitation processes in laser action.
2. Compare the different types of lasers based on pumping method, active medium and energy levels
3. Compute the rotation of earth, velocity and distance using lasers and apply the same for day today applications
4. Analyze the role of lasers in surgical and endoscopy applications
5. Apply the laser techniques in industrial applications

**Articulation Matrix**

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

**UNIT I** **9 Hours**

**LASER FUNDAMENTALS**

Introduction - principle - absorption and emission of light - thermal equilibrium - Einstein's prediction - Einstein's relations - A and B coefficients - condition for large stimulated emission - spontaneous and stimulated emission in optical region - light amplification - condition for light amplification - population inversion- Components of lasers - pumping methods - pumping mechanisms - optical resonator

**UNIT II** **9 Hours**

**LASER BEAM CHARACTERISTICS AND TYPES**

Characteristics of laser - Classification of lasers - principle, construction, working, energy level diagram and applications of molecular gas laser (CO2 laser) - liquid laser (dye laser) - excimer laser - Solid state laser (Nd: YAG laser) - semiconductor laser (homojunction laser).

**UNIT II** **9 Hours**

**LASERS IN SCIENCE**

Introduction - Harmonic generation (SHG) - Stimulated Raman emission - lasers in chemistry - laser in nuclear energy - lasers and gravitational waves - rotation of the earth - measurement of distance - Light detection And Ranging (LIDER) - velocity measurement - holography

**UNIT IV** **9 Hours**

**LASERS IN MEDICINE AND SURGERY**

Light induced biological hazards: Eye and skin - Eye laser surgery - photocoagulations - homeostasis - dentistry - laser angioplasty - different laser therapies - advantages & disadvantages - laser endoscopy.

**UNIT V** **9 Hours**

**LASERS IN INDUSTRY**

Applications in material processing: laser welding - hole drilling - laser cutting - Lasers in electronics industry: information storage - bar code scanner- Lasers in defence: laser based military weapons - laser walls.

**Total: 45 Hours**

**Reference(s)**

1. K. Thiyagarajan and A. K. Ghatak, "LASERS: Fundamentals and Applications", Springer, USA, 2015
2. M. N. Avadhanulu, "An Introduction to Lasers Theory and Applications", S. Chand Publisher, 2013
3. W. Koechner, M. Bass, "Solid State Lasers: a graduate text", Springer Verlag, New York, 2006
4. K. P. R. Nair, "Atoms, Molecules and Lasers", Narosa Publishing House, 2009
5. K. R. Nambiar, "Lasers: Principles Types and Applications", New Age International Publications, 2006
6. A. Sennaroglu, "Solid-State Lasers and Applications", CRC Press, 2006

## 22OPH04 BIOPHOTONICS 3 0 0 3

**Course Objective:**

- To understand the light-matter interaction in biological cells or tissues by using the principles of optics and lasers.
- To apply the properties of biological cells or tissues in biomedical applications by various optical imaging, sensing and activation techniques.
- To analyze the concepts of Modern optical measurement techniques and devices in early detection of disease and cure them.

**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.

PO5 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 fundamental laws of optics and their role in light interaction with biological cells and tissues.
2. Apply the principles of light interaction with biological tissues to enhance imaging resolution and contrast.
3. Use laser tweezers techniques to infer the activities of cells (tissues) and explain the single molecule detection processes in medical diagnosis.
4. Outline the properties of ultra short laser pulses and tissue engineering to rectify the affecting factors in biological cells.
5. Compare the various types of bio-imaging methods to detect the infected cells and molecules in biological science.

**Articulation Matrix**

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

**UNIT I** **9 Hours**

**INTRODUCTION TO BIOPHOTONICS**

Light as Photon Particles – Coherence of light - lasers – classification of lasers – Mechanisms of Non-linear Optics (NLO) processes associated with Biophotonics - Light scattering mechanisms: Rayleigh scattering, Miescattering, Brillouin Scattering, Raman Scattering -Different light sources – Quantitative description of light: Radiometry

**UNIT II** **9 Hours**

**PHOTOBIOLOGY**

Interaction of light with cells and tissues – Light – Tissue Interaction Variables – Light –Tissue Interaction Theory: Radiative Transport Theory – Photo process in biopolymers – In Vivo Photo excitation – photo-induced physical, chemical, thermal and mechanical effects in biological systems – Optical biopsy – Single molecule detection

**UNIT III** **9 Hours**

**BIONANO PHOTONICS**

Laser Microtools, Semiconductor quantum dots for bioimaging, Metallic nanoparticles and nanorods for biosensing – Optical biosensors: Fibre-Optic, evanescent wave, surface Plasmon resonance (SPR) based biosensors – biomaterials for photonics – Principle and design of laser tweezers – laser trapping and dissection for biological manipulation.

**UNIT IV** **9 Hours**

**TISSUE ENGINEERING WITH LIGHT**

Basics of tissue optics: Light absorption and scattering in tissues, Wavelength effects and spectra– the therapeutic window, Light penetration in tissues – Absorbing agents in tissues and blood –Skinoptics, response to the UV radiation, Optical parameters soft tissues – tissue welding – tissue contouring – tissue regeneration – Femto laser surgery – low level light therapy and photo dynamic therapy

**UNIT V** **9 Hours**

**BIO-IMAGING TECHNIQUES AND ITS APPLICATIONS**

An overview of optical imaging – Fluorescence Microscopy – Scanning Microscopy – In vivo Confocal Microscopy – Multi photon Microscopy – Optical Coherence Tomography (OCT) – Fluorescence Resonance Energy Transfer (FRET) imaging – fluorescence lifetime imaging Microscopy (FLIM) – Nonlinear optical imaging – Coherent Anti-stokes Raman Scattering –Bioimaging Applications.

**Total: 45 Hours**

**Reference(s)**

1. Paras N Prasad, Introduction to Biophotonics, Wiley Inter-science, A John Wiley & Sons, Inc., Publication, 2003.
2. Andrew GWebb, Introduction to Biomedical Imaging, IEEE Press, 2002.
3. Lihong V Wang and HSin-i Wu, Biomedical Optics: Principles and Imaging, Wiley 2007.
4. R Splinter and B A Hooper, An Introduction to Biomedical Optics, Wiley Inter science , Taylor & Francis, 2007.
5. D E Chandler and R W Roberson, Bioimaging Current Concepts in Light and Electron Microscopy, Jones and Bartlett publishers, 2008.
6. Peter Torok and Fu-Jen Kao, Optical Imaging and Microscopy: Techniques and Advanced Systems, Springer, 2004.

## 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 supra molecules
- To summarize the soft matter properties of structures and components of life

**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.

**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 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
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| 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

**UNIT IV** **9 Hours**

**SUPRAMOLECULAR SELF ASSEMBLY**

Aggragation and phase separation-types of micelles- bilayers and vesicles. Phase behaviour of concentrated surfactant solutions-phase separation in polymers, copolymers and block copolymers

**UNIT V** **9 Hours**

**SOFT MATTER IN NATURE**

Components and structures of life - Nucleic acids – proteins - interaction between proteins – polysaccharides - membranes

**Total: 45 Hours**

**Reference(s)**

1. Richard A L Jones, Soft Condensed 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. Fernandez-Nieves A and Puertas A M, Fluids, Colloids and Soft materials: An Introduction to Soft Matter Physics, John Wiley & Sons, 2016.
5. Maurice Kleman, and 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

**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.

PO7 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. Analyse the corrosion mechanism on steel, iron, zinc and copper metal surfaces
4. Analyse the rate of corrosion on metals using electrochemical methods of testing
5. Analyse 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 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
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| 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

digrams of Mg, Al and Fe and their advantages and disadvantages

**UNIT II** **7 Hours**

**TYPES OF CORROSION**

Eight forms of corrosion: uniform, galvanic, crevice corrosion, pitting, intergranular corrosion, selective leaching, erosion corrosion and stress corrosion-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

**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.

**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 the suitable polymerization techniques to synthesize the high quality polymers
3. Identify the structural, thermal, and mechanical properties of polymers for different 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 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 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.

**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.

PO7 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 methods of storing hydrogen fuel and 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 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
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| 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.

**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.

**Course Outcomes (COs)**

1. Apply the basic ideas of Graph and its characteristics.
2. Assess the characteristics of trees and its properties.
3. Predict 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 |
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| 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 Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO11 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. Students will be able to understand the basic concepts of Management.
2. Have some basic knowledge on planning process and its Tools & Techniques.
3. Ability to understand management concept of organizing and staffing.
4. Ability to understand management concept of directing.
5. Ability to understand management concept of controlling.

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
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| 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 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 Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

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

**Course Outcomes (COs)**

1. Analyze the role of entrepreneurship in economic development.
2. Explain the types of ideas that to be used for entrepreneurship development.
3. Examine the legal aspects of business and its association.
4. Examine the sources of business and its analysis.
5. Analyse the different modes of operation management.

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 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 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 Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

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

**Course Outcomes (COs)**

1. Examine the strategies and plans in marketing management.
2. Analyse the cases involved in human resource management.
3. Classify the direct and indirect taxes in business.
4. Analyze the supports given by government for improving the business.
5. Examine 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 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 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 Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems

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.

PO7 Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

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. Apply the understanding of religo-cultural diversity of the country and its impact on the lives of the people and their beliefs
2. Build 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. Apply the importance of Physical and Mental health and structure of communication organization and various mode of communication
5. Analyze the organizational structure, entry modes, and operational roles of Indian armed forces, CAPF, and NCC while developing leadership capabilities.

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
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| 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/

## 22OBM01 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 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 Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

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. 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. Analyse common risks for safety and health in emergencies
4. Adapt appropriate occupational safety practices in chemical accidents
5. Guide Occupational safety measures in radiation incidents

**Articulation Matrix**

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

## 22OBM02 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

**Course Outcomes (COs)**

1. Identify ambulance services, types and allied services
2. Formulate minimum ambulance rescue equipment and developing a transportation Strategy.
3. Understand the Emergency response team, Transportation interfaces, Transportation Service Characteristics& regulatory reforms involved.
4. Identify ambulance services, types and allied services
5. Formulate minimum ambulance rescue equipment and developing a transportation Strategy.

**Articulation Matrix**

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

## 22OBM03 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

**Course Outcomes (COs)**

1. Identify the factors in central power generating and monitoring systems
2. Analyze 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 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | - | - | - | - | - | - | - | - | - | - | - | - | - |
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| 3 | - | 2 | - | - | - | - | - | - | - | - | - | - | - | - |
| 4 | - | 2 | - | - | - | - | - | - | - | - | - | - | - | - |
| 5 | 3 | - | - | - | - | - | - | - | - | - | - | - | - | - |

**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.

## 22OAG01 RAIN WATER 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

**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.

PO7 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. Evaluate 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 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
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| 2 | 2 | 1 | - | - | - | - | - | - | - | - | - | - | - | - |
| 3 | 1 | 1 | 3 | - | - | - | 2 | - | - | - | - | - | - | - |
| 4 | 1 | 2 | 3 | - | - | - | 2 | - | - | - | - | - | - | - |
| 5 | 1 | 1 | 3 | - | - | - | 2 | - | - | - | - | - | - | - |

**UNIT I** **9 Hours**

**WATER RESOURCES**

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** **9 Hours**

**WATER 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 Y O, 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.

**Program Outcomes (POs)**

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.

PO11 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 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 Acquire a sense of responsibility, smartness in appearance and improve self confidence
2. Analyse the cost and worth of a product/service using the principles of economics
3. Evaluate the value of a product/service to take managerial decisions
4. Apply the softskills in understanding team building, team work and report writing
5. Asses the functions and values of product/services in industries using case studies

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | - | - | - | - | - | - | - | - | - | - | 3 | 1 | - | - |
| 2 | - | - | - | - | - | - | - | - | - | 1 | 3 | 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. Anil Kumar Mukhopadhyaya, Value Engineering Mastermind - From Concepts to Certification, Response. Business Books from SAGE, Los Angeles / London / New Delhi / Singapore / Washington DC, 2014.
2. Anil Kumar Mukhopadhyaya, Value Engineering -Concepts, Techniques and Applications, Response Books, A Division of SAGE Publications, New Delhi / Thousand Oaks / London, 2003
3. R. D. Miles, Techniques of Value analysis & Engineering, McGraw Hill, 2000.
4. E. Midge Arthur, Value Engineering -A Systematic Approach, McGraw Hill Book Co., New York, 2000.
5. Zimmerman, Value Engineering - A Practical Approach, CBS Publishers & Distributors, New Delhi, 2000.

## 22EC0XA MIMO ANTENNA DESIGN AND ITS ANALYSIS

**1 0 0 1**

**Course Objectives**

- Students will be able to Design antenna arrays for MIMO systems considering spatial multiplexing and beamforming principles.

**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 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 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 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. Analyze the fundamental concepts of MIMO technology, its applications, and advantages in wireless communication systems.
2. Assess antenna parameters including gain, impedance, radiation pattern, and polarization, and apply this knowledge to antenna selection and design.

**Articulation Matrix**

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

**ANTENNA FUNDAMENTALS AND MIMO REQUIREMENTS**

Antenna fundamentals: Gain, impedance, radiation pattern, and polarization, MIMO system requirements: Diversity gain, spatial multiplexing, and channel capacity - MIMO antenna configurations: SIMO, MISO, 2x2 & 4x4, Spatial multiplexing and beamforming concepts - Creating antenna geometries using HFSS tools, Defining material properties, boundary conditions, and excitations - Performing frequency domain simulations for MIMO antennas, Analyzing S-parameters, mutual coupling, and radiation patterns.

**Total: 15 Hours**

**Reference(s)**

1. Li, Y., & Wang, W. (2006). MIMO Antenna Technology for Wireless Communications.
2. Huang, J., Zong, Z., & Gao, Y. (2017). MIMO Antenna Technology for Beyond 4G.
3. ANSYS HFSS User Guide and Tutorials: Provided by ANSYS, these guides offer step-by-step instructions on using HFSS for antenna design and simulation.
4. IEEE Antennas and Wireless Propagation Letters: Shorter research articles and letters on the latest developments in antennas and wireless propagation.

## 22EC0XB NLP BEYOND BASICS 1 0 0 1

**Course Objectives**

- To explore NLP's Practical Applications, Algorithmic Fundamentals, and Build with Latest LLMs Models.

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

PSO2 Able to solve complex engineering problems using state-of-the-art hardware and software tools, along with analytical and managerial skills to arrive appropriate solutions.

**Course Outcomes (COs)**

1. Demonstrate the idea about NLP, LLMs models and its recent applications.
2. Assess supervised machine learning models based on the text.
3. Analyze the performance of the latest LLMs model.

**Articulation Matrix**

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

**BASIC TO LATEST LLMS CONCEPTS IN NLP**

Bag of words(BOG), Term Frequency - Inverse Document frequency(TF-IDF), Word2Vev, FastText, Doc2Vec, LSTM, Transformers, BERT, GPT

**Total: 15 Hours**

**Reference(s)**

1. Steven Bird, Ewan Klein, Edward Loper, Natural Language Processing with Python, First Edition, O'Reilly Media, 2009

**22EC0XC 32 BIT MICROPROCESSORS (MPUS) WITH EDGE AI** **1 0 0 1**

**Course Objectives**

- To explore the functions and capabilities of 32-Bit Microprocessor, and gain hands-on experience in developing Edge AI applications using ARM development boards.
- The course focuses on understanding the architecture, protocols, and practical aspects of building efficient and reliable Embedded solutions.

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

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

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.

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

PSO2 Able to solve complex engineering problems using state-of-the-art hardware and software tools, along with analytical and managerial skills to arrive appropriate solutions.

**Course Outcomes (COs)**

1. Analyze the ARM Processor Basics and architecture flow.
2. Integrate ARM development boards with sensors using GPIO pins.
3. Implement and Program 32-bit microprocessor boards for Edge AI applications.

**Articulation Matrix**

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

**ARM DESIGN PHILOSOPHY & RISC ARCHITECTURE**

ARM Design Philosophy & RISC Architecture, Programmer's Model. GPIO Configuration, Interfacing IO devices – LEDs, Switches. Timers Basics, PWM, UART, I2C, SPI, ADC & DAC. Introduction to AI and ML concepts. Types of AI, Applications of AI, Advantages and disadvantages of AI. Introduction to ML, Types of Ml algorithms: Supervised learning - Unsupervised learning - Reinforcement learning. Hardware and Software Platforms for AI. Real World Use Cases.

**Total: 15 Hours**

**Reference(s)**

1. Shibu K V, ―Introduction to Embedded Systems Tata McGraw Hill Education Private Limited, 2nd Edition.
2. Pete Warden, Daniel Situnayak-TinyML: Machine Learning with Tensor Flow Lite on Arduino and Ultra-Low, O'Reilly,2020.
3. Atul Krishna Gupta, Dr. Siva Prasad Nandyala-Deep Learning on Microcontrollers: Learn how to develop embedded AI applications using TinyML. BPB Publications,2023.
4. https://stm32ai.st.com/#stm32-sann-resourcescontainer
5. https://www.ti.com/technologies/edge-ai.html

**22EC0XD IoT APPLICATION DESIGN USING LoRa TECHNOLOGY** **0 0 0 1**

**Course Objectives**

- To explore the capabilities of LoRa technology, and gain hands-on experience in developing IoT applications using LoRa 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 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 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 Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

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

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.

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. Analyze LoRaWAN protocol and its role in enabling long-range communication.
2. Demonstrate hands-on proficiency in configuring and programming LoRa devices for simple IoT applications.

**Articulation Matrix**

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

**IoT ARCHITECTURE AND APPLICATIONS**

IoT Architecture - IIoT Applications - Introduction to ESP32 - Introduction to ESP32 library installation - Hands-On: Integration LED with WDM.Node to Node Communication with LoRa - Install LMIC Library for LoRaWAN Communication- Pin Mapping with Hardware using - Configure LoRaWAN Gateway in Network Serve Decoding the Received Data - Downlink Data from Network Page to End Device. Uplink from End Node to Network Server using OTAA Mode Data Visualization in Application Server with Multiple widgets - Hands on demo: Ultrasonic sensor Data visualization in Application Server

**Total: 15 Hours**

**Reference(s)**

1. Joseph Babcock and Raghav Bali, Generative AI with Python and TensorFlow 2: Create images, text, and music with VAEs, GANs, LSTMs, Transformer models, Packt Publishing Limited, 2021.
2. Bernard Marr, Generative AI in Practice, Wiley, 2023.
3. David M. Patel, Artificial Intelligence & Generative AI for Beginners: The Complete Guide, Generative AI & Chat GPT Mastery Series, 2023.

**22EC0XE EXPERIMENTING NETWORK PROTOCOLS USING ANALYZING TOOLS** **1 0 0 1**

**Course Objectives**

- To analyze, troubleshoot, and capture the packets in the network interface.
- To filter packets on many criteria and search for packets on many criteria.
- To create various statistics and colorize packet displays based on filters.

## 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.

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

PSO2 Able to solve complex engineering problems using state-of-the-art hardware and software tools, along with analytical and managerial skills to arrive appropriate solutions.

**Course Outcomes (COs)**

1. Analyze the fundamental elements of networking.
2. Analyze the structure of the network and its various challenges while transferring packets.
3. Differentiate hardware, software, and the aspects involved in networking devices.

**Articulation Matrix**

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

**WIRESHARK: PACKET ANALYSIS AND FILTERS**

Wireshark Installation – Wireshark Basics – Capture frames/packets/segments – Port SPAN / Mirroring Wireshark Filters – Demo of Wireshark Display filters – Two types of filters – Wireshark capture filters- IP Address / Protocols – T shark and Term shark – Overview of Wireshark Hacking Passwords.

**SPANNING TREE THEORY WITH DEMONSTRATIONS SPANNING** Tree Overview – Versions of Spanning Tree – Why Spanning Tree – BPDUs and Bridge IDs – Demo: STP Root – Root Ports and Designated – Extended Bridge ID – Port Fast – Path Cost – PVST versus RPVST Port – RPVST and PVST Interoperability – Demo: 802.1w – 802.1s / MSTP- Spanning Tree Comparison Summary.

**GRAPHICAL NETWORK SIMULATOR INTRODUCTION** to GNS3 – Basic Terminologies – Creating different network topologies – Ethernet switch devices – protocols – Packet capture – Firewall emulation – Virtual LAN Configuration – Routing protocols ATM switch and bridges.

**Total: 15 Hours**

**Reference(s)**

1. Laura Chappell, Gerald Combs, "Wireshark 101: Essential Skills for Network Analysis (Wireshark Solution)", Second Edition, 2017.
2. Laura Chappell, Gerald Combs, "Wireshark Network Analysis: The official Wireshark certified network analyst study guide", Second Edition, 2011.
3. Lisa Bock, "Learn Wireshark: A definitive guide to expertly analyzing protocols and troubleshooting networks using Wireshark" Second Edition, Kindle Edition

**22EC0XF AUTOMOTIVE COMMUNICATION BOOT CAMP LIN, OBD AND AUTOSAR** **1 0 0 1**

**Course Objectives**

- Gain a foundational understanding of semiconductor materials, principles, and manufacturing processes.
- Gain insights into reliability testing, failure analysis, and yield enhancement 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 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 Able to apply the concepts of Electronics, Communication, Signal processing and VLSI in the design and implementation of application oriented engineering systems.

PSO2 Able to solve complex engineering problems using state-of-the-art hardware and software tools, along with analytical and managerial skills to arrive appropriate solutions.

**Course Outcomes (COs)**

1. Analyze basic semiconductor device's life cycle from design to release.
2. Analyze the environments, tools, and processes in each stage of the semiconductor's life cycle.
3. Analyze the importance of design, instruments, and technologies involved, and the role of Electronics engineers in the processes.

**Articulation Matrix**

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

**LIN PROTOCOL:**
Lin BUS – CAN bus vs LIN bus – LIN Bus usage – LIN Messages – LIN Bit Timing – LIN Error Handling – LIN Connector – LIN Sleep & Wake-up. **DIAGNOSTIC COMMUNICATION:** Physical and Functional Addressing - ISO14229 UDS: UDS vs ISO OSI Layers – Diagnostic Message Structure &

Types – UDS Services – Types of Services: Simple, Periodic & Event-based – UDS Sessions OBD II – OBD vs ISO OSI Layers – OBD Connectors – OBD Services - OBD Parameter ID (PIDs)* **AUTOSAR ARCHITECTURE:** Introduction to Autosar Standard & Consortium – Need for Autosar Architecture – Virtual Function Bus - Layered Architecture Model – Microcontroller Abstraction Layer – ECU Abstraction Layer – Service layer – Autosar example – Classic vs Adaptive Autosar - Secure On-board Communication

**Total: 15 Hours**

**Reference(s)**

1. Christoph Marscholik and Peter Subkey, "Road Vehicles – Diagnostic Communication Oliver Scheid", "Autosar Compendium – Part 1"
2. Dominique Paret, "Multiplexed Networks for Embedded Systems: CAN, LIN, Flex Ray, and Safe-by-wire." SAE International, Wiley, Automated Embedded Systems: Handbook.
3. https://www.autosar.org/fileadmin/standards/classic/2211/AUTOSAR_EXP_Layered SoftwareArchitecture.pdf

**22EC0XG SEMICONDUCTOR LIFE CYCLE 1 0 0 1**

**Course Objectives**

- Gain a foundational understanding of semiconductor materials, principles, and manufacturing processes.
- Gain insights into reliability testing, failure analysis, and yield enhancement 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 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 Able to apply the concepts of Electronics, Communication, Signal processing and VLSI in the design and implementation of application oriented engineering systems.

PSO2 Able to solve complex engineering problems using state-of-the-art hardware and software tools, along with analytical and managerial skills to arrive appropriate solutions.

**Course Outcomes (COs)**

1. Analyze semiconductor device's life cycle from design to release.
2. Analyze the environments, tools, and processes in each stage of the semiconductor's life cycle.
3. Analyze the importance of design, instruments, and technologies involved, and the role of Electronics engineers in the processes.

**Articulation Matrix**

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

**15 Hours**

**OVERVIEW OF SEMICONDUCTOR LIFE CYCLE**

High level overview of the semiconductor life cycle – pre-silicon processes, silicon fabrication, post-silicon lab processes, mass production and market release – common terminologies. **PRE-SILICON PROCESSES:** Requirement identification – IC generations – RTL Design – tools and processes – HDLs – design verification processes – design data sheet. **SILICON FABRICATION:** Fabrication process basic overview – wafer manufacturing, oxidation, photolithography, etching, deposition & ion implantation, metal wiring, EDS, packaging – wafer level testing – IC packaging types, **POST-SILICON LAB PROCESSES:** Lab validation process – environment, processes, and tools – wakeup, debug, characterization, compliance testing – test bench, test plans, test programs and automation – instruments in lab validation – final datasheet. **SILICON PRODUCTION AND RELEASE:** Mass Production – production testing – environment, processes, and tools – ATEs – Market release – Evaluation GUIs – Version upgrades Summary – the importance of design, instrumentation, GUIs, and data at different stages – role of Electronics engineers in the processes.

**Total: 15 Hours**

**Reference(s)**

1. Semiconductor Manufacturing Handbook by Hwaiyu Geng
2. Semiconductor Devices: Physics and Technology by S. M. Sze and Kwok K. Ng
3. Introduction to Semiconductor Manufacturing Technology by Hong Xiao

**22EC0XH GENERATIVE AI** **1 0 0 1**

**Course Objectives**

- To understand simple and complex algorithms involved in NLP and computer vision.
- To create real-world applications based on the latest recent models like chatbot.

## 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 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 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.

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

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

PSO2 Able to solve complex engineering problems using state-of-the-art hardware and software tools, along with analytical and managerial skills to arrive appropriate solutions

**Course Outcomes (COs)**

1. Develop practical skills in implementing generative models using deep learning frameworks.
2. Construct & train supervised machine learning models based on the text and image.
3. Develop students' critical thinking skills to analyze and solve problems related to generative I.

**Articulation Matrix**

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

**BASIC TO LATEST MODEL IN THE EVALUATION OF GENERATIVE AI**

Basic of NLP - BOG, TFIDF, Word2Vec, Bert, GPT. Basic of Computer Vision - Pixel, CNN, GAN. Large Language model, Image Generation model, Open model- Google Text-to-Text Transfer Transformer (T5), Bidirectional Encoder Representations from Transformers (BERT), llama, mistral. API model - openai, Gemini, amazon bedrock

**Total: 15 Hours**

**Reference(s)**

1. Joseph Babcock and Raghav Bali, Generative AI with Python and TensorFlow 2: Create images, text, and music with VAEs, GANs, LSTMs, Transformer models, Packt Publishing Limited, 2021.
2. Bernard Marr, Generative AI in Practice, Wiley, 2023.
3. David M. Patel, Artificial Intelligence & Generative AI for Beginners: The Complete Guide, Generative AI & Chat GPT Mastery Series, 2023.

**22EC0XI FROM CONCEPT TO PROTOTYPE PCB ELECTRONIC DESIGN ESSENTIALS** **1 0 0 1**

**Course Objectives**

- To Transform the circuit ideas into Electrical/Electronic Circuits and to convert circuits into Single and Multi-layer PCB.

## 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.

PO5 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 Able to apply the concepts of Electronics, Communication, Signal processing and VLSI in the design and implementation of application oriented engineering systems.

PSO2 Able to solve complex engineering problems using state-of-the-art hardware and software tools, along with analytical and managerial skills to arrive appropriate solutions

**Course Outcomes (COs)**

1. Design, simulate and lay out the electronic circuits using PCB Design Software.
2. Analyze a single-layer and multilayer PCB design.
3. Assess and Test a PCB for Single layer PCB Prototype.

**Articulation Matrix**

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

**PCB DESIGN AND PROTOTYPING**

Types of PCB & Single Page Schematic Design - Multipage Schematic Design - Mounting Technologies and Single Layer (TH) Component Placement - Single Layer Through Hole (TH) Routing - Single Layer Surface Mount Device (SMD) Component Placement and Routing – Multi-Layer Through Hole (TH) Component Placement - Multi-Layer Through Hole (TH) Routing.**PCB DESIGN AND PROTOTYPING** Prototyping, Assembling & Soldering of single-layer PCB Board.

**Total: 15 Hours**

**Reference(s)**

1. Jon Varteresian, Fabricating Printed Circuit Boards, Newnes, 2002
2. R. Tummala, Fundamentals of Microsystems Packaging, McGraw-Hill 2001
3. Mark Madou, Fundamentals of Microfabrication, CRC Press, ISBN: 0-8493-9451-1.

## 22EC0XJ PROTOCOLS IN AUTOMOTIVE COMMUNICATION TECHNOLOGIES

**1 0 0 1**

**Course Objectives**

- Explore the fundamental concepts of communication protocols.
- Analyse the key features and characteristics of UART communication.
- Understand the benefits and limitations of using SENT in automotive 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 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 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 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 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 Able to apply the concepts of Electronics, Communication, Signal processing and VLSI in the design and implementation of application oriented engineering systems.

PSO2 Able to solve complex engineering problems using state-of-the-art hardware and software tools, along with analytical and managerial skills to arrive appropriate solutions.

**Course Outcomes (COs)**

1. Analyze the physical layer of CAN, including bit timing and signal levels.
2. Compare UART to other serial protocols (e.g., SPI, I2C).
3. Analyse the key components of an OBD-II system, including the Data Link Connector (DLC) and Electronic Control Unit (ECU).

**Articulation Matrix**

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

**CAN, UART, AND SPI PROTOCOLS**

CAN (Hands-on): Gain insights into the CAN protocol, covering frame formats, understanding CAN nodes, signaling, bus states, bit timing calculation, and networking with transceivers. Explore the bx CAN peripheral of STM32, including self-testing modes and block diagrams. UART Protocols (Hands-on): Understand UART, its functionality, and programming aspects. SPI Communication (Hands-on): Explore SPI, its working principles, and programming with a focus on interfacing with MEMS accelerometer sensors. **MOST IN AUTOMOTIVE CONNECTIVITY** MOST Architecture - Communication Protocols in MOST - MOST Interfaces and Components OBD-II: Overview of OBD-II - OBD-II Communication Protocols - OBD-II Scanning Tools-Implementation of OBD-II in Vehicles SENT Protocols: Introduction to SENT - SENT Frame Structure - SENT Communication Protocol Features - Application of SENT in Automotive Systems.

**Total: 15 Hours**

**Reference(s)**

1. Bosch CAN Specification: http://esd.cs.ucr.edu/webres/can20.pdf
2. CAN Bus for Beginners: https://www.ti.com/lit/gpn/SN65HVDA1040A-Q1
3. Texas Instruments SPI Resources: https://www.ti.com/video/6245520669001
4. OBD-I & OBD-II: A Complete Guide to Diagnosis, Repair, & Emissions Compliance by Greg Banish. Automotive Ethernet Handbook by Claus Bode
5. Controller Area Network (CAN) Buses and Arbitration Schemes by Georg Jung.

## 22EC0XK PHYSICAL COMPUTING WITH UNITY AND CONTROLLER

**1 0 0 1**

**Course Objectives**

- To understand the integration of Unity3D and Controller for interactive applications.
- To create interactive simulations and games with real-world inputs.

**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 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.

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

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

PSO2 Able to solve complex engineering problems using state-of-the-art hardware and software tools, along with analytical and managerial skills to arrive appropriate solutions.

**Course Outcomes (COs)**

1. Develop proficiency in using Unity, including creating and manipulating 3D objects, scripting with C#, and working with GameObjects and components.
2. Design and implement interactive applications that combine Unity's graphics and Arduino's real-world interactions.
3. Apply advanced Arduino programming techniques to extend the capabilities of Unity and Arduino integration.

**Articulation Matrix**

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

**BUILDING INTERACTIVE APPLICATIONS WITH UNITY AND ARDUINO**

Overview of Arduino platform, Understanding Arduino board and components, Introduction to Unity game development engine, Unity interface and project setup, Understanding Game Objects, components, and scripts, Creating and manipulating 3D objects in Unity, Introduction to Unity scripting with C#, Overview of communication protocols (UART, I2C, SPI), Establishing a serial connection between Arduino and Unity, Data transmission and synchronization techniques, Sending and receiving data between Arduino and Unity, Introduction to various sensors (e.g., temperature, light, proximity), Connecting sensors to Arduino and reading sensor data, Processing sensor data in Arduino, Sending sensor data to Unity for visualization and interaction, Planning and designing interactive applications, Integrating multiple Arduino devices with Unity, Implementing user input and feedback mechanisms, Optimizing performance and responsiveness.

**Total: 15 Hours**

**Reference(s)**

1. Joseph Babcock and Raghav Bali, Generative AI with Python and TensorFlow 2: Create images, text, and music with VAEs, GANs, LSTMs, Transformer models, Packt Publishing Limited, 2021.
2. Bernard Marr, Generative AI in Practice, Wiley, 2023.
3. David M. Patel, Artificial Intelligence & Generative AI for Beginners: The Complete Guide, Generative AI & Chat GPT Mastery Series, 2023.