G. Pullaiah College of Engineering and Technology

(Autonomous)

(Approved by AICTE | NAAC Accreditation with 'A' Grade | Accredited by NBA (ECE & EEE) | Affiliated to JNTUA)

Nandikotkur Road, Venkayapalli (V), Kurnool – 518452, Andhra Pradesh

MASTER OF TECHNOLOGY
Digital Electronics & Communication Systems

ACADEMIC REGULATIONS GPCET – R25

M.Tech Regular Two Year Degree Programme

(for the batches admitted from the academic year 2025-26)

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Academic Regulations of M.Tech. (Full Time/Regular) Programme

(Effective for the students admitted into I year from the Academic Year 2024-25 and onwards)

G.Pullaiah College of Engineering and Technology, Kurnool offers **Two** Years (**Four** Semesters) full-time Master of Technology (M.Tech.) Degree programme, under Choice Based Credit System (CBCS) in different branches of Engineering and Technology with different specializations.

The G.Pullaiah College of Engineering and Technology, Kurnool shall confer M. Tech. degree on candidates who are admitted to the programme and fulfill all the requirements for the award of the degree.

1. **Award of the M.Tech. Degree**

   A student will be declared eligible for the award of the M.Tech. degree if he/she fulfills the following:

   1.1 Pursues a course of study for not less than two academic years and not more than four academic years.

   1.2 Registers for 75 credits and secures all 75 credits.

2. Students, who fail to fulfill all the academic requirements for the award of the degree within four academic years from the year of their admission, shall forfeit their seat in M.Tech. course and their admission stands cancelled.

3. **Programme of Study:**

   The following M.Tech. Specializations are offered at present in different branches of Engineering and Technology.

S.No.	Discipline	Name of the Specialization	Code
01	Electrical and Electronics Engineering	Electrical Power Systems	07
02	Electronics and Communication Engineering	Digital Electronics & Communication Systems	38
03	Computer Science and Engineering	Computer Science & Engineering	58

4. **Eligibility for Admissions**:

   4.1 Admission to the M. Tech Program shall be made subject to the eligibility, qualification and specialization prescribed by the A.P. State Government/University from time to time.

   4.2 Admissions shall be made either on the basis of the merit rank or Percentile obtained by the qualified student in the relevant qualifying GATE Examination/ the merit rank obtained by the qualified student in an entrance test conducted by A.P. State Government (APPGECET) for M.Tech. programmes an entrance test conducted by University/on the basis of any other exams approved by the University, subject to reservations as laid down by the Govt. from time to time.

5. Programme related terms:

5.1 ***Credit:*** A unit by which the course work is measured. It determines the number of hours of instructions required per week. One credit is equivalent to one hour of teaching (Lecture/Tutorial) or two hours of practical work/field work per week.

Credit definition:

1 Hr. Lecture (L) per week	1 credit
1 Hr. Tutorial (T) per week	1 credit
1 Hr. Practical (P) per week	0.5 credit

5.2 ***Academic Year:*** Two consecutive (one odd + one even) semesters constitute one academic year.

5.3 ***Choice Based Credit System (CBCS):*** The CBCS provides choice for students to select from the prescribed courses.

6. Programme Pattern:

6.1 Total duration of the M.Tech. programme is two academic years

6.2 Each academic year of study is divided into two semesters.

6.3 Each Semester shall be of 22 weeks duration (inclusive of Examinations), with a minimum of 90 instructional days per semester.

6.4 The student shall not take more than four academic years to fulfill all the academic requirements for the award of M.Tech. degree from the date of commencement of first year first semester, failing which the student shall forfeit the seat in M.Tech. programme.

6.5 The medium of instruction of the programme (including examinations and project reports) will be in English only.

6.6 All subjects/courses offered for the M.Tech. degree programme are broadly classified as follows:

S.No.	Broad Course Classification	Course Category	Description
1.	Core Courses	Foundational & Professional Core Courses (PC)	Includes subjects related to the parent discipline/department/branch of Engineering
2.	Elective Courses	Professional Elective Courses (PE)	Includes elective subjects related to the parent discipline/department/ branch of Engineering
		Open Elective Courses (OE)	Elective subjects which include inter-disciplinary subjects or subjects in an area outside the parent discipline which are of importance in the context of special skill development
3.	Mandatory Course	Quantum Technology and Application	To understand importance of latest technologies, research and process of creation of patents through research
		Research methodology & IPR	
4.	Research	Skill Enhancement courses (SE)	Interdisciplinary/job-oriented/domain courses which are relevant to the industry
		Comprehensive Viva	To test the overall domain knowledge
		Short Term Industry Internship	To provide real time exposure

		Dissertation	To provide application of domain knowledge to solve real problems
5.	Audit Courses	Mandatory noncredit courses	Covering subjects of developing desired attitude among the learners.

6.7 The college shall take measures to implement Virtual Labs (https://www.vlab.co.in) which provide remote access to labs in various disciplines of Engineering and will help student in learning basic and advanced concept through remote experimentation. Student shall be made to work on virtual lab experiments during the regular labs.

6.8 A faculty advisor/mentor shall be assigned to each specialization to advise students on the programme, its Course Structure and Curriculum, Choice of Courses, based on his competence, progress, pre-requisites and interest.

6.9 Preferably 25% course work for the theory courses in every semester shall be conducted in the blended mode of learning.

7. Attendance Requirements:

7.1 A student shall be eligible to appear for the University external examinations if he/she acquires i) a minimum of 50% attendance in each course and ii) 75% of attendance in aggregate of all the courses.

7.2 Condonation of shortage of attendance in aggregate up to 10% (65% and above and below 75%) in each semester may be granted by the College Academic Committee.

7.3 Condonation of shortage of attendance shall be granted only on genuine and valid reasons on representation by the candidate with supporting evidence

7.4 Students whose shortage of attendance is not condoned in any semester are not eligible to take their end examination of that class.

7.5 A stipulated fee shall be payable towards condonation of shortage of attendance.

7.6 A student will not be promoted to the next semester unless he satisfies the attendance requirements of the present semester. They may seek re-admission into that semester when offered next.

7.7 If any candidate fulfils the attendance requirement in the present semester, he shall not be eligible for readmission into the same class.

7.8 If the learning is carried out in blended mode (both offline & online), then the total attendance of the student shall be calculated considering the offline and online attendance of the student.

8. Evaluation – Distribution and Weightage of Marks:

The performance of a student in each semester shall be evaluated subject - wise (irrespective of credits assigned), for a maximum of 100 marks for theory and 100 marks for practical, based on Internal Evaluation and End Semester Examination.

8.1 There shall be five units in each of the theory subjects. For the theory subjects 60 marks will be for the End Examination and 40 marks will be for Internal Evaluation.

8.2 Two Internal Examinations shall be conducted for 30 marks each, one in the middle of the Semester and the other immediately after the completion of instruction period. The other 10 marks is awarded for continuous assessment in the form of

assignments, quizzes, open book examination, presentation, etc. First mid examination shall be conducted for I & II units of the syllabus and second mid examination for III, IV & V units. Each mid exam shall be conducted for a total duration of 120 minutes with 3 questions (without choice) and each question carries 10 marks. Final Internal marks for a total of 40 marks shall be arrived at by considering the marks secured by the student in both the internal examinations with 80% weightage to the better internal exam and 20% to the other.

8.3 The following pattern shall be followed in the End Examination:

i. Five questions shall be set from each of the five units with either/or type for 12 marks each.
ii. All the questions have to be answered compulsorily.
iii. Each question may consist of one, two or more bits.

8.4 For practical subjects, 60 marks shall be for the End Semester Examinations and 40 marks will be for internal evaluation based on the day-to-day performance.
The internal evaluation based on the day-to-day work-10 marks, record- 10 marks and the remaining 20 marks to be awarded by conducting an internal laboratory test.
The end examination shall be conducted by the examiners, with a breakup mark of Procedure-10, Experimentation-25, Results-10, Viva- voce-15.

8.5 There shall be Mandatory **Audit courses** in I & II semesters for zero credits. There is no external examination for audit courses. However, attendance shall be considered while calculating aggregate attendance and student shall be declared to have passed the mandatory course only when he/she secures 50% or more in the internal examinations. In case, the student fails, a re- examination shall be conducted for failed candidates for 40 marks for every six months/semester satisfying the conditions mentioned in item 1 & 2 of the regulations.

8.6 A candidate shall be deemed to have secured the minimum academic requirement in a subject if he secures a minimum of 40% of marks in the End Examination and a minimum aggregate of 50% of the total marks in the End Semester Examination and Internal Evaluation taken together.

8.7 In case the candidate does not secure the minimum academic requirement in any of the subjects he/she has to reappear for the Semester Examination either supplementary or regular in that subject or repeat the course when next offered or do any other specified subject as may be required.

8.8 The laboratory records and mid semester test papers shall be preserved for a minimum of 3 years in the respective institutions as per the University norms and shall be produced to the Committees of the University as and when the same are asked for.

9. Credit Transfer Policy

As per University Grants Commission (Credit Framework for Online Learning Courses through SWAYAM) Regulation, 2016, the University shall allow up to a maximum of 40% of the Professional and Open Electives in a semester through SWAYAM/SWAYAM Plus.

9.1 The University shall offer credit mobility for MOOCs and give the equivalent credit weightage to the students for the credits earned through online learning courses through SWAYAM platform.

9.2 The online learning courses available on the SWAYAM platform will be considered for credit transfer. SWAYAM course credits are as specified in the platform

9.3 Student registration for the MOOCs shall be only through the institution, it is mandatory for the student to share necessary information with the institution

9.4 The institution shall select the courses to be permitted for credit transfer through SWAYAM. However, while selecting courses in the online platform institution would essentially avoid the courses offered through the curriculum in the offline mode.

9.5 The institution shall notify at the beginning of semester the list of the online learning courses eligible for credit transfer in the forthcoming Semester.

9.6 Students may register for an 8-week (2 credits) or 12-week (3 credits) SWAYAM / SWAYAM plus course with the approval of the Head of the Department (HoD).

9.7 Examination fees, if applicable, shall be borne by the student. Pass marks and grading will be as per the GPCET academic regulations.

9.8 A student must get minimum 40% marks for assignments and quizzes on the SWAYAM/ SWAYAM plus platform to be eligible for the end-semester examination. The students who are unable to get minimum internal marks in SWAYAM/ SWAYAM plus platform, they have to re-register for the course in subsequent semester through SWAYAM/ SWAYAM plus platform.

9.9 The end-semester exam may be conducted by the National Testing Agency (NTA), the National Programme on Technology Enhanced Learning (NPTEL) or the University during the regular end-term exams. Evaluation shall comprise 60% weightage for the end-semester examination and 40% for assignments and quizzes conducted by the SWAYAM/ SWAYAM plus course coordinator. The student has to get 50% marks for internal and external with minimum of 40% marks in the external examination to declare them as pass.

9.10 The institution shall also ensure that the student has to complete the course and produce the course completion certificate as per the academic schedule given for the regular courses in that semester. However, the credits will be transferred to the students who got minimum 50% marks with 40% marks in the external examination

9.11 The institution shall designate a faculty member as a Mentor for each course to guide the students from registration till completion of the credit course.

9.12 The university shall ensure no overlap of SWAYAM MOOC exams with that of the university examination schedule. In case of delay in SWAYAM results, the university will re-issue the marks sheet for such students.

9.13 Student pursuing courses under MOOCs shall acquire the required credits only after successful completion of the course and submitting a certificate issued by the competent authority along with the minimum 50% of marks and grades.

9.14 The institution shall submit the following to the examination section of the university:

a) List of students who have passed MOOC courses in the current semester along with the certificates of completion.

b) Undertaking form filled by the students for credit transfer.

9.15 The university shall resolve any issues that may arise in the implementation of this policy from time to time and shall review its credit transfer policy in the light of periodic changes brought by UGC, SWAYAM, NPTEL and state government.

Note: Students shall also be permitted to register for MOOCs offered through online platforms other than SWAYAM NPTEL. In such cases, credit transfer shall be permitted only after seeking approval of the University at least three months prior to the commencement of the semester.

10. Re-registration for Improvement of Internal Evaluation Marks:

A candidate shall be given one chance to re-register for each subject provided the internal marks secured by a candidate are less than 50% and has failed in the end examination

10.1 The candidate should have completed the course work and obtained examinations results for **I, II and III** semesters.

10.2 The candidate should have passed all the subjects for which the Internal Evaluation marks secured are more than 50%.

10.3 Out of the subjects the candidate has failed in the examination due to Internal Evaluation marks secured being less than 50%, the candidate shall be given one chance for each Theory subject and for a maximum of **three** Theory subjects for Improvement of Internal evaluation marks.

10.4 The candidate has to re-register for the chosen subjects and fulfill the academic requirements.

10.5 For reregistration the candidates have to apply to the University through the college by paying the requisite fees and get approval from the University before the start of the semester in which re-registration is required

10.6 In the event of availing the Improvement of Internal evaluation marks, the internal evaluation marks as well as the End Examinations marks secured in the previous attempt(s) for the reregistered subjects stand cancelled.

11. Evaluation of Project/Dissertation Work:

The Project work shall be initiated at the beginning of the III Semester and the duration of the Project is of two semesters. Evaluation of Project work is for 300 marks with 200 marks for internal evaluation and 100 marks for external evaluation. Progress of the project work is monitored through three reviews:

- Project review – I at the beginning of the III semester for zero marks
- Project review – II at the end of the third semester for 100 marks
- Project review – III before submission of the thesis i.e., end of the IV semesters for 100 marks

External evaluation of final Project work viva voce in IV semester shall be for 100 marks.

A Project Review Committee (PRC) shall be constituted with the Head of the Department as Chairperson, Project Supervisor and one faculty member of the department offering the M.Tech. programme.

11.1 A candidate is permitted to register for the Project Work in III Semester after satisfying the attendance requirement in all the subjects, both theory and laboratory (in I & II semesters).

11.2 A candidate is permitted to submit Project dissertation with the approval of PRC. The candidate has to pass all the theory, practical and other courses before submission of the Thesis.

11.3 Project work shall be carried out under the supervision of teacher in the parent department concerned.

11.4 A candidate shall be permitted to work on the project in an industry/research organization on the recommendation of the Head of the Department. In such cases, one of the teachers from the department concerned would be the internal guide and an expert from the industry/ research organization concerned shall act as co-

supervisor/ external guide. It is mandatory for the candidate to make full disclosure of all data/results on which they wish to base their dissertation. They cannot claim confidentiality simply because it would come into conflict with the Industry's or R&D laboratory's own interests. A certificate from the external supervisor is to be included in the dissertation.

11.5 Continuous assessment of Project Work - I and Project Work – II in III & IV semesters respectively will be monitored by the PRC.

11.6 The candidate shall submit status report by giving seminars in three different phases (two in III semester and one in IV semester) during the project work period. These seminar reports must be approved by the PRC before submission of the Project Thesis.

11.7 After registration, a candidate must present in Project Review - I, in consultation with his Project Supervisor, the title, objective and plan of action of his Project work to the PRC for approval within four weeks from the commencement of III Semester. Only after obtaining the approval of the PRC can the student initiate the project work.

11.8 The Project Review - II in III semester carries internal marks of 100. Evaluation should be done by the PRC for 50 marks and the Supervisor will evaluate the work for the other 50 marks. The Supervisor and PRC will examine the Problem Definition, Objectives, Scope of Work, Literature Survey in the same domain and progress of the Project Work.

11.9 A candidate has to secure a minimum of 50% of marks to be declared successful in Project Review - II. Only after successful completion of Project Review – II, candidate shall be permitted for Project Work Review – III in IV Semester. The unsuccessful students in Project Review - II shall reappear after three months.

11.10 The Project Review - III in IV semester carries 100 internal marks. Evaluation should be done by the PRC for 50 marks and the Supervisor will evaluate it for the other 50 marks. The PRC will examine the overall progress of the Project Work and decide whether or not eligible for final submission. A candidate has to secure a minimum of 50% of marks to be declared successful in Project Review - III. If student fails to obtain the required minimum marks, he/she has to reappear for Project Review - III after a month.

11.11 For the approval of PRC the candidate shall submit the draft copy of dissertation to the Head of the Department and make an oral presentation before the PRC.

11.12 After approval from the PRC, the student is permitted to submit a report. The dissertation report will be accepted only when the plagiarism is within 30% checked through Turnitin software (repository mode). The plagiarism report shall be submitted along with the dissertation report.

11.13 Research paper related to the Project Work shall be published in an SCI/ESCI/Scopus/UGC Care listed journal, or in conference proceedings with ISBN number organized by professional societies such as IEEE, IEI, etc.

11.14 After successful plagiarism check and publication of research paper, three copies of the dissertation certified by the supervisor and HOD shall be submitted to the College.

11.15 The dissertation shall be adjudicated by an external examiner selected by the University. For this, the Principal of the College shall submit a panel of three examiners as submitted by the supervisor concerned and department head for each

student. However, the dissertation will be adjudicated by one examiner nominated by the University.

11.16 If the report of the examiner is not satisfactory, the candidate shall revise and resubmit the dissertation, in the time frame as decided by the PRC. If report of the examiner is unfavorable again, the thesis shall be summarily rejected. The candidate has to reregister for the project and complete the project within the stipulated time after taking the approval from the University

11.17 If the report of the examiner is satisfactory, the Head of the Department shall coordinate and make arrangements for the conduct of Project Viva voce exam.

11.18 The Project Viva voce examinations shall be conducted by a board consisting of the Supervisor, Head of the Department and the external examiner who has adjudicated the dissertation. For Dissertation Evaluation (Viva voce) in IV Sem. there are external marks of 100 and it is evaluated by external examiner. The candidate has to secure a minimum of 50% marks in Viva voce exam.

11.19 If he fails to fulfill the requirements as specified, he will reappear for the Project Viva voce examination only after three months. In the reappeared examination also, if he fails to fulfill the requirements, he will not be eligible for the award of the degree.

12 Industry Internships:

Industry internship either onsite or virtual with a minimum of 06-08 weeks" duration, done at the end of Ist year second semester. It shall be completed in collaboration with local industries, Govt. Organizations, construction agencies, Power projects, software MNCs or any industries in the areas of concerned specialization of the PG program. The student shall register for the internship as per course structure after commencement of academic year.

Evaluation of the summer internships shall be through the departmental committee. A student will be required to submit a summer internship report to the concerned department and appear for an oral presentation before the departmental committee comprising of Head of the Department, Mentor/Supervisor of the internship and a senior faculty member of the department. A certificate of successful completion from industry shall be included in the report. Internship will be evaluated for 100 marks with 50 marks for the report evaluated by the mentor and 50 marks for oral presentation. A student should secure minimum 50% of marks for successful completion. In case, if a student fails, he/she shall reappear as and when semester supplementary examinations are conducted by the University.

13 Comprehensive Viva

A Comprehensive Viva shall be conducted after the II Semester examinations for 100 marks by a committee consisting of the Head of the Department, one senior faculty member of the same specialization, and an external subject expert appointed by the University. The student must secure a minimum of 50% marks to be declared as passed

14 Credits for Co-curricular Activities

The credits assigned for co-curricular activities shall be given by the principals of the colleges and the same shall be submitted to the University. A Student should earn 01 credits under the head of co-curricular activities, viz., attending Conference, Scientific Presentations and Other Scholarly Activities.

Following are the guidelines for awarding Credits for Co-curricular Activities

Name of the Activity	Maximum Credits / Activity
Participation in National Level Seminar/ Conference / Workshop /Training programs (related to the specialization of the student)	0.5

Participation in International Level Seminar / Conference / workshop/Training programs held outside India (related to the specialization of the student)	1
Academic Award/Research Award from State Level/National Agencies	0.5
Academic Award/Research Award from International Agencies	1
Research / Review Publication in National Journals (Indexed in Scopus / Web of Science)	0.5
Research / Review Publication in International Journals with Editorial board outside India (Indexed in Scopus / Web of Science)	1

Note:

i) Credit shall be awarded only for the first author. Certificate of attendance and participation in a Conference/Seminar is to be submitted for awarding credit. A minimum participation of five days is required to earn the necessary credits. Alternatively, the student may attend five different one day programs to meet this requirement.

ii) Certificate of attendance and participation in workshops and training programs (Internal or External) is to be submitted for awarding credit. The total duration should be at least one week.

iii) Participation in any activity shall be permitted only once for acquiring required credits under cocurricular activities

15 Grading:

As a measure of the student's performance, a 10-point Absolute Grading System using the following Letter Grades and corresponding percentage of marks shall be followed:

After each course is evaluated for 100 marks, the marks obtained in each course will be converted to a corresponding letter grade as given below, depending on the range in which the marks obtained by the student fall.

Structure of Grading of Academic Performance

Letter Grade	Marks Range	Grade Point
S	91-100	10
A	81-90	9
B	70-80	8
C	60-69	7
D	55-59	6
E	50-54	5
F	<50	0
Absent	Ab (Absent)	0

i) A student obtaining Grade 'F' or Grade 'Ab' in a subject shall be considered failed and will be required to reappear for that subject when it is offered the next supplementary examination.

ii) For noncredit audit courses, "Satisfactory" or "Unsatisfactory" shall be indicated instead of the letter grade and this will not be counted for the computation of SGPA/CGPA/Percentage.

Computation of Semester Grade Point Average (SGPA) and Cumulative Grade Point Average (CGPA):

The Semester Grade Point Average (SGPA) is the ratio of sum of the product of the number of credits with the grade points scored by a student in all the courses taken by a student and the sum of the number of credits of all the courses undergone by a student, i.e.,

$$SGPA = \Sigma (C_i \times G_i)/\Sigma C_i$$

where, C_i is the number of credits of the i^{th} subject and G_i is the grade point scored by the student in the i^{th} course.

i) The Cumulative Grade Point Average (CGPA) will be computed in the same manner considering all the courses undergone by a student over all the semesters of a program, i.e.,

$$CGPA = \Sigma (C_i \times S_i) / \Sigma C_i$$

where "S_i" is the SGPA of the i^{th} semester and C_i is the total number of credits up to that semester.

ii) Both SGPA and CGPA shall be rounded off to 2 decimal points and reported in the transcripts.

iii) While computing the SGPA the subjects in which the student is awarded Zero grade points will also be included.

Grade Point: It is a numerical weight allotted to each letter grade on a 10-point scale. Letter Grade: It is an index of the performance of students in a said course. Grades are denoted by letters S, A, B, C, D and F.

16 Award of Class:

After a student has satisfied the requirements prescribed for the completion of the program and is eligible for the award of M. Tech. Degree, he shall be placed in one of the following three classes:

Class Awarded	Percentage of Marks to be secured
First Class with Distinction	>=8
First Class	>= 7 and < 8
Pass Class	>=5 and < 7

17 Exit Policy:

The student shall be permitted to exit with a PG Diploma based on his/her request to the university through the respective institution at the end of first year subject to passing all the courses in first year.

The University shall resolve any issues that may arise in the implementation of this policy from time to time and shall review the policy in the light of periodic changes brought by UGC, AICTE and State government.

18 Withholding of Results:

If the candidate has any case of in-discipline pending against him/her, the result of the candidate shall be withheld, and he/she will not be allowed/promoted into the next higher semester. The issue of degree is liable to be withheld in such cases.

19 Transitory Regulations

Discontinued, detained, or failed candidates are eligible for readmission as and when the semester is offered after fulfillment of academic regulations. Candidates who have been detained for want of attendance or not fulfilled academic requirements or who have failed after having undergone the course in earlier regulations or have discontinued and wish to continue the course are eligible for admission into the unfinished semester from the date of commencement of class work with the same or equivalent subjects as and when subjects are offered, subject to Section 2 and they will follow the academic regulations into which they are readmitted.

20 General:

20.1 The academic regulations should be read as a whole for purpose of any interpretation.

20.2 Disciplinary action for Malpractice/improper conduct in examinations is appended.

20.3 Where the words “he”, “him”, “his”, occur in the regulations, they include “she”, “her”, “hers”.

20.4 In the case of any doubt or ambiguity in the interpretation of the above rules, the decision of the Vice-Chancellor is final.

20.5 The University may change or amend the academic regulations or syllabi at any time and the changes or amendments shall be made applicable to all the students on rolls with effect from the dates notified by the University.

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RULES FOR

DISCIPLINARY ACTION FOR MALPRACTICES / IMPROPER CONDUCT IN EXAMINATIONS

	Nature of Malpractices/Improper conduct	**Punishment**
	If the candidate:	
1.(a)	Possesses or keeps accessible in examination hall, any paper, note book, programmable calculators, Cell phones, pager, palm computers or any other form of material concerned with or related to the subject of the examination (theory or practical) in which he is appearing but has not made use of (material shall include any marks on the body of the candidate which can be used as an aid in the subject of the examination)	Expulsion from the examination hall and cancellation of the performance in that subject only.
(b)	Gives assistance or guidance or receives it from any other candidate orally or by any other body language methods or communicates through cell phones with any candidate or persons in or outside the exam hall in respect of any matter.	Expulsion from the examination hall and cancellation of the performance in that subject only of all the candidates involved. In case of an outsider, he will be handed over to the police and a case is registered against him.
2.	Has copied in the examination hall from any paper, book, programmable calculators, palm computers or any other form of material relevant to the subject of the examination (theory or practical) in which the candidate is appearing.	Expulsion from the examination hall and cancellation of the performance in that subject and all other subjects the candidate has already appeared including practical examinations and project work and shall not be permitted to appear for the remaining examinations of the subjects of that semester/year. The Hall Ticket of the candidate is to be cancelled and sent to the University.
3.	Impersonates any other candidate in connection with the examination.	The candidate who has impersonated shall be expelled from examination hall. The candidate is also debarred for four consecutive semesters from class work and all University examinations. The continuation of the course by the candidate is subject to the academic regulations in

		connection with forfeiture of seat. The performance of the original candidate, who has been impersonated, shall be cancelled in all the subjects of the examination (including practical's and project work) already appeared and shall not be allowed to appear for examinations of the remaining subjects of that semester/year. The candidate is also debarred for four consecutive semesters from class work and all University examinations if his involvement is established. Otherwise, the candidate is debarred for two consecutive semesters from class work and all University examinations. The continuation of the course by the candidate is subject to the academic regulations in connection with forfeiture of seat. If the imposter is an outsider, he will be handed over to the police and a case is registered against him.
4.	Smuggles in the Answer book or additional sheet or takes out or arranges to send out the question paper during the examination or answer book or additional sheet, during or after the examination.	Expulsion from the examination hall and cancellation of performance in that subject and all the other subjects the candidate has already appeared including practical examinations and project work and shall not be permitted for the remaining examinations of the subjects of that semester/year. The candidate is also debarred for two consecutive semesters from class work and all University examinations. The continuation of the course by the candidate is subject to the academic regulations in connection with forfeiture of seat.
5.	Uses objectionable, abusive or offensive language in the answer paper or in letters to the examiners or writes to the examiner requesting him to award pass marks.	Cancellation of the performance in that subject only.
6.	Refuses to obey the orders of the Chief Superintendent /Assistant - Superintendent /any officer on duty or misbehaves or creates disturbance of any kind in and around the examination hall or organizes a walk out or instigates others to walk out, or threatens the officer-in charge or any person on duty in or outside the examination hall of any injury to his person or to any of his relations whether by words, either spoken or written or by signs or by visible representation, assaults the officer-in-charge, or any person on duty in or outside the examination hall or any of his relations, or indulges in any other act of misconduct or mischief which result in damage to or destruction of property in the examination hall or any part of the College campus or engages in any other act which in the opinion of the officer on duty amounts to use of unfair means or misconduct	In case of students of the college, they shall be expelled from examination halls and cancellation of their performance in that subject and all other subjects the candidate(s) has (have) already appeared and shall not be permitted to appear for the remaining examinations of the subjects of that semester/year. If the candidate physically assaults the invigilator/ officer-in-charge of the Examinations, then the candidate is also debarred and forfeits his/her seat. In case of outsiders, they will be handed over to the police and a police case is registered against them.

	or has the tendency to disrupt the orderly conduct of the examination.	
7.	Leaves the exam hall taking away answer script or intentionally tears of the script or any part thereof inside or outside the examination hall.	Expulsion from the examination hall and cancellation of performance in that subject and all the other subjects the candidate has already appeared including practical examinations and project work and shall not be permitted for the remaining examinations of the subjects of that semester/year. The candidate is also debarred for two consecutive semesters from class work and all University examinations. The continuation of the course by the candidate is subject to the academic regulations in connection with forfeiture of seat.
8.	Possess any lethal weapon or firearm in the examination hall.	Expulsion from the examination hall and cancellation of the performance in that subject and all other subjects the candidate has already appeared including practical examinations and project work and shall not be permitted for the remaining examinations of the subjects of that semester/year. The candidate is also debarred and forfeits the seat.
9.	If student of the college, who is not a candidate for the particular examination or any person not connected with the college indulges in any malpractice or improper conduct mentioned in clause 6 to 8.	Student of the colleges expulsion from the examination hall and cancellation of the performance in that subject and all other subjects the candidate has already appeared including practical examinations and project work and shall not be permitted for the remaining examinations of the subjects of that semester/year. The candidate is also debarred and forfeits the seat. Person(s) who do not belong to the College will be handed over to police and, a police case will be registered against them.
10.	Comes in a drunken condition to the examination hall.	Expulsion from the examination hall and cancellation of the performance in that subject and all other subjects the candidate has already appeared including practical examinations and project work and shall not be permitted for the remaining examinations of the subjects of that semester/year.
11.	Copying detected on the basis of internal evidence, such as, during valuation or during special scrutiny.	Cancellation of the performance in that subject only or in that subject and all other subjects the candidate has appeared including practical examinations and project work of that semester/year examinations, depending on the recommendation of the committee.
12.	If any malpractice is detected which is not covered in the above clauses 1 to 11 shall be reported to the University for further action to award suitable punishment.	

1. Malpractices identified by squad or special invigilators
2. Punishments to the candidates as per the above guidelines.
3. Punishment for institutions: (if the squad reports that the college is also involved in encouraging malpractices)
4. A show cause notice shall be issued to the college.
5. Impose a suitable fine on the college.
6. Shifting the examination center from the college to another college for a specific period of not less than one year.

Note:

Whenever the performance of a student is cancelled in any subject/subjects due to Malpractice, he has to register for End Examinations in that subject/subjects consequently and has to fulfill all the norms required for the award of Degree.

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G. Pullaiah College of Engineering and Technology

(Autonomous)

(Approved by AICTE | NAAC Accreditation with 'A' Grade | Accredited by NBA (ECE & EEE) | Affiliated to JNTUA)

Nandikotkur Road, Venkayapalli (V), Kurnool – 518452, Andhra Pradesh

M.TECH IN DIGITAL ELECTRONICS & COMMUNICATION SYSTEMS

COURSE STRUCTURE & SYLLABI

SEMESTER – I

S.No.	Course codes	Course Name	Category	Hours per week			Credits	Scheme of Examination		
				L	T	P	C	Interna	Externa	Total
1.	C43801	Advanced Digital System Design	PC	3	0	0	3	40	60	100
2.	C43802	Wireless Communication and	PC	3	0	0	3	40	60	100
3.	C43803a C43803b C43803c	**Program Elective – I** Design for Testability VLSI Technology and Design SoC Architecture	PE	3	0	0	3	40	60	100
4.	C43804a C43804b C43804c	**Program Elective – II** Software Defined Radio Optical Communication and Networks	PE	3	0	0	3	40	60	100
5.	C43805	Advanced Digital System Design Lab	PC	0	0	4	2	40	60	100
6.	C43806	Wireless Communication and Networks Lab	PC	0	0	4	2	40	60	100
7.	C43807	Research Methodology and IPR	MC	2	0	0	2	40	60	100
8.	C43808	RTL Synthesis, Simulation and Verification	SE	0	1	2	2	40	60	100
9.	C43809a C43809b C43809c	**Audit Course – I** English for Research Paper Writing Disaster Management Essence of Indian Traditional	AC	2	0	0	0	40*	-	40*
						Total	20	320	480	800

*There is no external examination for audit course. Student shall be declared to have passed the mandatory course only when he/she secures 50% or more in the internal examinations.

SEMESTER – II

S.No.	Course codes	Course Name	Category	Hours per week			Credits	Scheme of Examination		
				L	T	P		Internal	External	Total
1.	C43810	Network Security and Cryptography	PC	3	0	0	3	40	60	100
2.	C43811	Advanced Communications and	PC	3	0	0	3	40	60	100
3.	C43812a C43812b C43812c	**Program Elective – III** Embedded Real Time Operating Systems Communication Buses and Interfaces	PE	3	0	0	3	40	60	100
4.	C43813a C43813b C43813c	**Program Elective – IV** Cognitive Radio Image and Video Processing Ad hoc and Wireless Sensor Networks	PE	3	0	0	3	40	60	100
5.	C43814	Network Security and Cryptography	PC	0	0	4	2	40	60	100
6.	C43815	Advanced Communications and Networks Lab	PC	0	0	4	2	40	60	100
7.	C43816	Quantum Technologies and	MC	2	0	0	2	40	60	100
8.	C43817	Comprehensive Viva Voce	PC	0	0	0	2	100	-	100
9.	C43818a C43818b C43818c	**Audit Course – II** Pedagogy Studies Personality Development Through Life Enlightenment Skills Yoga For Stress Management	AC	2	0	0	0	40*	-	-
						Total	20	380	420	800

*There is no external examination for audit course. Student shall be declared to have passed the mandatory course only when he/she secures 50% or more in the internal examinations.

SEMESTER – III

S.No.	Course codes	Course Name	Category	Hours per week			Credits	Scheme of Examination Maximum Marks		
				L	T	P		Internal	External	Total
1.	C43819a C43819b C43819c	**Program Elective – V** Voice and Data Networks Industrial Internet of Things Artificial Intelligence and Machine Learning	PE	3	0	0	3	40	60	100
2.		**Open Elective –I**	OE	3	0	0	3	40	60	100
3.	C43820	Dissertation Phase – I	PR	0	0	20	10	100	-	100
4.	C43821	Industry Internship		0	0	0	2	100	-	100
5.	C43822	Co-curricular Activities		0	0	0	1	Grade		
Total							**19**	**280**	**120**	**400**

Open Elective – I

Course code	Title of the Course	L-T-P	Credits	Offered by
C42051	Green Buildings	3-0-0	3	CE
C42052	Road Safety Engineering	3-0-0	3	CE
C45851	Advanced Data Structures & Algorithms	3-0-0	3	CSE
C45852	Cloud Computing	3-0-0	3	CSE
C45853	AI Tools	3-0-0	3	CSE
C43851	IoT and its Applications	3-0-0	3	ECE
C40751	Photovoltaic Systems	3-0-0	3	EEE
C41551	Integrated Product Design and Development	3-0-0	3	ME
C41051	Advanced Numerical Methods and Computational Mathematics	3-0-0	3	H&S
C41052	Mathematics for Machine Learning and Data Science	3-0-0	3	H&S
C41053	Statistical Learning Theory and Mathematical Foundations of AI	3-0-0	3	H&S
C41054	Chemistry Of Nanomaterials And Applications In Engineering	3-0-0	3	H&S
C41055	Photonics For Engineers	3-0-0	3	H&S

SEMESTER - IV

S.No.	Course codes	Course Name	Category	Hours per week			Credits	Scheme of Examination		
				L	T	P		Internal	External	Total
1.	C43823	Dissertation Phase – II	PR	0	0	32	16	100	100	200
Total							**16**	**100**	**100**	**200**

COURSE STRUCTURE

I - SEMESTER

PROGRAMME CURRICULUM STRUCTURE UNDER R25 REGULATIONS

M. TECH - DIGITAL ELECTRONICS & COMMUNICATION SYSTEMS

SEMESTER – I

S.No.	Course codes	Course Name	Category	Hours per week			Credits	Scheme of Examination		
				L	T	P	C	Internal	Externa	Total
1.	C43801	Advanced Digital System Design	PC	3	0	0	3	40	60	100
2.	C43802	Wireless Communication and	PC	3	0	0	3	40	60	100
3.	C43803a C43803b C43803c	**Program Elective – I** Design for Testability VLSI Technology and Design SoC Architecture	PE	3	0	0	3	40	60	100
4.	C43804a C43804b C43804c	**Program Elective – II** Software Defined Radio Optical Communication and Networks	PE	3	0	0	3	40	60	100
5.	C43805	Advanced Digital System Design Lab	PC	0	0	4	2	40	60	100
6.	C43806	Wireless Communication and Networks Lab	PC	0	0	4	2	40	60	100
7.	C43807	Research Methodology and IPR	MC	2	0	0	2	40	60	100
8.	C43808	RTL Synthesis, Simulation and Verification	SE	0	1	2	2	40	60	100
9.	C43809a C43809b C43809c	**Audit Course – I** English for Research Paper Writing Disaster Management Essence of Indian Traditional	AC	2	0	0	0	40*	-	40*
						Total	20	320	480	800

*There is no external examination for audit course. Student shall be declared to have passed the mandatory course only when he/she secures 50% or more in the internal examinations.

Course Code	ADVANCED DIGITAL SYSTEM DESIGN	L	T	P	C
C43801		3	0	0	3
Semester		I			

Course Objectives:

- To understand an overview of system design approach using programmable logic devices.
- To implement combinational logic circuit design.
- To implement sequential logic circuit design.
- To learn software tools used for design process with the help of case studies.

Course Outcomes (CO): Student will be able to

- Understand an overview of system design approach using programmable logic devices.
- Implement combinational logic circuit design.
- Implement sequential logic circuit design.
- Learn software tools used for design process with the help of case studies.

UNIT - I		Lecture Hrs:

Processor Arithmetic: Two's Complement Number System - Arithmetic Operations; Fixed point Number System; Floating Point Number system - IEEE 754 format, Basic binary codes.

UNIT - II		Lecture Hrs:

Combinational circuits: CMOS logic design, Static and dynamic analysis of Combinational circuits, timing hazards. Functional blocks: Decoders, Encoders, Three-state devices, Multiplexers, Parity circuits, Comparators, Adders, Subtractors, Carry look-ahead adder – timing analysis. Combinational multiplier structures.

UNIT - III		Lecture Hrs:

Sequential Logic - Latches and Flip-Flops, Sequential logic circuits - timing analysis (Set up and hold times), State machines - Mealy & Moore machines, Analysis, FSM design using D Flip-Flops, FSM optimization and partitioning; Synchronizers and metastability. FSM Design examples: Vending machine, Traffic light controller, Washing machine.

UNIT - IV		Lecture Hrs:

Subsystem Design using Functional Blocks (1) - Design (including Timing Analysis) of different logical blocks of varying complexities involving mostly combinational circuits: ALU, 4-bit combinational multiplier, Barrel shifter, Simple fixed point to floating point encoder, Dual Priority encoder, Cascading comparators

UNIT - V		Lecture Hrs:

Subsystem Design using Functional Blocks (2) - Design, (including Timing Analysis) of different logical blocks of different complexities involving mostly sequential circuits: Pattern (sequence) detector, Programmable Up-down counter, Round robin arbiter with 3 requesters, Process Controller, FIFO

Textbooks:

1. M. Morris Mano, Michael D. Ciletti, “Digital Design: With an Introduction to the Verilog HDL, VHDL, and System Verilog”, Pearson Education; 6th Edition, 2018
2. John F. Wakerly, “Digital Design”, Prentice Hall, 3rd Edition, 2002.

Reference Books:

1. Digital Circuits and Logic Design-Samuel C.LEE, PHI, 2008.
2. Digital System Design using programmable logic devices- Parag K. Lala, BS publications.

Course Code	WIRELESS COMMUNICATIONS AND NETWORKS	L	T	P	C
C43802		3	0	0	3
Semester		I			

Course Objectives:

- To study the Channel planning for Wireless Systems
- To study the Mobile Radio Propagation
- To study the Equalization and Diversity
- To study the Wireless Networks

Course Outcomes (CO):

- Understand Cellular communication concepts
- Study the mobile radio propagation
- Study the wireless network different type of MAC protocols

UNIT - I | Lecture Hrs:

The Cellular Concept-System Design Fundamentals: Introduction, Frequency Reuse, Channel Assignment Strategies, Handoff Strategies- Prioritizing Handoffs, Practical Handoff Considerations, Interference and system capacity – Co channel Interference and system capacity, Channel planning for Wireless Systems, Adjacent Channel interference, Power Control for Reducing interference, Trunking and Grade of Service, Improving Coverage & Capacity in Cellular Systems- Cell Splitting, Sectoring.

UNIT - II | Lecture Hrs:

Mobile Radio Propagation: Large-Scale Path Loss: Introduction to Radio Wave Propagation, Free Space Propagation Model, Relating Power to Electric Field, The Three Basic Propagation Mechanisms, Reflection-Reflection from Dielectrics, Brewster Angle, Reflection from prefect conductors, Ground Reflection (Two-Ray) Model, Diffraction-Fresnel Zone Geometry, Knife-edge Diffraction Model, Multiple knife-edge Diffraction, Scattering, Outdoor Propagation Models-Longley-Ryce Model, Okumura Model, Hata Model, PCS Extension to Hata Model, Walfisch and Bertoni Model, Wideband PCS Microcell Model, Indoor Propagation Models-Partition losses (Same Floor), Partition losses between Floors, Log-distance path loss model, Ericsson Multiple Breakpoint Model, Attenuation Factor Model, Signal penetration into buildings, Ray Tracing and Site Specific Modeling.

UNIT - III | Lecture Hrs:

Mobile Radio Propagation: Small –Scale Fading and Multipath: Small Scale Multipath propagation Factors influencing small scale fading, Doppler shift, Impulse Response Model of a multipath channel Relationship between Bandwidth and Received power, Small-Scale Multipath Measurements-Direct RF Pulse System, Spread Spectrum Sliding Correlator Channel Sounding, Frequency Domain Channels Sounding, Parameters of Mobile Multipath Channels-Time Dispersion Parameters, Coherence Bandwidth, Doppler Spread and Coherence Time, Types of Small-Scale Fading-Fading effects Due to Multipath Time Delay Spread, Flat fading, Frequency selective fading, Fading effects Due to Doppler Spread-Fast fading, slow fading, Statistical Models for multipath Fading Channels Clarke's model for flat fading, spectral shape due to Doppler spread in Clarke's model, Simulation of Clarke and Gans Fading Model, Level crossing and fading statistics, Two-ray Rayleigh Fading Model.

UNIT - IV | Lecture Hrs:

Equalization and Diversity: Introduction, Fundamentals of Equalization, Training A Generic Adaptive Equalizer, Equalizers in a communication Receiver, Linear Equalizers, Non-linear Equalization-Decision Feedback Equalization (DFE), Maximum Likelihood Sequence Estimation (MLSE) Equalizer, Algorithms for adaptive equalization-Zero Forcing Algorithm, Least Mean Square Algorithm, Recursive least squares algorithm. Diversity Techniques-Derivation of selection Diversity improvement, Derivation of Maximal Ratio Combining improvement, Practical Space Diversity Consideration-Selection Diversity, Feedback or Scanning Diversity, Maximal Ratio Combining, Equal Gain Combining, Polarization Diversity, Frequency Diversity, Time Diversity, RAKE Receiver.

UNIT - V		Lecture Hrs:
Wireless Networks: Introduction to wireless Networks, Advantages and disadvantages of Wireless Local Area Networks, WLAN Topologies, WLAN Standard IEEE 802.11, IEEE 802.11 Medium Access Control, Comparison of IEEE 802.11 a, b, g and n standards, IEEE 802.16 and its enhancements, Wireless PANs, Hiper Lan, WLL.		
Textbooks:		
1. Wireless Communications, Principles, Practice – Theodore, S. Rappaport, 2nd Ed., 2002, PHI. 2. Wireless Communications-Andrea Goldsmith, 2005 Cambridge University Press. 3. Principles of Wireless Networks – Kaveh Pah Laven and P. Krishna Murthy, 2002, PE 4. Mobile Cellular Communication – Gottapu Sasibhushana Rao, Pearson Education, 2012.		
Reference Books:		
1. Wireless Digital Communications – Kamilo Feher, 1999, PHI. 2. Wireless Communication and Networking – William Stallings, 2003, PHI		

Course Code	DESIGN FOR TESTABILITY	L	T	P	C
C43803a	Program Elective – I	3	0	0	3
	Semester	I			

Course Objectives:

- To introduce the fundamental concepts, types, and philosophies of VLSI testing.
- To familiarize fault models and apply logic/fault simulation techniques for test evaluation.
- To study testability measures and design-for-test (DFT) techniques including scan design.
- To explore Built-In Self-Test (BIST) strategies and their application in digital systems.
- To learn the boundary scan architecture and standards used in board-level testing.

Course Outcomes (CO): Student will be able to

- Explain the role of testing in VLSI systems and differentiate between fault models and testing types.
- Apply simulation algorithms for design verification and fault analysis in digital circuits.
- Evaluate testability using measures like SCOAP and design scan-based test structures.
- Design and implement BIST strategies for logic and memory testing.
- Demonstrate understanding of boundary scan standards and describe systems using BSDL.

UNIT - I		Lecture Hrs:

Introduction to Testing: Testing Philosophy, Role of Testing, Digital and Analog VLSI Testing, VLSI Technology Trends affecting Testing, Types of Testing, Fault Modelling: Defects, Errors and Faults, Functional Versus Structural Testing, Levels of Fault Models, Single Stuck-at Fault.

UNIT - II		Lecture Hrs:

Logic and Fault Simulation: Simulation for Design Verification and Test Evaluation, Modelling Circuits for Simulation, Algorithms for True-value Simulation, Algorithms for Fault Simulation.

UNIT - III		Lecture Hrs:

Testability Measures: SCOAP Controllability and Observability, High Level Testability Measures, Digital DFT and Scan Design: Ad-Hoc DFT Methods, Scan Design, Partial-Scan Design, Variations of Scan.

UNIT - IV		Lecture Hrs:

Built-In Self-Test: The Economic Case for BIST, Random Logic BIST: Definitions, BIST Process, Pattern Generation, Response Compaction, Built-In Logic Block Observers, Test-Per-Clock, Test-Per- Scan BIST Systems, Circular Self-Test Path System, Memory BIST, Delay Fault BIST.

UNIT - V		Lecture Hrs:

Boundary Scan Standard: Motivation, System Configuration with Boundary Scan: TAP Controller and Port, Boundary Scan Test Instructions, Pin Constraints of the Standard, Boundary Scan Description Language: BDSL Description Components, Pin Descriptions.

Textbooks:

1. Essentials of Electronic Testing for Digital, Memory and Mixed Signal VLSI Circuits - M.L. Bushnell, V. D. Agrawal, Kluwer Academic Publishers.
2. VLSI Test Principles and Architectures: Design for Testability" – L.-T. Wang, C.-W. Wu, X. Wen

Reference Books:

1. Digital Systems and Testable Design - M. Abramovici, M. A. Breuer and A.D Friedman, Jaico Publishing House.
2. Digital Circuits Testing and Testability - P.K. Lala, Academic Press.

Course Code	VLSI TECHNOLOGY AND DESIGN	L	T	P	C
C43803b	Program Elective – I	3	0	0	3
	Semester	I			

Course Objectives:

- To familiarize with large scale integration technology.
- To expose fabrication methods, layout and design rules.
- To learn methods to improve Digital VLSI system's performance.
- To know about VLSI Design constraints.

Course Outcomes (CO):

- Familiarize with large scale integration technology.
- Expose fabrication methods, layout and design rules.
- Learn methods to improve Digital VLSI system's performance.
- Know about VLSI Design constraints.

UNIT - I		Lecture Hrs:

Review of Microelectronics and Introduction to MOS Technologies- MOS, CMOS, Bi CMOS Technology. Basic Electrical Properties of MOS, CMOS &Bi CMOS Circuits: Ids – Vds relationships, Threshold Voltage V_T, g_m, g_{ds} and ω_o, Pass Transistor, MOS, CMOS & Bi CMOS Inverters, Zpu/Zpd, MOS Transistor circuit model, Latch-up in CMOS circuits.

UNIT - II		Lecture Hrs:

Layout Design and Tools: Transistor structures, Wires and Vias, Scalable Design rules, Layout Design tools.
Logic Gates & Layouts: Static Complementary Gates, Switch Logic, Alternative Gate circuits, Low power gates, Resistive and Inductive interconnect delays.

UNIT - III		Lecture Hrs:

Combinational Logic Networks: Layouts, Simulation, Network delay, Interconnect design, Power optimization, Switch logic networks, Gate and Network testing.

UNIT - IV		Lecture Hrs:

Sequential Systems: Memory cells and Arrays, Clocking disciplines, Design, Power optimization, Design validation and testing.

UNIT – V		Lecture Hrs:

Floor Planning: Floor planning methods, Global Interconnect, Floor Plan Design, Off-chip connections.

Textbooks:

1. Neil Weste, David Harris, "CMOS VLSI Design: A Circuits and Systems Perspective", 4th Edition, Pearson, 2010
2. Essentials of VLSI Circuits and Systems, K. Eshraghian Eshraghian. D, A. Pucknell, 2005, PHI.
3. Modern VLSI Design – Wayne Wolf, 3rd Ed., 1997, Pearson Education.

Reference Books:

1. Introduction to VLSI Systems: A Logic, Circuit and System Perspective – Ming-BO Lin, CRC Press, 2011.
2. Principals of CMOS VLSI Design – N.H.E Weste, K. Eshraghian, 2nd Ed., Addison Wesley.

Course Code	SoC ARCHITECTURE	L	T	P	C
C43803c	Program Elective – I	3	0	0	3
	Semester	I			

Course Objectives:

- To understand the basics related to SoC architecture and different approaches related to SoC Design.
- To select an appropriate robust processor for SoC Design
- To select an appropriate memory for SoC Design.
- To realize real time case studies

Course Outcomes (CO): Student will be able to

- Understand the basics related to SoC architecture and different approaches related to SoC Design.
- Select an appropriated robust processor for SoC Design
- Select an appropriate memory for SoC Design.
- Realize real time case studies

UNIT - I		Lecture Hrs:

Introduction to the System Approach: System Architecture, Components of the system, Hardware & Software, Processor Architectures, Memory &Addressing. System level interconnection, An approach for SOC Design, System Architecture and Complexity.

UNIT - II		Lecture Hrs:

Processors: Introduction, Processor Selection for SOC, Basic concepts in Processor Architecture, Basic concepts in Processor Microarchitecture, Basic elements in Instruction handling. Buffers: minimizing Pipeline Delays, Branches, More Robust Processors, Vector Processors and Vector Instruction extensions, VLIW Processors, Superscalar Processors

UNIT - III		Lecture Hrs:

Memory Design for SOC: Overview: SOC external memory, SOC Internal Memory, Size, Scratchpads and Cache memory, Cache Organization, Cache data, Write Policies, Strategies for line replacement at miss time, Other Types of Cache, Split – I, and D – Caches, Multilevel Caches, SOC Memory System, Models of Simple Processor – memory interaction.

UNIT - IV		Lecture Hrs:

Interconnect, Customization and Configurability: Interconnect Architectures, Bus: Basic Architectures, SOC Standard Buses, Analytic Bus Models, Using the Bus model, Effects of Bus transactions and contention time.

SOC Customization: An overview, Customizing Instruction Processor, Reconfigurable Technologies, Mapping design onto Reconfigurable devices, Instance- Specific design, Customizable Soft Processor, Reconfiguration - overhead analysis and trade-off analysis on reconfigurable Parallelism.

UNIT - V		Lecture Hrs:

Application Studies / Case Studies: SOC Design approach; AES-algorithms, Design and evaluation; Image compression–JPEG compression.

Textbooks:

1. Computer System Design System-on-Chip - Michael J. Flynn and Wayne Luk, Wiely India Pvt. Ltd.
2. ARM System on Chip Architecture – Steve Furber, 2ndEdition, 2000, Addison Wesley Professional.

Reference Books:

1. Design of System on a Chip: Devices and Components – Ricardo Reis, 1st Ed., 2004, Springer
2.Co-Verification of Hardware and Software for ARM System on Chip Design (Embedded Technology) – Jason Andrews – Newnes, BK and CDROM.
3.System on Chip Verification – Methodologies and Techniques –Prakash Rashinkar, Peter Paterson and Leena Singh L, 2001, Kluwer Academic Publishers

Course Code	SOFTWARE DEFINED RADIO	L	T	P	C
C43804a	Program Elective – II	3	0	0	3
	Semester	I			

Course Objectives:

- Introduce the evolution of radio communication systems and the fundamental concepts, architectures, and design principles of Software Defined Radio (SDR).
- Understand the implementation challenges in RF front-end systems, including dynamic range, receiver topologies, and performance-affecting factors.
- Explore digital signal generation techniques, particularly direct digital synthesis (DDS), and analyze related spurious signal behaviors.
- Introduce multi rate signal processing methods such as sample rate conversion, polyphase filters, and timing recovery in digital receivers.
- Study analog-to-digital and digital-to-analog conversion techniques and methods for improving data converter performance in SDR systems.

Course Outcomes (CO):

Upon completion of the course students will be able to:

- Know the fundamentals of Software Radios, their evolution from traditional radios, and various levels including SCR, SDR, ISR, and USR.
- Analyse RF front-end architectures, dynamic range requirements, and the role of RF Components in system performance for Software Radio implementation.
- Explain and compare different signal generation techniques including direct digital synthesis, and analyse sources of spurious components and jitter effects.
- Apply multi-rate signal processing techniques such as sample rate conversion, polyphase Filtering, and digital filter banks in software radio systems.
- Evaluate the performance of A/D and D/A converters in practical systems, and describe Methods to improve conversion performance, including relevance to JTRS

UNIT - I	Lecture Hrs:

Introduction to Software radio concepts: Introduction, need, characteristics, benefits and design principles of Software Radios. Traditional radio implemented in hardware (first generations of 2G cell phones), Software controlled radio (SCR), Software defined radio (SDR), Ideal software radio (ISR), Ultimate software radio (USR)

UNIT - II	Lecture Hrs:

Radio frequency implementation issues: The purpose of RF Front-End, Dynamic range, RF Receiver Front-End Topologies, Enhanced Flexibility of the RF Chain with Software Radios, Importance of Components to Overall performance, Transmitter Architecture and their issues, Noise and Distortion in RF Chain.

UNIT - III	Lecture Hrs:

Digital generation of signals: Introduction, Comparison of Direct Digital Synthesis with Analog Signal Synthesis, Approaches to Direct Digital Synthesis, Analysis of Spurious Signals, Spurious components due to Periodic Jitter.

UNIT - IV	Lecture Hrs:

Multi rate Signal Processing: Introduction, Sample Rate Conversion Principles, Polyphase Filters, Digital Filter Banks, Timing Recovery in Digital receivers Using Multi rate Digital Filters.

UNIT - V	Lecture Hrs:

A/D & D/A Conversion: Introduction, Parameters of Ideal Data Converters, Parameters of Practical data Converters, Techniques to improve Data Converter performance, JTRS.

Textbooks:

1. Jeffery H. Reed, “Software Radio, (A modern approach to radio engineering)”, PHI PTR, 2002
2. John J. Rouphael, “RF and Digital Signal Processing for Software Defined Radio” Elsevier, Newness Publications.

Reference Books:
1. C. Richard Johnson, Jr., and William A. Sethares, Telecommunication Breakdown, Prentice Hall, ISBN 0-13-143047-5, 2004 2. Software Defined Radio: Theory and Practice by John M. Reyland (Artech House, 2023)

Course Code	OPTICAL COMMUNICATIONS AND NETWORKS	L	T	P	C
C43804b	Program Elective – II	3	0	0	3
	Semester	I			

Course Objectives:

- To understand the concept and structures of optical fibers.
- To study about the photo sources and detectors in digital and analog domains.
- To learn various network topologies and protocols
- To study about performance measurement and monitoring of optical communication systems.

Course Outcomes (CO):

- Understand the concept and structures of optical fibers.
- Study about the photo sources and detectors in digital and analog domains.
- Learn various network topologies and protocols
- Study about performance measurement and monitoring of optical communication systems.

UNIT - I		Lecture Hrs:

Optical Fibers: Structures, waveguiding and Fabrication: Nature of Light, Basic optical laws and definitions, Single mode fibers, Graded index fiber structure, Attenuation, Signal Dispersion in fibers.

Optical Sources- LEDs, Laser Diodes, Line Coding.

UNIT - II		Lecture Hrs:

Photo detectors: Photo detector Noise, Detector Response Time, Avalanche Multiplication Noise.

Optical Receiver Operation: Fundamental receiver operation, Digital receiver performance, Eye diagrams.

WDM Concepts and Components: Passive optical Couplers, Isolators and Circulators

UNIT - III		Lecture Hrs:

Digital Links: Point to point links, power penalties, error control, Coherent detection, Differential Quadrature Phase Shift Keying.

Analog Links: Carrier to noise ration, Multichannel Transmission Techniques, RF over Fiber, Radio over fiber links, Microwave Photonics.

UNIT - IV		Lecture Hrs:

Optical Networks: Network Concepts, Network Topologies, SONET/SDH, High speed light wave links, Optical add/ Drop Multiplexing, Optical Switching, WDM Network, Passive Optical Networks, IP Over DWDM, Optical Ethernet, Mitigation of Transmission Impairments

UNIT - V		Lecture Hrs:

Performance Measurement and Monitoring: Measurement standards, Basic Test Equipment, Optical power measurement, Optical fiber characterization, Eye diagram tests, optical time domain reflectometer, optical performance monitoring, optical fiber system performance measurements.

Textbooks:

1. Gerd Keiser, “Optical Fiber Communications”, 5th Edition, Mc Graw Hill.
2. Rajeev Ramaswamy and Kumar N Sivarajan, “Optical Networks: A Practical Perspective”, 2nd Ed., 2004, Elsevier Morgan Kaufmann Publishers (An imprint of Elsevier).

Reference Books:

1. John. M. Senior, “Optical Fiber Communications: Principles and Practice”, 2nd Ed, 2000, PE.
2. Harold Kolimbris, “Fiber Optic Communication”, 2nd Ed, 2004, PEI
3. Uyless Black, “Optical Networks: Third Generation Transport Systems”, 2nd Ed, 2009, PEI
4. Govind Agarwal, “Optical Fiber Communications”, 2nd Ed, 2004, TMH.
5. S. C. Gupta, “Optical Fiber Communications and its Applications”, 2004, PH

Course Code	5G COMMUNICATIONS	L	T	P	C
C43804c	Program Elective – II	3	0	0	3
	Semester	I			

Course Objectives:

- To understand 5G Technology advances and their benefits
- To learn the key RF, PHY, MAC and air interface changes required to support 5G
- To acquire knowledge on Device-to-device communication and millimeter wave communication
- To explore implementation options for 5G

Course Outcomes (CO):

- Understand 5G Technology advances and their benefits
- Learn the key RF, PHY, MAC and air interface changes required to support 5G
- Acquire knowledge on Device-to-device communication and millimeter wave communication
- Explore implementation options for 5G

UNIT - I		Lecture Hrs:

Overview of 5G Broadband Wireless Communications:
Evolution of mobile technologies 1G to 4G (LTE, LTEA, LTEA Pro), An Overview of 5G requirements, Regulations for 5G, Spectrum Analysis and Sharing for 5G.

UNIT - II		Lecture Hrs:

The 5G wireless Propagation Channels:
Channel modeling requirements, propagation scenarios and challenges in the 5G modeling, Channel Models for mm Wave MIMO Systems.

UNIT - III		Lecture Hrs:

Transmission and Design Techniques for 5G:
Basic requirements of transmission over 5G, Modulation Techniques – Orthogonal frequency division multiplexing (OFDM), generalized frequency division multiplexing (GFDM), filter bank multi-carriers (FBMC) and universal filtered multi-carrier (UFMC), Multiple Accesses Techniques – orthogonal frequency division multiple accesses (OFDMA), generalized frequency division multiple accesses (GFDMA), nonorthogonal multiple accesses (NOMA).

UNIT - IV		Lecture Hrs:

Device-to-Device (D2D) and Machine-to-Machine (M2M) type Communications
Extension of 4G D2D standardization to 5G, radio resource management for mobile broadband D2D, multi-hop and multi-operator D2D communications.

UNIT - V		Lecture Hrs:

Millimeter-wave Communications
Spectrum regulations, deployment scenarios, beamforming, physical layer techniques, interference and mobility management, Massive MIMO propagation channel models, Channel Estimation in Massive MIMO, Massive MIMO with Imperfect CSI, Multi-Cell Massive MIMO, Pilot Contamination, Spatial Modulation (SM).

Textbooks:

1. Martin Sauter “From GSM From GSM to LTE–Advanced Pro and 5G: An Introduction to Mobile Networks and Mobile Broadband”, Wiley-Blackwell.
2. Afif Osseiran, Jose. F. Monserrat, Patrick Marsch, “Fundamentals of 5G Mobile Networks”, Cambridge University Press.
3. Athanasios G. Kanatos, Konstantina S. Nikita, Panagiotis Mathiopoulos, “New Directions in Wireless Communication Systems from Mobile to 5G”, CRC Press.
4. Theodore S. Rappaport, Robert W. Heath, Robert C. Danials, James N. Murdock “Millimeter Wave Wireless Communications”, Prentice Hall Communications.

Reference Books:

1. Jonathan Rodriguez, “Fundamentals of 5G Mobile Networks”, John Wiley & Sons.
2. Amitabha Ghosh and Rapeepat Ratasuk “Essentials of LTE and LTE-A”, Cambridge University Pres

Course Code	ADVANCED DIGITAL SYSTEM DESIGN LAB	L	T	P	C
C43805		0	0	4	2
Semester		I			

Course Objectives:

- To familiarize the HDL simulator / synthesis tool
- To design and implement given combinational circuit on FPGA device
- To design and implement given sequential circuit on FPGA device

Course Outcomes (CO):

- Familiarize the HDL simulator / synthesis tool
- Design and implement given combinational circuit on FPGA device
- Design and implement given sequential circuit on FPGA device

List of Experiments:

Student has to design ANY TWELVE experiments of his/her user defined library components by using and standard HDL simulator / Synthesis tool for target FPGA device.

1. HDL code to realize all the logic gates
2. Design and Simulation of adder, Serial Binary Adder, Multi Precession Adder, Carry
3. Look Ahead Adder.
4. Design of 2-to-4 decoder
5. Design of 8-to-3 encoder (without and with parity)
6. Design of 8-to-1 multiplexer
7. Design of 4 bit binary to gray converter
8. Design of Multiplexer/ Demultiplexer, comparator
9. Design of Full adder using 3 modeling styles
10. Design of flip flops: SR, D, JK, T
11. Design of 4-bit binary, BCD counters (synchronous/ asynchronous reset) or any sequence counter
12. Design of a N- bit Register of Serial- in Serial –out, Serial in parallel out, Parallel in
13. Serial out and Parallel in Parallel Out.
14. Design of Sequence Detector (Finite State Machine- Mealy and Moore Machines).
15. Design of 4- Bit Multiplier, Divider.
16. Design of ALU to Perform – ADD, SUB, AND-OR, 1’s and 2’s Compliment, Multiplication, and Division.
18. Design of Finite State Machine.
19. Implementing the above designs on Xilinx/Altera/Cypress/equivalent based FPGA/CPLD kits.

Course Code	WIRELESS COMMUNICATIONS AND NETWORKS LAB	L	T	P	C
C43806		0	0	4	2
Semester		I			

Course Objectives:

- To understand concepts of GSM/CDMA technologies
- To implement signal processing algorithms for the given specifications
- To implement wireless communication algorithms for the given specifications

Course Outcomes (CO):

- Understand concepts of GSM/CDMA technologies
- Implement signal processing algorithms for the given specifications
- Implement wireless communication algorithms for the given specifications

List of Experiments:

Student has to design ANY TWELVE experiments.

1. Implementation of Convolutional Encoder and Decoder.
2. Simulation of the following Outdoor Path loss propagation models using MATLAB.
a. Free Space Propagation model
b. Okumura model
c. Hata model
3. Simulation of Adaptive Linear Equalizer using MAT LAB software.
4. Measurement of call blocking probability for GSM &CDMA networks using NetSim software.
5. Study of GSM handset for various signaling and fault insertion techniques (Major GSM handset sections: clock, SIM card, charging, LCD module, Keyboard, User interface).
6. Study of transmitter and receiver section in mobile handset and measure frequency
7. Baseband signal and GMSK modulating signal.
8. Simulation of RAKE Receiver for CDMA communication using MAT LAB software.
9. Simulate and test various types of PN codes, chip rate, spreading factor and processing gain on performance of DSSS in CDMA.
10. Simulate and test the 3G Network system features using GSM AT Commands. (Features of 3G Communication system: Transmission of voice, video calls, SMS, MMS, TCP/IP, HTTP, GPS)
11. Modelling of communication system using Simulink.
12. Simulate Least Mean Square Algorithm
13. Simulate Recursive least squares algorithm.
14. Observe Waveforms at various test points of a mobile phone using Mobile Phone Trainer

Course Code	RESEARCH METHODOLOGY AND INTELLECTUAL PROPERTY RIGHTS	L	T	P	C
C43807		2	0	0	2
	Semester	I			

Course Objectives:

1. To understand the research design process and data collection methods.
2. To develop skills in data analysis and reporting.
3. To familiarize students with intellectual property rights (IPR) and patents.
4. To apply research skills in real-world contexts.

Course Outcomes(CO):

CO1- Recall key concepts and terminology related to research design, data collection, and intellectual property rights.

CO2 - Explain the importance of research design and data analysis in research studies, and describe the concept of intellectual property rights.

CO3 - Design a research study, including data collection and analysis methods, and apply intellectual property rights principles to protect research findings.

CO4 - Analyze research studies to identify strengths and limitations, and evaluate the effectiveness of data collection and analysis methods.

CO5- Assess the impact of intellectual property rights on research and innovation, and evaluate the effectiveness of research designs and methods.

CO6 - Develop a comprehensive research plan, including a detailed research design, data collection and analysis methods, and a plan for protecting intellectual property.

***B.T-Blooms Taxonomy**

CO	B.T	PO1	PO2	PO3	P04	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO
CO1	L1	3	2	-	-	-	-	-	-	1	-	-	-
CO2	L2	3	3	-	2	2	-	1	-	2	–	-	1
CO3	L3	3	3	1	2	3	2	-	2	3	2	3	2
CO4	L4	2	3	1	2	2	2	-	-	3	2	2	3
CO5	L5	2	3	1	1	3	2	-	3	2	2	2	3
CO6	L6	3	3	2	3	3	3	-	3	3	3	3	3

UNIT - I FUNDAMENTALS OF RESEARCH METHODOLOGY

Overview of research process and design - Types of Research - Approaches to Research (Qualitative vs Quantitative) - Observation studies, Experiments and Surveys - Use of Secondary and exploratory data to answer the research question - Importance of Reasoning in Research and Research ethics - Documentation Styles (APA/IEEE etc.) - Plagiarism and its consequences

Learning Outcomes

- Recall key concepts of the research process, including different types and approaches to research, and the importance of ethics.
- Differentiate between qualitative and quantitative research approaches and the various uses of secondary data.
- Identify the core principles of research design and ethics, including plagiarism and documentation styles.
- Explain the significance of reasoning and ethical conduct in all stages of the research process.
- Apply knowledge of different documentation styles, such as APA and IEEE, to properly cite sources and avoid plagiarism.

UNIT - II	DATA COLLECTION AND SOURCES	

Importance of Data Collection - Types of Data - Data Collection Methods - Data Sources - primary, secondary and Big Data sources - Data Quality & Ethics - Tools and Technology for Data Collection

Learning Outcomes

- Identify different types of data and the various methods for collecting both primary and secondary data.
- Explain the importance of data quality and ethical considerations in data collection.
- Differentiate between primary, secondary, and Big Data sources.
- Describe the various tools and technologies used for effective data collection.
- Analyze the ethical implications of data collection and ensure data quality in a research study.

UNIT - III	DATA ANALYSIS AND REPORTING	

Overview of Multivariate analysis - Experimental research, cause-effect relationship, and development of hypotheses- Measurement systems analysis, error propagation, and validity of experiments - Guidelines for writing abstracts, introductions, methodologies, results, and discussions - Writing Research Papers & proposals

Learning Outcomes

- Apply knowledge of multivariate analysis and experimental research to develop hypotheses and analyze data.
- Explain the process of measurement systems analysis and error propagation in experimental design.
- Formulate clear and concise abstracts, introductions, and methodologies for research papers.
- Write effective results and discussion sections based on data analysis.
- Develop comprehensive research papers and proposals based on proper data analysis and reporting guidelines.

UNIT - IV	UNDERSTANDING INTELLECTUAL PROPERTY RIGHTS	

Intellectual Property – The concept of IPR, Evolution and development of concept of IPR, IPR development process, Trade secrets, utility Models, IPR & Bio diversity, Role of WIPO and WTO in IPR establishments, Right of Property, Common rules of IPR practices, Types and Features of IPR Agreement, Trademark, Functions of UNESCO in IPR maintenance.

Learning Outcomes

- Recall the fundamental concepts of Intellectual Property (IP) and its evolution.
- Describe the roles of organizations like **WIPO** and **WTO** in the establishment of IPR.
- Differentiate between various types of IPR, including trade secrets and trademarks.
- Explain the common rules and features of IPR agreements and the role of UNESCO.
- Analyze the relationship between IPR and biodiversity, and its broader impact.

UNIT - V	**PATENTS**	

Patents – objectives and benefits of patent, Concept, features of patent, Inventive step, Specification - Types of patent application, process E-filling, Examination of patent, Grant of patent, Revocation, Equitable Assignments, Licenses, Licensing of related patents, patent agents, Registration of patent agents

Learning Outcomes

- Explain the objectives, benefits, and key features of a patent, including the concept of an inventive step.
- Differentiate between the various types of patent applications and the e-filing process.
- Describe the process of patent examination, grant, and revocation.
- Identify the roles of patent agents and the process for their registration.
- Analyze the concepts of equitable assignments, licenses, and licensing of related patents.

Text books:

1. Stuart Melville and Wayne Goddard, *Research Methodology: An introduction for Science & Engineering students*, Juta and Company Ltd, 2004
2. Catherine J. Holland, *Intellectual property: Patents, Trademarks, Copyrights, Trade Secrets*, Entrepreneur Press, 2007.

1. Cooper Donald R, Schindler Pamela S and Sharma JK, "Business Research Methods", Tata McGraw Hill Education 11e (2012).
2. Ranjit Kumar, *Research Methodology: A Step-by-Step Guide for Beginners. .* David Hunt, Long Nguyen, Matthew Rodgers, "Patent searching: tools & techniques", Wiley, 2007.
3. Deborah E. Bouchoux , *Intellectual Property: The Law of Trademarks, Copyrights, Patents, and Trade Secrets, 6th Edition,* Cengage 2024.
4. Wayne C. Booth, Gregory G. Colomb, Joseph M. Williams, *The Craft of Research*, 5th Edition, University of Chicago Press, 2024
5. The Institute of Company Secretaries of India, Statutory body under an Act of parliament, "Professional Programme Intellectual Property Rights, Law and practice", September 2013.
6. Peter Elbow, *Writing With Power*, Oxford University Press, 1998.

Online Resources (Free & Authentic)

- **Coursera / edX** – Research Methodology and Data Analysis courses
- **Springer Link & ScienceDirect** – Latest journals on research design and statistics
- **Google Scholar** – Free access to research papers
- **NCBI Bookshelf** – Open-access research methodology resources
- **Khan Academy (Statistics & Probability)** – For fundamentals of hypothesis testing, regression, and ANOVA.

Course Code	RTL SYNTHESIS, SIMULATION AND VERIFICATION	L	T	P	C
C43808		0	1	2	2
Semester		I			

Course objectives: This course aims to

- The simulation of combinational and sequential circuits.
- FSM based designs.
- Implementation of DFT and FFTs.
- Verify layout of basic digital circuits.

Course outcomes: After completion of this course, students will be able to

1. Demonstrate the process steps required for simulation /synthesis.
2. Design and simulate various combinational and sequential circuits using HDL.
3. Develop an RTL code for various real time applications.
4. Synthesize / Simulate an RTL code for several digital designs
5. Build and verify various digital circuits.

Module 1 – Introduction to RTL Design

- RTL design flow: Specification → RTL coding → Synthesis → Simulation → Verification.
- HDL coding styles for synthesis (SystemVerilog/VHDL basics).
- Lab:
    1. Write synthesizable Verilog/SystemVerilog code for:
        a) Half Adder, Full Adder
        b) 4-bit Ripple Carry Adder
        c) 4-bit Synchronous Counter (Up/Down)
    2. FSM Design: Sequence Detector (e.g., detect “1011”).

Module 2 – RTL Synthesis

- Synthesis concepts: mapping RTL to gate-level netlist.
- Constraints: clock, area, power.
- Lab:
    1. Synthesize combinational and sequential circuits (Adder, Counter, FSM) using EDA tool
    2. Generate gate-level netlist and analyze area, delay, power reports.
    3. Apply constraints (clock, timing) and observe impact on synthesis results.

Module **3 – Simulation**

- Functional vs. Timing simulation.
- Testbench creation, waveforms, debugging.
- Lab: Run simulations
    1. Develop testbenches for:
    a) 4-bit ALU (add, sub, AND, OR).
    b) Universal Shift Register.
    2. Perform functional simulation using EDA tools
    3. Perform post-synthesis (timing) simulation and compare results with functional simulation.

Module 4 – Verification

- Verification basics: functional verification, assertion-based verification.
- Introduction to UVM/OVM concepts.
- Lab: Writing simple verification testbenches.
    1. Write self-checking testbenches for combinational and sequential circuits.
    2. Use assertion-based verification (SystemVerilog Assertions – SVA) for protocol checks (e.g., handshaking signals).
    3. Coverage-driven verification experiment: Create random test cases for FIFO/Memory.

Module 5 – Case Study & Mini Project

- Design, synthesize, and verify a digital subsystem (e.g., ALU, UART, FIFO).
- End-to-end RTL → Synthesis → Simulation → Verification flow.
- Lab: Design, synthesize, simulate, and verify a **digital subsystem** such as:

    1. UART Transmitter/Receiver
    2. Simple CPU Core Module (Instruction Decoder + ALU + Register File)
    3. FIFO Buffer with full/empty flags

Textbooks / References

1. Samir Palnitkar – *Verilog HDL: A Guide to Digital Design and Synthesis*.
2. Michael Ciletti – *Advanced Digital Design with the Verilog HDL*.
3. Chris Spear & Greg Tumbush – *SystemVerilog for Verification*.
4. David Rich – *Design and Verification with SystemVerilog*.

Suggested reading:

1. Samir Palnitkar, "Verilog HDL, a guide to digital design and synthesis", Prentice Hall 2003.
2. Doug Amos, Austin Lesea, Rene Richter, "FPGA based prototyping methodology manual", Xilinx, 2011.
3. Bob Zeidman, "Designing with FPGAs & CPLDs", CMP Books, 2002.

Subject Code	ENGLISH FOR RESEARCH PAPER WRITING	L	T	P	C
C43809a	(Audit Course-I)	2	0	0	0

Course Objectives:

1. To equip students with the fundamentals of academic English for research paper writing.
2. To develop students' advanced reading skills for analyzing and evaluating research articles.
3. To refine students' grammar and language skills for clarity and precision in research writing.
4. To master the skills of revising, editing, and proofreading research papers.
5. To familiarize students with the role of technology and AI in research writing, including digital literacy and ethical considerations.

Course Outcomes (CO): Student will be able to

CO1 - Recall the key language aspects and structural elements of academic writing in research papers.

CO2 –Explain the importance of clarity, precision, and objectivity in research writing.

CO3 - Apply critical reading strategies and advanced grammar skills to analyze and write research papers.

CO4 –Analyze research articles and identify the strengths and limitations of different methodologies.

CO4 – Evaluate research papers to check for plagiarism, structure, clarity, and language accuracy.

CO5 – Evaluate the effectiveness of different language and technology tools in research writing, including AI-assisted tools and plagiarism detection software.

6. CO6 – Develop a well-structured research paper that effectively communicates complex ideas.

UNIT - I	Fundamentals of Academic English	Lecture Hrs:

Academic English - MAP (Message-Audience-Purpose) - Language Proficiency for Writing - Key Language Aspects - Clarity and Precision - Objectivity - Formal Tone - Integrating References - Word order - Sentences and Paragraphs - Link Words for Cohesion - Avoiding Redundancy / Repetition - Breaking up long sentences - Structuring Paragraphs - Paraphrasing Skills – Framing Title and Sub-headings

UNIT - II	Reading Skills for Researchers	Lecture Hrs:

Reading Academic Texts - Critical Reading Strategies - Skimming and Scanning - Primary Research Article vs. Review Article - Reading an Abstract - Analyzing Research Articles - Identifying Arguments - Classifying Methodologies - Evaluating Findings - Making Notes

UNIT - III	Grammar Refinement for Research Writing	Lecture Hrs:

Advanced Punctuation Usage - Grammar for Clarity - Complex Sentence Structures - Active- Passive Voice - Subject-Verb Agreement - Proper Use of Modifiers - Avoiding Ambiguous Pronoun References - Verb Tense Consistency - Conditional Sentences

UNIT - IV	Mastery in Refining Written Content/Editing Skills	Lecture Hrs:

Effective Revisions - Restructuring Paragraph - Editing vs Proofreading, Editing for Clarity and Coherence - Rectifying Sentence Structure Issues - Proofreading for Grammatical Precision – Spellings - Tips for Correspondence with Editors - Critical and Creative Phases of Writing

UNIT - V	Technology and Language for Research	Lecture Hrs:

Digital Literacy and Critical Evaluation of Online Content - Technology and Role of AI in Research Writing – Assistance in Generating Citations and References - Plagiarism and Ethical Considerations – Tools and Awareness – Fair Practices

Textbooks:

1.Bailey. S. A*cademic Writing: A Handbook for International Students.* London and New York: Routledge,2015.

2. Adrian Wallwork, *English for Writing Research Papers*, Springer New York Dordrecht Heidelberg London, 2011.

Reference Books:

1. Craswell, G. *Writing for Academic Success,* Sage Publications, 2004.
2. Peter Elbow, *Writing With Power, E-book*, Oxford University Press, 2007
3. Oshima, A. & Hogue, A. *Writing Academic English*, Addison-Wesley, New York, 2005
4. Swales, J. & C. Feak, Academic Writing for Graduate Students: Essential Skills and Tasks. Michigan University Press, 2012.
5.Goldbort R.*Writing for Science*, Yale University Press (available on Google Books), 2006
6. Day R.*How to Write and Publish a Scientific Paper*, Cambridge University Press, 2006

Online Learning Resources:

1. https://nptel.ac.in/noc/courses/noc20/SEM1/noc20-ge04/
2. https://onlinecourses.swayam2.ac.in/ntr24_ed15/preview

3.. "Writing in the Sciences" – Stanford University (MOOC on Coursera) https://www.coursera.org/learn/sciwrite

4. Academic Phrasebank – University of Manchester http://www.phrasebank.manchester.ac.uk

5. OWL (Online Writing Lab) – Purdue University, https://owl.purdue.edu
(Resources on APA/MLA formats, grammar, structure, paraphrasing)

6. Zotero or Mendeley (Reference Management Tools) – Useful for managing citations and sources.

Subject Code	DISASTER MANAGEMENT	L	T	P	C
C43809b	(Audit Course-I)	2	0	0	0
Semester		I			

Course Objectives:

1. **To enable the students to understand** the fundamental concepts of disasters, hazards, their factors, and significance with special reference to India.
2. **To prepare them to classify and analyze** different types of natural and man-made disasters, their causes, magnitude, and impacts.
3. **To foster them develop understanding** of disaster preparedness, monitoring systems, and the role of government, community, and media.
4. **To equip them in learning** risk assessment techniques, disaster risk reduction strategies, and the importance of global and national cooperation.
5. **To foster their ability to think critically and respond to disasters and design** effective mitigation measures (structural and non-structural) with a focus on emerging trends and Indian disaster management programs.

Course Outcomes

On successful completion, students will be able to:

CO1 - Define and distinguish between hazards and disasters, and explain their types, nature, and impacts.

CO2 Identify and map disaster-prone areas in India and understand the epidemiological consequences of disasters.

CO3 Assess the economic, social, and ecological repercussions of major natural and man-made disasters.

CO4 Demonstrate knowledge of disaster preparedness tools such as remote sensing, meteorological data, risk evaluation, and community awareness.

CO5 Apply risk assessment methods and propose disaster risk reduction strategies at local, national, and global levels.

CO6: Formulate and evaluate structural and non-structural disaster mitigation strategies, with emphasis on Indian programs and emerging trends.

SYLLABUS

UNIT –I	Introduction	

Disaster - Definition, Factors and Significance - Difference Between Hazard and Disaster - Natural and Man-made Disasters - Difference, Nature, Types and Magnitude -

Disaster Prone Areas in India - Study of Seismic Zones - Areas Prone to Floods and Droughts, Landslides and Avalanches - Areas Prone to Cyclonic and Coastal Hazards with Special Reference to Tsunami - Post-Disaster Diseases and Epidemics.

UNIT - II	Repercussions of Disasters and Hazards	

Economic Damage - Loss of Human and Animal Life - Destruction of Ecosystem - Natural Disasters - Earthquakes, Volcanism, Cyclones, Tsunamis, Floods, Droughts and Famines, Landslides and Avalanches, Man-made disaster - Nuclear Reactor Meltdown - Industrial Accidents - Oil Slick sand Spills - Outbreaks of Disease and Epidemics War and Conflicts

UNIT - III	Disaster Preparedness and Management	

Preparedness - Monitoring of Phenomena - Triggering a Disasteror Hazard - Evaluation of Risk-Application of Remote Sensing - Data from Meteorological and Other Agencies - Media Reports- Governmental and Community Preparedness

UNIT - IV	Risk Assessment	

Disaster Risk -Concept and Elements, Disaster Risk Reduction - Global and National Disaster Risk Situation - Techniques of Risk Assessment – Global Co-Operation in Risk Assessment and Warning - People's participation in Risk Assessment – Strategies for Survival

UNIT - V	Disaster Mitigation	

Meaning, Concept and Strategies of Disaster Mitigation - EmergingTrends in Mitigation - Structural Mitigation and Non- Structural Mitigation - Programs of Disaster Mitigation in India

Text books

1. Gupta, H. K. *Disaster Management*. Universities Press, 2003
2. Singh, R. B. *Natural Hazards and Disaster Management*. Rawat Publications, 2006.

Reference Books

1. Coppola, D. P. (2020). *Introduction to International Disaster Management* (4th ed.). Elsevier.
2. Shaw, R., & Izumi, T. (2022). *Science and Technology in Disaster Risk Reduction in Asia*. Springer.
3. Wisner, B., Gaillard, J. C., & Kelman, I. (2021). *Handbook of Hazards and Disaster Risk Reduction and Management* (2nd ed.). Routledge.
4. Saini, V. K. (2021). *Disaster Management in India: Policy, Issues and Perspectives*. Sage India.
5. Kelman, I. *Disaster by Choice: How Our Actions Turn Natural Hazards into Catastrophes,* Oxford University Press, 2022
6. Sahni, P. & Dhameja, A. *Disaster Mitigation: Experiences and Reflections*. Prentice Hall of India, 2004.

Online Resources

- **National Disaster Management Authority (NDMA), India**: https://ndma.gov.in – official guidelines, reports, and policy frameworks.
- **United Nations Office for Disaster Risk Reduction (UNDRR)**: https://www.undrr.org – Sendai Framework, global risk reduction strategies.
- **Global Disaster Alert and Coordination System (GDACS)**: https://www.gdacs.org – real-time disaster alerts.
- **World Health Organization (WHO)** – https://www.who.int/emergencies – disaster-related health guidelines.

Subject Code	ESSENCE OF INDIAN TRADITIONAL KNOWLEDGE	L	T	P	C
C43809c	(Audit Course-I)	2	0	0	0

	COURSE OBJECTIVES : The objective of this course is
1	To facilitate the students with the concepts of Indian traditional knowledge and to make them understand the importance of roots of knowledge system.
2	To make them understand the need for protecting traditional knowledge and its significance in the global economy.
3	To make them understand the legal frame work and policies related to traditional knowledge protection.
4	To enable them to understand the relationship between traditional knowledge and intellectual property rights.
5	To make them explore the applications of traditional knowledge in different sectors, such as engineering, medicine, agriculture, and biotechnology

Unit-I: Introduction to traditional knowledge - Definition, Nature and characteristics, scope and importance - Kinds of traditional knowledge - Physical and social contexts in which traditional knowledge develop - Historical impact of social change on traditional knowledge systems - Indigenous Knowledge (IK) – Characteristics - traditional knowledge vis-à-vis indigenous knowledge - Traditional knowledge Vs western knowledge, traditional knowledge vis-à-vis formal knowledge

Learning Outcomes:

At the end of the unit the student will able to:

- Understand the concept of traditional knowledge.
- Contrast and compare characteristics, importance& kinds of traditional knowledge.
- Analyze physical and social contexts of traditional knowledge.
- Evaluate social change on traditional knowledge.

Unit-II: Protection of traditional knowledge- Need for protecting traditional knowledge - Significance of TK Protection - Value of TK in global economy - Role of Government to harness TK.

Learning Outcomes:

At the end of the unit the student will able to:

- Know the need of protecting traditional knowledge.
- Apply significance of TK protection.
- Analyze the value of TK in global economy.
- Evaluate role of government

Unit-III: Legal frame work and TK - A)The Scheduled Tribes and Other Traditional Forest Dwellers (Recognition of Forest Rights) Act, 2006 - Plant Varieties Protection and Farmer's Rights Act, 2001 (PPVFR Act) – B)The Biological Diversity Act 2002 and Rules 2004 - the protection of traditional knowledge bill, 2016 - Geographical Indicators Act 2003.

Learning Outcomes:

At the end of the unit the student will able to:

- Understand legal frame work of TK.
- Contrast and compare the ST and other traditional forest dwellers
- Analyze plant variant protections
- Understand the rights of farmers forest dwellers

Unit-IV: Traditional knowledge and Intellectual property - Systems of traditional knowledge protection - Legal concepts for the protection of traditional knowledge - Certain non-IPR mechanisms of traditional knowledge protection - Patents and traditional knowledge - Strategies to increase

protection of traditional knowledge -Global legal FORA for increasing protection of Indian Traditional Knowledge.

Learning Outcomes:

At the end of the unit the student will able to:

- Understand TK and IPR
- Apply systems of TK protection.
- Analyze legal concepts for the protection of TK.
- Evaluate strategies to increase the protection of TK.

Unit-V: Traditional knowledge in different sectors - Traditional knowledge and Engineering - Traditional medicine system - TK and Biotechnology - TK in Agriculture - Traditional societies depend on it for their food and healthcare needs - Importance of conservation and sustainable development of environment - Management of biodiversity, Food security of the country and protection of TK

Learning Outcomes:

At the end of the unit the student will be able to:

- Know TK in different sectors.
- Apply TK in Engineering.
- Analyze TK in various sectors.
- Evaluate food security and protection of TK in the country.

Prescribed Books:

1. Mahadevan, B., Bhat Vinayak Rajat, Nagendra Pavana R.N. *Introduction to Indian Knowledge System: Concepts and Applications*, PHI Learning Pvt.Ltd. Delhi, 2022.
2. Basanta Kumar Mohanta and Vipin Kumar Singh,*Traditional Knowledge System and Technology in India,* PratibhaPrakashan 2012.

Reference Books

1. Pride of India: A Glimpse into India's Scientific Heritage, Samskrita Bharati, New Delhi.
2. Kak, S.C. "On Astronomy in Ancient India", Indian Journal of History of Science, 22(3), 1987
3. Subbarayappa, B.V. and Sarma, K.V. *Indian Astronomy: A Source Book*, Nehru Centre, Mumbai, 1985.
4. Bag, A.K. *History of Technology in India*, Vol. I, Indian National Science Academy, New Delhi, 1997.
5. Acarya, P.K. *Indian Architecture*, Munshiram Manoharlal Publishers, New Delhi, 1996.
6. Banerjea, P. *Public Administration in Ancient India,* Macmillan, London, 1961.
7. Kapoor Kapil, Singh Avadhesh,*Indian Knowledge Systems Vol – I & II,* Indian Institute of .Advanced Study, Shimla, H.P, 2022

COURSE OUTCOMES: At the end of the course, students will be able to	
CO1	Define and explain the concept of traditional knowledge, its nature, characteristics, and scope
CO2	Understand the need for protecting traditional knowledge and its significance in the global economy
CO3	Explain the legal framework and policies related to traditional knowledge protection
CO4	Apply traditional knowledge in different sectors, such as engineering, medicine, agriculture, and biotechnology
CO5	Analyze the importance of traditional knowledge in various contexts, including its historical impact and social change
CO6	Analyze the relationship between traditional knowledge and intellectual property rights, including patents and non-IPR mechanisms

E-Resources:

1. https://www.youtube.com/watch?v=LZP1StpYEPM
   2.http://nptel.ac.in/courses/121106003/

COURSE STRUCTURE

II - SEMESTER

PROGRAMME CURRICULUM STRUCTURE UNDER R25 REGULATIONS

M. TECH - DIGITAL ELECTRONICS & COMMUNICATION SYSTEMS

SEMESTER – II

S.No.	Course codes	Course Name	Category	Hours per week			Credits	Scheme of Examination		
				L	T	P		Internal	External	Total
1.	C43810	Network Security and Cryptography	PC	3	0	0	3	40	60	100
2.	C43811	Advanced Communications and	PC	3	0	0	3	40	60	100
3.	C43812a C43812b C43812c	**Program Elective – III** Embedded Real Time Operating Systems Communication Buses and Interfaces	PE	3	0	0	3	40	60	100
4.	C43813a C43813b C43813c	**Program Elective – IV** Cognitive Radio Image and Video Processing Ad hoc and Wireless Sensor Networks	PE	3	0	0	3	40	60	100
5.	C43814	Network Security and Cryptography	PC	0	0	4	2	40	60	100
6.	C43815	Advanced Communications and Networks Lab	PC	0	0	4	2	40	60	100
7.	C43816	Quantum Technologies and	MC	2	0	0	2	40	60	100
8.	C43817	Comprehensive Viva Voce	PC	0	0	0	2	100	-	100
9.	C43818a C43818b C43818c	**Audit Course – II** Pedagogy Studies Personality Development Through Life Enlightenment Skills Yoga For Stress Management	AC	2	0	0	0	40*	-	-
						Total	20	380	420	800

*There is no external examination for audit course. Student shall be declared to have passed the mandatory course only when he/she secures 50% or more in the internal examinations.

Course Code	NETWORK SECURITY AND CRYPTOGRAPHY	L	T	P	C
C43810		3	0	0	3
Semester		**II**			

Course Objectives:

- To identify and utilize different forms of cryptography techniques.
- To incorporate authentication and security in the network applications.
- To distinguish among different types of threats to the system and handle the same.

Course Outcomes (CO):

- Identify and utilize different forms of cryptography techniques.
- Incorporate authentication and security in the network applications.
- Distinguish among different types of threats to the system and handle the same.

UNIT - I Lecture Hrs:

Security: Need, security services, Attacks, OSI Security Architecture, one-time passwords, Model for Network security, Classical Encryption Techniques like substitution ciphers, Transposition ciphers, Cryptanalysis of Classical Encryption Techniques.

UNIT - II Lecture Hrs:

Number Theory: Introduction, Fermat's and Euler's Theorem, The Chinese Remainder Theorem, Euclidean Algorithm, Extended Euclidean Algorithm, and Modular Arithmetic.

UNIT - III Lecture Hrs:

Private-Key (Symmetric) Cryptography: Block Ciphers, Stream Ciphers, RC4 Stream cipher, Data Encryption Standard (DES), Advanced Encryption Standard (AES), Triple DES, RC5, IDEA, Linear and Differential Cryptanalysis.

UNIT - IV Lecture Hrs:

Public-Key (Asymmetric) Cryptography: RSA, Key Distribution and Management, Diffie-Hellman Key Exchange, Elliptic Curve Cryptography, Message Authentication Code, hash functions, message digest algorithms: MD4 MD5, Secure Hash algorithm, RIPEMD-160, HMAC.

UNIT - V Lecture Hrs:

Authentication and System Security: IP and Web Security Digital Signatures, Digital Signature Standards, Authentication Protocols, Kerberos, IP security Architecture, Encapsulating Security Payload, Key Management, Web Security Considerations, Secure Socket Layer, Secure Electronic Transaction Intruders, Intrusion Detection, Password Management, Worms, viruses, Trojans, Virus Countermeasures, Firewalls, Trusted Systems.

Textbooks:

1. William Stallings, —Cryptography and Network Security, Principles and Practices‖, Pearson Education, 3rd Edition.
2. Charlie Kaufman, Radia Perlman and Mike Speciner, —Network Security, Private Communication in a Public World‖, Prentice Hall, 2ND Edition.

Reference Books:

1. Christopher M. King, Ertem Osmanoglu, Curtis Dalton, —Security Architecture, Design Deployment and Operations‖, RSA Pres,
. Stephen Northcutt, Leny Zeltser, Scott Winters, Karen Kent, and Ronald W. Ritchey, — Inside Network Perimeter Security‖, Pearson Education, 2nd Edition
3. Richard Bejtlich, —The Practice of Network Security Monitoring: Understanding Incident Detection and Response‖, William Pollock Publisher, 2013.

Course Code	ADVANCED COMMUNICATIONS AND NETWORKS	L	T	P	C
C43811		3	0	0	3
Semester		II			

Course Objectives:

- To understand about various spread spectrum communication techniques.
- To understand about different aspects related to OFDM.
- To learn about concepts of MIMO systems
- To understand various protocols used in wireless networks

Course Outcomes (CO):

Student will be able to

- Understand about various spread spectrum communication techniques.
- Understand about different aspects related to OFDM.
- Learn about concepts of MIMO systems
- Understand various protocols used in wireless networks

UNIT - I Lecture Hrs:

Spread Spectrum Communications: Spreading sequences- Properties of Spreading Sequences, Pseudo- noise sequence, Gold sequences, Kasami sequences, Walsh Sequences, Orthogonal Variable Spreading Factor Sequences, Barker Sequence, Complementary Codes

Direct sequence spread spectrum: DS-CDMA Model, Conventional receiver, Rake Receiver, Synchronization in CDMA, Power Control, Soft handoff, Multiuser detection – Optimum multiuser detector, Liner multiuser detection.

UNIT - II Lecture Hrs:

Orthogonal Frequency Division Multiplexing: Basic Principles of Orthogonality, Single vs Multicarrier Systems, OFDM Block Diagram and Its Explanation, OFDM Signal Mathematical Representation, Selection parameter for Modulation, Pulse shaping in OFDM Signal and Spectral Efficiency, Window in OFDM Signal and Spectrum, Synchronization in OFDM, Pilot Insert in OFDM Transmission and Channel Estimation, Amplitude Limitations in OFDM, FFT Point Selection Constraints in OFDM, CDMA vs OFDM, Hybrid OFDM.

UNIT - III Lecture Hrs:

MIMO Systems: Introduction, Space Diversity and System Based on Space Diversity, Smart Antenna system and MIMO, MIMO Based System Architecture, MIMO Exploits Multipath, Space – Time Processing, Antenna Consideration for MIMO, MIMO Channel Modelling, MIMO Channel Measurement, MIMO Channel Capacity, Cyclic Delay Diversity (CDD), Space Time Coding, Advantages and Applications of MIMO in Present Context, MIMO Applications in 3G Wireless System and Beyond, MIMO-OFDM

UNIT - IV Lecture Hrs:

Wireless LANs/IEEE 802.11x: Introduction to IEEE802.11x Technologies, Evolution of wireless LANs, IEEE 802.11 Design Issues, IEEE 802.11 Services, IEEE 802.11 MAC Layer operations, IEEE 802.11 Layer1, IEEE 802.11 a/b/g Higher Rate Standards, Wireless LAN Security, Computing Wireless Technologies, Typical WLAN Hardware

UNIT - V Lecture Hrs:

Wireless PANs/IEEE 802.15x: Introduction to IEEE 802.15x Technologies: Wireless PAN Applications and Architecture, IEEE 802.15.1 Physical Layer Details, Bluetooth Link Controllers Basics, Bluetooth Link Controllers Operational States, IEEE 802.15.1 Protocols and Host Control Interface. Evaluation of IEEE 802.15 Standards

Broad Band Wireless MANs/IEEE 802.16x: Introduction to WMAN/IEEE 802.16x Technology, IEEE 802.16Wireless MANs, IEEE 802.16 MAC Layer Details, IEEE 802.16 Physical Layer Details, IEEE 802.16 Physical Layer Details for 2-11 GHz, IEEE 802.16 Common System Operations.

Textbooks:

Gary J. Mullett, —Introduction to Wireless Telecommunications Systems and Networks‖, CENGAGE

2. Upena Dalal, —Wireless Communication‖, Oxford University Press, 2009

Reference Books:

Ke-Lin Du & M N S Swamy, —Wireless Communication System‖, Cambridge University Press, 2010
2. Gottapu Sasibhusan Rao, —Mobile Cellular Communication‖, 1st Edition, Pearson Education, 2012

Course Code	EMBEDDED REAL TIME OPERATING SYSTEMS	L	T	P	C
C43812a	Program Elective – III	3	0	0	3
	Semester	II			

Course Objectives:

- To provide broad understanding of the requirements of Real Time Operating Systems.
- To make the student understand, applications of these Real Time features using case studies.
- To use the real time operating system concepts.

Course Outcomes (CO): Student will be able to

- Acquire knowledge on Real Time features of UNIX and LINUX.
- Understand the basic building blocks of Real Time Operating Systems in terms of scheduling, context switching and ISR.
- Understand on Real Time applications using Real Time Linux, ucos2, VX works, Embedded Linux.

UNIT - I		Lecture Hrs:

Introduction

Introduction to UNIX/LINUX, Overview of Commands, File I/O,(open, create, close, seek, read, write), Process Control (fork, exit, wait, waitpid, exec).

UNIT - II		Lecture Hrs:

Real Time Operating Systems

Brief History of OS, Defining RTOS, The Scheduler, Objects, Services, Characteristics of RTOS, Defining a Task, asks States and Scheduling, Task Operations, Structure, Synchronization, Communication and Concurrency. Defining Semaphores, Operations and Use, Defining Message Queue, States, Content, Storage, Operations and Use.

UNIT - III		Lecture Hrs:

Objects, Services and I/O

Pipes, Event Registers, Signals, Other Building Blocks, Component Configuration, Basic I/O Concepts, I/O Subsystem.

UNIT - IV		Lecture Hrs:

Exceptions, Interrupts and Timers

Exceptions, Interrupts, Applications, Processing of Exceptions and Spurious Interrupts, Real Time Clocks, Programmable Timers, Timer Interrupt Service Routines (ISR), Soft Timers, Operations.

UNIT - V		Lecture Hrs:

Case Studies of RTOS

RT Linux, Micro C/OS-II, Vx Works, Embedded Linux, and Tiny OS.

Textbooks:

1. Real Time Concepts for Embedded Systems – Qing Li, Elsevier, 2011.

Reference Books:

1. Embedded Systems- Architecture, Programming and Design by Rajkamal, TMH, 2007.
2. Advanced UNIX Programming, Richard Stevens.
3. Embedded Linux: Hardware, Software and Interfacing – Dr. Craig Hollabaugh.

Course Code	COMMUNICATION BUSES AND INTERFACES	L	T	P	C
C43812b	**Program Elective – III**	**3**	**0**	**0**	**3**
	Semester		**II**		

Course Objectives:

- To understand the concepts of different types of serial buses.
- To learn about CAN, PCIe and USB architecture
- To learn about data streaming using serial communication protocols

Course Outcomes (CO): Student will be able to

- Understand the concepts of different types of serial buses.
- Learn about CAN, PCIe and USB architecture
- Learn about data streaming using serial communication protocols

UNIT - I	Lecture Hrs:

Serial Busses- Cables, Serial busses, serial versus parallel, Data and Control Signal- data frame, data rate, features, Limitations and applications of RS232, RS485, I2C , SPI

UNIT - II	Lecture Hrs:

CAN ARCHITECTURE- ISO 11898-2, ISO 11898-3, Data Transmission- ID allocation, Bit timing, Layers- Application layers, Object layer, Transfer layer, Physical layer, Frame formats- Data frame, Remote frame, Error frame, Overload frame, Ack slot, Inter frame spacing, Bit spacing, Applications.

UNIT - III	Lecture Hrs:

PCIe : Revision, Configuration space- configuration mechanism, Standardized registers, Bus enumeration, Hardware and Software implementation, Hardware protocols, Applications.

UNIT - IV	Lecture Hrs:

USB: Transfer Types- Control transfers, Bulk transfer, Interrupt transfer, Isochronous transfer. Enumeration- Device detection, Default state, Addressed state, Configured state, enumeration sequencing. Descriptor types and contents- Device descriptor, configuration descriptor, Interface descriptor, Endpoint descriptor, String descriptor. Device driver.

UNIT - V	Lecture Hrs:

Data streaming Serial Communication Protocol- Serial Front Panel Data Port (SFPDP) configurations, Flow control, serial FPDP transmission frames, fiber frames and copper cable.

Textbooks:

A Comprehensive Guide to controller Area Network – Wilfried Voss, Copperhill Media Corporation, 2nd Ed., 2005.

2. Serial Port Complete-COM Ports, USB Virtual Com Ports and Ports for Embedded Systems- Jan Axelson, Lakeview Research, 2nd Ed.,

Reference Books:

1. USB Complete – Jan Axelson, Pen ram Publications.
2. PCI Express Technology – Mike Jackson, Ravi Budruk, Mindshare Press.

Course Code	EMBEDDED SYSTEMS PROTOCOLS	L	T	P	C
C43812c	Program Elective – III	3	0	0	3
	Semester	II			

Course Objectives:

- To acquire knowledge on communication protocols of connecting Embedded Systems.
- To understand the design parameters of USB and CAN bus protocols.
- To understand the design issues of Ethernet in Embedded networks.
- To acquire the knowledge of wireless protocols in Embedded domain.

Course Outcomes (CO): Student will be able to

- Acquire knowledge on communication protocols of connecting Embedded Systems.
- Understand the design parameters of USB and CAN bus protocols.
- Understand the design issues of Ethernet in Embedded networks.
- Acquire the knowledge of wireless protocols in Embedded domain.

UNIT - I — Lecture Hrs:

Embedded Communication Protocols

Embedded Networking: Introduction – Serial/Parallel Communication – Serial communication protocols -RS232 standard – RS485 – Synchronous Serial Protocols -Serial Peripheral Interface (SPI) – Inter Integrated Circuits (I2C) – PC Parallel port programming - ISA/PCI Bus protocols – Firewire.

UNIT - II — Lecture Hrs:

USB and CAN Bus

USB bus – Introduction – Speed Identification on the bus – USB States – USB bus communication Packets –Data flow types –Enumeration –Descriptors –PIC 18 Microcontroller USB Interface – C Programs –CAN Bus – Introduction - Frames –Bit stuffing –Types of errors –Nominal Bit Timing – PIC microcontroller CAN Interface –A simple application with CAN.

UNIT - III — Lecture Hrs:

Ethernet Basics

Elements of a network – Inside Ethernet – Building a Network: Hardware options – Cables, Connections and network speed – Design choices: Selecting components –Ethernet Controllers – Using the internet in local and internet communications – Inside the Internet protocol.

UNIT - IV — Lecture Hrs:

Embedded Ethernet

Exchanging messages using UDP and TCP – Serving web pages with Dynamic Data – Serving web pages that respond to user Input – Email for Embedded Systems – Using FTP – Keeping Devices and Network secure.

UNIT - V — Lecture Hrs:

Wireless Embedded Networking

Wireless sensor networks – Introduction – Applications – Network Topology – Localization –Time Synchronization - Energy efficient MAC protocols –SMAC – Energy efficient and robust routing – Data Centric routing.

Textbooks:

1. Embedded Systems Design: A Unified Hardware/Software Introduction - Frank Vahid, Tony Givargis, John & Wiley Publications, 2002.
2. Parallel Port Complete: Programming, interfacing and using the PCs parallel printer port - Jan Axelson, Penram Publications, 1996.

Reference Books:

1. Advanced PIC microcontroller projects in C: from USB to RTOS with the PIC18F series - Dogan Ibrahim, Elsevier 2008.
2. Embedded Ethernet and Internet Complete - Jan Axelson, Penram publications, 2003.
3. Networking Wireless Sensors – Bhaskar Krishnamachari□, Cambridge press 2005.

Course Code	COGNITIVE RADIO	L	T	P	C
C43813a	Program Elective – IV	3	0	0	3
	Semester	II			

Course Objectives:

- To understand the fundamental concepts of cognitive radio networks.
- To develop the cognitive radio, as well as techniques for spectrum holes detection that cognitive radio takes advantages in order to exploit it.
- To understand technologies to allow an efficient use of TVWS for radio communications based on two spectrum sharing business models/policies.
- To understand fundamental issues regarding dynamic spectrum access, the radio-resource management and trading, as well as a number of optimization techniques for better spectrum exploitation.

Course Outcomes (CO):

Students will be able to

- Understand the fundamental concepts of cognitive radio networks.
- Develop the cognitive radio, as well as techniques for spectrum holes detection that cognitive radio takes advantages in order to exploit it.
- Understand technologies to allow an efficient use of TVWS for radio communications based on two spectrum sharing business models/policies.
- Understand fundamental issues regarding dynamic spectrum access, the radio-resource management and trading, as well as a number of optimization techniques for better spectrum exploitation.

UNIT - I		Lecture Hrs:

Introduction to Cognitive Radios: Digital dividend, cognitive radio (CR) architecture, functions of cognitive radio, dynamic spectrum access (DSA), components of cognitive radio, spectrum sensing, spectrum analysis and decision, potential applications of cognitive radio.

UNIT - II		Lecture Hrs:

Spectrum Sensing: Spectrum sensing, detection of spectrum holes (TVWS), collaborative sensing, geo-location database and spectrum sharing business models (spectrum of commons, real time secondary spectrum market).

UNIT - III		Lecture Hrs:

Optimization Techniques of Dynamic Spectrum Allocation: Linear programming, convex programming, non-linear programming, integer programming, dynamic programming, stochastic programming.

UNIT - IV		Lecture Hrs:

Dynamic Spectrum Access and Management: Spectrum broker, cognitive radio architectures, centralized dynamic spectrum access, distributed dynamic spectrum access, learning algorithms and protocols.

UNIT - V		Lecture Hrs:

Spectrum Trading: Introduction to spectrum trading, classification to spectrum trading, radio resource pricing, brief discussion on economics theories in DSA (utility, auction theory), and classification of auctions (single auctions, double auctions, concurrent, sequential). Research Challenges in Cognitive Radio: Network layer and transport layer issues, cross layer design for cognitive radio networks.

Textbooks:

1. Ekram Hossain, Dusit Niyato, Zhu Han, —Dynamic Spectrum Access and Management in Cognitive Radio Networks‖, Cambridge University Press, 2009.
2. Kwang-Cheng Chen, Ramjee Prasad, —Cognitive radio networks‖, John Wiley & Sons Ltd., 2009.

Reference Books:

1. Bruce Fette, —Cognitive radio technology‖, Elsevier, 2nd edition, 2009.
2. Huseyin Arslan, —Cognitive Radio, Software Defined Radio, and Adaptive Wireless Systems‖, Springer, 2007.
3. Francisco Rodrigo Porto Cavalcanti, Soren Andersson, —Optimizing Wireless Communication Systems‖ Springer, 2009.
4. Linda Doyle, —Essentials of Cognitive Radio‖, Cambridge University Press, 2009

Course Code	IMAGE AND VIDEO PROCESSING	L	T	P	C
C43813b	Program Elective – IV	3	0	0	3
	Semester	II			

Course Objectives:

- To understand the quality improvement methods of Image.
- To study the basic digital image and video filter operations.
- To understand the fundamentals of Image Compression.
- To understand the Representation of video, principles and methods of motion estimation.

Course Outcomes (CO):

Student will be able to

- Understand the quality improvement methods of Image.
- Study the basic digital image and video filter operations.
- Understand the fundamentals of Image Compression.
- Understand the Representation of video, principles and methods of motion estimation.

UNIT - I		Lecture Hrs:

Fundamentals of Image Processing and Image Transforms

Basic steps of Image Processing System Sampling and Quantization of an image, Basic relationship between pixels.

Image Segmentation

Segmentation concepts, Point, Line and Edge Detection, Thresholding, Region based segmentation.

UNIT - II		Lecture Hrs:

Image Enhancement

Spatial domain methods: Histogram processing, Fundamentals of Spatial filtering, Smoothing spatial filters, Sharpening spatial filters.

Frequency domain methods: Basics of filtering in frequency domain, image smoothing, image sharpening, Selective filtering.

UNIT - III		Lecture Hrs:

Image Compression

Image compression fundamentals- Coding Redundancy, Spatial and Temporal redundancy, Compression models: Lossy& Lossless, Huffman coding, , Bit plane coding, Transform coding, Predictive coding, Wavelet coding, Lossy Predictive coding, JPEG Standards.

UNIT - IV		Lecture Hrs:

Basic Steps of Video Processing

Analog Video, Digital Video. Time-Varying Image Formation models: Three-Dimensional Motion Models, Geometric Image Formation, Photometric Image Formation, Sampling of Video signals, Filtering operations.

UNIT - V		Lecture Hrs:

2-D Motion Estimation

Optical flow, General Methodologies, Pixel Based Motion Estimation, Block- Matching Algorithm, Mesh based Motion Estimation, Global Motion Estimation, Region based Motion Estimation, Multi resolution motion estimation, Waveform based coding, Block based transform coding, Predictive coding, Application of motion estimation in Video coding.

Textbooks:

1. Digital Image Processing – Gonzaleze and Woods, 4rd Ed., Pearson, 2018.
2. Digital Video Processing – M. Tekalp, Prentice Hall International

Reference Books:

1. Video Processing and Communication – Yao Wang, Joem Ostermann and Ya–quin Zhang. 1st Ed., PH Int.
2. Digital Image Processing – S. Jayaraman, S. Esakkirajan, T. Veera Kumar –TMH, 2009

Course Code	ADHOC AND WIRELESS SENSOR NETWORKS	L	T	P	C
C43813c	Program Elective – IV	3	0	0	3
	Semester	II			

Course Objectives:

- To understand the various wireless networks
- To analyze MAC, routing and transport layer protocols
- To learn about the concepts of wireless sensor networks

Course Outcomes (CO):

Students will be able to

- Understand the various wireless networks
- Analyze MAC, routing and transport layer protocols
- Learn about the concepts of wireless sensor networks

UNIT - I		Lecture Hrs:

Wireless LANs and PANs: Introduction, Fundamentals of WLANS, IEEE 802.11 Standards, HIPERLAN Standard, Bluetooth, Home RF.
AD HOC WIRELESS NETWORKS: Introduction, Issues in Ad Hoc Wireless Networks

UNIT - II		Lecture Hrs:

MAC Protocols: Introduction, Issues in Designing a MAC protocol for Ad Hoc Wireless Networks, Design goals of a MAC Protocol for Ad Hoc Wireless Networks, Classifications of MAC Protocols, Contention - Based Protocols, Contention - Based Protocols with reservation Mechanisms, Contention – Based MAC Protocols with Scheduling Mechanisms, MAC Protocols that use Directional Antennas, Other MAC Protocols.

UNIT - III		Lecture Hrs:

Routing Protocols: Introduction, Issues in Designing a Routing Protocol for Ad Hoc Wireless Networks, Classification of Routing Protocols, Table –Driven Routing Protocols, On – Demand Routing Protocols, Hybrid Routing Protocols, Routing Protocols with Efficient Flooding Mechanisms, Hierarchical Routing Protocols, Power – Aware Routing Protocols.

UNIT - IV		Lecture Hrs:

Transport Layer Protocols: Introduction, Issues in Designing a Transport Layer Protocol for Ad Hoc Wireless Networks, Design Goals of a Transport Layer Protocol for Ad Hoc Wireless Networks, Classification of Transport Layer Solutions, TCP Over Ad Hoc Wireless Networks, Other Transport Layer Protocol for Ad Hoc Wireless Networks.

UNIT - V		Lecture Hrs:

Wireless Sensor Networks: Introduction, Sensor Network Architecture, Data Dissemination, Data Gathering, MAC Protocols for Sensor Networks, Location Discovery, Quality of a Sensor Network, Evolving Standards, Other Issues.

Textbooks:

1. Ad Hoc Wireless Networks: Architectures and Protocols - C. Siva Ram Murthy and B. S. Manoj, 2004, PHI.
2. Wireless Ad- hoc and Sensor Networks: Protocols, Performance and Control – Jagannathan Sarangapani, CRC Press.

Reference Books:

1. Ad- Hoc Mobile Wireless Networks: Protocols & Systems, C. K. Toh, 1st Ed. Pearson Education.
2. Wireless Sensor Networks - C. S. Raghavendra, Krishna M. Sivalingam, 2004, Springer

Course Code	NETWORK SECURITY AND CRYPTOGRAPHY LAB	L	T	P	C
C43814		0	0	4	2
Semester		**II**			

Course Objectives:

- To familiarize the concepts of network security and cryptographic algorithms
- To implement the network security and cryptographic algorithms for given specifications

Course Outcomes (CO):

- Familiarize the concepts of network security and cryptographic algorithms
- Implement the network security and cryptographic algorithms for given specifications.

List of Experiments:

1. Write a program to perform encryption and decryption using substitution and transposition cipher.
2. Write a program to implement DES algorithm logic
3. Write a program for evaluation of AES
4. Write a program for evaluation Triple DES
5. Write a program to implement Blowfish algorithm logic
6. Write a program to implement RSA algorithm logic
7. Implement Diffie-Hellman key exchange mechanism using html
8. Write a program to implement Euclid algorithm
9. Calculate the message digest of a text using SHA-1 algorithm
10. Implement the signature scheme digital signature standard
11. Implement electronic mail security
12. Case study on web security requirement

Software Requirements:

C/C++/Java/Python

Course Code	ADVANCED COMMUNICATIONS AND NETWORKS LAB	L	T	P	C
C43815		0	0	4	2
Semester		**II**			

Course Objectives:

- To implement digital filters for the given specifications
- To implement modulation schemes for the given specifications

Course Outcomes (CO):

Student will be able to

- Implement digital filters for the given specifications
- Implement modulation schemes for the given specifications

List of Experiments:

Student has to do minimum **TWELVE** experiments in the given list.

1. Implementation of Matched Filters.
2. Optimum receiver for the AWGN channel.
3. Design FIR (LP/HP/BP) filter using Window method.
4. Measurement of effect of Inter Symbol Interference.
5. Generation of constant envelope PSK signal wave form for different values of M.
6. Simulation of PSK system with M=4
7. Simulation of DPSK system with M=4
8. Design of FSK system
9. Simulation of correlation type demodulation for FSK signal
10. BPSK Modulation and Demodulation techniques
11. QPSK Modulation and Demodulation techniques
12. DQPSK Modulation and Demodulation techniques
13. 8-QAM Modulation and Demodulation techniques
14. DQAM Modulation and Demodulation techniques
15. Verification of Decimation and Interpolation of a given signal
16. Power spectrum estimation using AR model

Software Requirements:

MATLAB

Course Code	QUANTUM TECHNOLOGIES AND APPLICATIONS	L	T	P	C
C43816		2	0	0	2

Course Objectives

1. Present core quantum principles such as superposition and entanglement without mathematical formalism.
2. Develop conceptual clarity on qubits, quantum states, and information frameworks.
3. Examine the theoretical challenges in realizing scalable quantum systems.
4. Introduce foundational ideas in quantum communication and computing.
5. Highlight applications, industrial adoption, and future research directions in quantum technologies.

Course Outcomes

Upon completion, the learner will be able to:
Explain fundamental quantum concepts conceptually.
Distinguish classical information systems from quantum information frameworks. Identify the principal theoretical limitations in building quantum computers.
Describe the conceptual basis of quantum communication and computation.
Discuss current applications, technological trajectories, and career opportunities in the quantum domain.

Unit 1: Foundations of Quantum Theory and Technologies

Transition from classical to quantum physics. Key conceptual principles: Superposition, Entanglement, Uncertainty, Wave-particle duality. Quantum states and measurement; the role of the observer. Representative quantum systems: electrons, photons, atoms. Concept of quantization and discrete energy levels. Strategic relevance of quantum technologies.
Overview of major domains: Computing, Communication, Sensing. Global quantum initiatives: India's National Quantum Mission, EU Quantum Flagship, USA, China.

Unit 2: Conceptual Structure of Quantum Information

Qubits: qualitative understanding using spin and polarization. Classical bits vs quantum bits: distinctions and implications. Quantum systems (non-engineering perspective): trapped ions, superconducting qubits, photonics. Coherence and decoherence mechanisms. Abstract notions: quantum states, measurement operators, Hilbert space—interpretation without mathematics. Entanglement and non-locality as foundational resources. Quantum vs classical information principles; philosophical considerations.

Unit 3: Building a Quantum Computer – Challenges and Requirements

Conceptual prerequisites for functional quantum hardware. Fragility of quantum states: decoherence, noise, stability issues. Requirements: isolation, error resilience, scalability, control. Why maintaining entanglement is difficult; theoretical necessity of quantum error correction. Comparative overview of hardware platforms (superconducting circuits, trapped ions, photonics).Current progress vs scientific constraints; conceptual view of quantum software's role.

Unit 4: Quantum Communication and Computing

(Redundant explanations removed, retaining only unique themes.)Quantum vs classical communication paradigms. Essentials of Quantum Key Distribution (QKD) and its security rationale. Entanglement-enabled communication protocols. Concept of the Quantum Internet and secure global networking. Introduction to quantum computing and quantum parallelism.

Conceptual comparison of classical and quantum gate operations. Challenges: decoherence, noise, and the necessity of error correction frameworks.

Unit 5: Applications, Industry, and Future Directions

Application domains: Healthcare and drug discovery, Material science and chemistry, Optimization and logistics, Quantum sensing and precision timing. Case studies: IBM, Google, Microsoft, PsiQuantum. Ethical, societal, and policy considerations. Barriers to adoption: cost, skilled workforce, standards. Emerging research and career landscapes; India's strategic opportunity in the global quantum ecosystem.

Textbooks

1. Nielsen & Chuang, Quantum Computation and Quantum Information, Cambridge University Press, 2010.
2. Rieffel & Polak, Quantum Computing: A Gentle Introduction, MIT Press, 2011.
3. Chris Bernhardt, Quantum Computing for Everyone, MIT Press, 2019.

Reference Books

David McMahon, Quantum Computing Explained, Wiley, 2008.
Kaye, Laflamme, Mosca, An Introduction to Quantum Computing,
OUP, 2007. Scott Aaronson, Quantum Computing Since Democritus,
CUP, 2013.
Susskind & Friedman, Quantum Mechanics: The Theoretical Minimum, Basic
Books, 2014. Rosenblum & Kuttner, Quantum Enigma, OUP, 2011.
Benenti et al., Principles of Quantum Computation and Information, World
Scientific, 2004. DST India and MeitY: Official Quantum Mission Reports, 2020
onwards.
Quantum Flagship EU: Roadmaps and Strategy Documents.

Online Learning Resources

IBM Quantum Experience & Qiskit Textbook Coursera – Quantum Mechanics and Quantum Computation (UC Berkeley) edX – Quantum Internet & Quantum Computers
YouTube – Quantum Computing for the Determined (Michael Nielsen)

Course Code	PEDAGOGY STUDIES	L	T	P	C
C43818a	(Audit Course-II)	2	0	0	0
Semester		II			

Course Objectives:

1. To enable the students to understand the aims, rationale, policy background, and conceptual frameworks in pedagogy, curriculum, and teacher education research.
2. To develop an understanding of diverse pedagogical practices
3. To make them learn the methodologies for assessing the effectiveness of pedagogical practices and teacher education models.
4. To enable them to learn professional development strategies, including peer support, community engagement, and alignment with curriculum and assessment.

Course Outcomes(CO):Students will be able to

1. Define and explain key concepts, frameworks, and methodologies in pedagogy and teacher education research.
2. Critically analyze pedagogical practices used in diverse classroom settings, with reference to teacher education and curriculum design.
3. Evaluate the effectiveness of pedagogical approaches using quality assessment tools and theory of change models.
4. Apply evidence-based strategies to improve classroom practices, curriculum alignment, and teacher professional development.
5. Identify and address barriers to learning through innovative pedagogical strategies.
6. Design and propose research studies that contribute to filling gaps in pedagogy, curriculum, and teacher education, with focus on dissemination and impact.

UNIT -I	Foundations of Pedagogy	

Introduction to pedagogy and its importance in education - Historical and philosophical foundations of pedagogy - Theories of learning and teaching (behaviorist, cognitive, constructivist) - Role of pedagogy in
shaping educational practices - Role of technology in modern pedagogy (ICT, e-learning, blended learning)

UNIT - II	Teaching-Learning Processes	

Understanding the teaching-learning process - Lesson planning and curriculum design - Strategies for effective teaching and learning (expository, collaborative, experiential) - Use of technology to enhance teaching-learning processes (multimedia, simulations, gamification)

UNIT - III	Technology Integration in Education	

Educational technology and system design - Instructional design models (ADDIE, ASSURE, Dick and Carey Model) - Emerging trends in e-learning (social learning, MOOCs, mobile learning) - ICT tools for teaching and learning (Learning Management Systems, online resources)

UNIT - IV	Pedagogy and Assessment	

Pedagogy, pedagogical analysis, and assessment - Types of assessment (placement, formative, diagnostic, summative) - Technology-based assessment tools (online quizzes, polls, discussions) - Rubrics for self and peer evaluation- Reflective Practices

UNIT - V	Contemporary Issues and Trends	

Inclusive education and technology (assistive technology, accessibility) - Change management and innovation in education - Quality assurance and evaluation in education (TQM, Six Sigma) - Future trends in pedagogy and technology (AI, AR, VR in education) - Personalized learning and adaptive teaching

Textbooks

1. Alexander, R. J. *Essays on Pedagogy*. Routledge, 2008.
2. Shulman, L. S. *The Wisdom of Practice: Essays on Teaching, Learning, and Learning to Teach*. Jossey-Bass, 2004

Reference Books

1. *Teaching for the Future: Effective Teacher Education and Pedagogical Practices*. OECD Publishing., 2021
2. Fullan, M., & Edwards, M. *System Change in Education: Sustainability and Impact*. Routledge, 2022.
3. Coe, R., Rauch, C., Kime, S., & Singleton, D. *Great Teaching Toolkit: Evidence Review*. Evidence Based Education., 2020
4. Zeichner, K. M. *The Struggle for the Soul of Teacher Education*. Routledge, 2024
5. UNESCO. *Global Education Monitoring Report: Pedagogy, Teachers and Learning*. UNESCO Publishing, 2024
6. Hattie, J. *Visible Learning: A Synthesis of Over 800 Meta-Analyses Relating to Achievement*. Routledge., 2009
7. Darling-Hammond, L. *Teacher Education Around the World: What Can We Learn from International Practice?* Routledge, 2007

Online Resources

- **UNESCO Education Resources** – https://www.unesco.org/education
- **OECD Education and Skills** – https://www.oecd.org/education
- **ERIC (Education Resources Information Center)** – https://eric.ed.gov (peer-reviewed papers, reports).
- **World Bank Education** – https://www.worldbank.org/en/topic/education (research reports on teacher development in developing countries).
- **NPTEL/SWAYAM MOOCs** – Teacher education and pedagogy-focused courses.
- **Google Scholar Alerts** – set alerts for "pedagogical practices", "teacher education", "curriculum research" for the latest academic papers.

Course Code	PERSONALITY DEVELOPMENT THROUGH LIFE ENLIGHTENMENT SKILLS (Audit Course-II)	L	T	P	C
C43818b		2	0	0	0
Semester		II			

Course Objectives: This course will enable students:

- To develop students' self-awareness by identifying their strengths, weaknesses, opportunities, and challenges (SWOC analysis).
- To enable students to understand and apply the principles of emotional intelligence and effective interpersonal communication.
- To cultivate positive thinking, resilience, mindfulness, and a growth-oriented mindset.
- To enhance verbal and non-verbal communication skills, including confidence in public speaking and professional presentations.
- To familiarize students with leadership styles, teamwork strategies, and collaborative problem-solving in personal and professional contexts.

Course Outcomes(CO):Student will be able to

1. Define and explain key concepts of self-awareness, personality, and personal growth.
2. Identify and apply strategies of emotional intelligence to regulate emotions and build effective interpersonal relationships
3. Demonstrate positive thinking, gratitude, and resilience to overcome personal and professional challenges
4. Analyze barriers to effective communication and apply verbal and non-verbal communication techniques in diverse contexts.
5. Prepare, deliver, and evaluate effective presentations and public speeches with confidence
6. Develop leadership and teamwork skills to collaborate, negotiate, and solve problems in group settings.

UNIT –I	**Self-Awareness and Personal Growth**	

Understanding personality and its development- Identifying strengths, weaknesses, opportunities, and challenges (SWOC analysis)- Setting personal and professional goals- Practicing Self-Reflection and Journaling
(Activities: Personality aassessments, self-reflection exercises, group discussions, SWOC analysis worksheet, Action Plan, SMART goal activities, Reflective journaling, Self-care Planning)

UNIT – II	**Emotional Intelligence and Interpersonal Skills**	

Understanding emotional intelligence and its importance - Developing self-awareness, self-regulation, and motivation - Building effective communication and interpersonal skills
- Conflict resolution and negotiation strategies.
(Activities: Emotional Intelligence Quiz, Self-Reflection exercises, feedback sessions, mindfulness exercises, Positive self-talk, Active Listening exercises, conflict-resolution Role-play, Case studies & Group activities)

UNIT – III	**Positive Thinking and Attitude**	

Understanding the power of positive thinking- Developing a growth mindset and resilience - Practicing gratitude and mindfulness- Overcoming negative thoughts and behaviors
(Activities on positive thinking, growth mindset, mindfulness and self-care plan for overcoming negative thoughts)

UNIT – IV	**Effective Communication and Presentation Skills**	

Understanding the importance of effective communication- Developing verbal and non-verbal communication skills- Preparing and delivering effective presentations- Building confidence and public speaking skills
(Activities: Group discussions, Case studies, Role-Play, Non-verbal communication exercises, Practice presentations, Peer feedback, Public speaking exercises, Storytelling, Debates)

UNIT – V	**Leadership and Teamwork**	

Understanding leadership styles and qualities - Developing leadership skills and qualities- Building effective teams and teamwork strategies- Practicing collaboration and problem-solving

(Activities: Case studies, Group discussions, Debates, Leadership role-playing, team building activities, Group projects, Collaborative problem-solving exercies, feedback sessions)

Prescribed Books

1. Daniel Goleman,*Emotional Intelligence: Why It Can Matter More Than IQ*, Bantam Books, 2017.
2. Stephen R. Covey, *The 7 Habits of Highly Effective People*, Simon & Schuster, 2020.

Reference Books

1. Dale Carnegie, *How to Win Friends and Influence People*, Simon & Schuster, 2020.
2. Brian Tracy, *Goals!: How to Get Everything You Want Faster Than You Ever Thought Possible*, Berrett-Koehler Publishers, 2021.
3. Robin Sharma, *The 5 AM Club: Own Your Morning, Elevate Your Life*, HarperCollins, 2020.
4. Carol S. Dweck, *Mindset: The New Psychology of Success*, Random House, 2016.
5. Daniel H. Pink,*Drive: The Surprising Truth About What Motivates Us*, Riverhead Books, 2018.
6. John C. Maxwell, *Leadershift: 11 Essential Changes Every Leader Must Embrace*, HarperCollins, 2019.

Online Resources

1. **Coursera** – *Personal Development Specialization* (https://www.coursera.org)
2. **edX** – *Leadership and Emotional Intelligence Courses* (https://www.edx.org)
3. **FutureLearn** – *Mindfulness and Resilience Training* (https://www.futurelearn.com)
4. **MindTools** – Practical resources on leadership, communication, and emotional intelligence (https://www.mindtools.com)
5. **Positive Psychology** – Articles and tools on resilience, gratitude, and well-being (https://positivepsychology.com)
6. **TED Talks** – Inspirational talks on leadership, communication, and self-growth (https://www.ted.com)
7. **Harvard Business Review (HBR)** – Leadership, negotiation, and workplace communication (https://hbr.org)

Course Code	YOGA FOR STRESS MANAGEMENT (Audit Course-II)	L	T	P	C
C43818c		2	0	0	0
Semester		II			

Course Objectives:

1. To make the students understand the foundational concepts of Yoga, including Ashtanga (eight limbs) as prescribed in classical texts.
2. To enable them analyze the principles of Yama and Niyama, and their role in ethical, personal, and social development.
3. To make them learn do's and don'ts of life through the practice of ahimsa, satya, astheya, brahmacharya, aparigraha, shaucha, santosh, tapa, swadhyaya, and ishwar-pranidhana.
4. To make them practice asanas and pranayama techniques for physical fitness, mental balance, and spiritual awareness.
5. To make them understand the holistic lifestyle through regular yoga practice, leading to personality development.

Course Outcomes(CO):Student will be able to

1. Explain the eight limbs of Yoga (Ashtanga) and their interrelationship in holistic development.
2. Demonstrate understanding of Yama and Niyama as ethical guidelines and apply them in personal and professional life.
3. Differentiate between do's and don'ts in daily life with reference to Yogic principles like ahimsa, satya, and swadhyaya.
4. Perform selected asanas and pranayama techniques with correct posture, breathing, and awareness.
5. Evaluate the physical, mental, and emotional benefits of yoga practices in stress reduction, concentration, and self-discipline.
6. Integrate yoga philosophy and practices into a personal routine for sustainable health and inner growth.

UNIT -I

Definitions of Eight parts of yoga.(Ashtanga)

UNIT - II

Yam and Niyam.

UNIT - III

Do's and Don'tsin life.

i) Ahinsa,satya,astheya,bramhacharya and aparigraha

ii)Shaucha,santosh,tapa,swadhyay,ishwarpranidhan

UNIT - IV

Asanand Pranayam

UNIT - V

i) Various yoga poses and their benefits for mind and body

ii) Regularization of breathing techniques and its effects-Types of pranayam

Textbooks

1. Swami Prabhavananda and Christopher Isherwood (translation & commentary), *Patanjali Yoga Sutras*,Sri Ramakrishna Math, 1953.
2. B.K.S. Iyengar, *Light on Yoga*, Thorsons, 2003.

Reference Books

1. T.K.V. Desikachar, *The Heart of Yoga: Developing a Personal Practice*, Inner Traditions 2nd Edition, 1999.
2. Acharya Yatendra, *Yoga & Stress Management*, Fingerprint Publishers, 2019
3. Yamini Muthanna, *The Power of Yoga*, Om Books International, 2015.
4. Nayaswami Devarshi, *Kriya Yoga: Spiritual Awakening for the New Age*, Ananda Sangha Publications, 2023

Online Resources

- **NPTEL / SWAYAM Online Courses** – Yoga and Physical Education modules.
- **AYUSH Ministry Website**: https://yoga.ayush.gov.in – official yoga resources, protocols, and research.
- **Yoga Journal**: https://www.yogajournal.com – practical guides, research updates, asana tutorials.

- **Art of Living Foundation**: https://www.artofliving.org – pranayama, meditation, and wellness practices.
- **YouTube Channels** (scholarly & practice-based):
    - *Sivananda Yoga Vedanta Centre*
    - *Yoga with Adriene* (for practical asana guidance)

COURSE STRUCTURE

III - SEMESTER

PROGRAMME CURRICULUM STRUCTURE UNDER R25 REGULATIONS

M. TECH - DIGITAL ELECTRONICS & COMMUNICATION SYSTEMS

SEMESTER – III

S.No.	Course codes	Course Name	Category	Hours per week			Credits	Scheme of Examination Maximum Marks		
				L	T	P		Internal	External	Total
1.	C43819a C43819b C43819c	**Program Elective – V** Voice and Data Networks Industrial Internet of Things Artificial Intelligence and Machine Learning	PE	3	0	0	3	40	60	100
2.		**Open Elective –I**	OE	3	0	0	3	40	60	100
3.	C43820	Dissertation Phase – I	PR	0	0	20	10	100	-	100
4.	C43821	Industry Internship		0	0	0	2	100	-	100
5.	C43822	Co-curricular Activities		0	0	0	1	Grade		
Total							**19**	**280**	**120**	**400**

Open Elective – I

Course code	Title of the Course	L-T-P	Credits	Offered by
C42051	Green Buildings	3-0-0	3	CE
C42052	Road Safety Engineering	3-0-0	3	CE
C45851	Advanced Data Structures & Algorithms	3-0-0	3	CSE
C45852	Cloud Computing	3-0-0	3	CSE
C45853	AI Tools	3-0-0	3	CSE
C43851	IoT and its Applications	3-0-0	3	ECE
C40751	Photovoltaic Systems	3-0-0	3	EEE
C41551	Integrated Product Design and Development	3-0-0	3	ME
C41051	Advanced Numerical Methods and Computational Mathematics	3-0-0	3	H&S
C41052	Mathematics for Machine Learning and Data Science	3-0-0	3	H&S
C41053	Statistical Learning Theory and Mathematical Foundations of AI	3-0-0	3	H&S
C41054	Chemistry Of Nanomaterials And Applications In Engineering	3-0-0	3	H&S
C41055	Photonics For Engineers	3-0-0	3	H&S

Course Code	VOICE AND DATA NETWORKS	L	T	P	C
C43819a	Program Elective – V	3	0	0	3
	Semester	III			

Course Objectives:

- To understand the protocols, algorithms, trade-offs rationale in voice and data networks.
- To understand the routing, transport, DNS resolutions in voice and data networks.
- To learn the network extensions and next generation architectures.

Course Outcomes (CO):

Students will be able to

- Understand the protocols, algorithms, trade-offs rationale in voice and data networks.
- Understand the routing, transport, DNS resolutions in voice and data networks.
- Learn the network extensions and next generation architectures.

UNIT - I Lecture Hrs:

Network Design Issues, Network Performance Issues, Network Terminology, centralized and distributed approaches for networks design, Issues in design of voice and data networks.

UNIT - II Lecture Hrs:

Layered and Layer less Communication, Cross layer design of Networks, Voice Networks (wired and wireless) and Switching, Circuit Switching and Packet Switching, Statistical Multiplexing.

UNIT - III Lecture Hrs:

Data Networks and their Design, Link layer design- Link adaptation, Link Layer Protocols, Retransmission. Mechanisms (ARQ), Hybrid ARQ (HARQ), Go Back N, Selective Repeat protocols and their analysis.

UNIT - IV Lecture Hrs:

Queuing Models of Networks, Traffic Models, Little's Theorem, Markov chains, M/M/1 and other Markov systems, Multiple Access Protocols, Aloha System, Carrier Sensing, Examples of Local area networks

UNIT - V Lecture Hrs:

Inter-networking, Bridging, Global Internet, IP protocol and addressing, Sub netting, Classless Inter domain Routing (CIDR), IP address lookup, Routing in Internet. End to End Protocols, TCP and UDP. Congestion Control, Additive Increase/Multiplicative Decrease, Slow Start, Fast Retransmit/ Fast Recovery: Congestion avoidance, RED TCP Throughput Analysis, Quality of Service in Packet Networks. Network Calculus, Packet Scheduling Algorithms.

Textbooks:

1. D. Bertsekas and R. Gallager, —Data Networks‖, 2nd Edition, Prentice Hall, 1992.
2. L. Peterson and B. S. Davie, —Computer Networks: A Systems Approach‖,5th Edition, Morgan

Reference Books:

1. Kumar, D. Manjunath and J. Kuri, —Communication Networking: An analytical approach‖, 1st Edition, Morgan Kaufman, 2004.
2. Walrand, —Communications Network: A First Course‖, 2nd Edition, McGraw Hill, 2002.
3. Leonard Kleinrock, —Queueing Systems, Volume I: Theory‖, 1st Edition, John Wiley and Sons, 1975.

Course Code	INDUSTRIAL INTERNET OF THINGS	L	T	P	C
C43819b	Program Elective – V	3	0	0	3
Semester		III			

Course Objectives: This course aims to

- To study about IoT, Sensors, IoT devices and their applications.
- To understand the operating systems and networking concepts used in IIoT deployments.
- To learn the data driven analytics and protocols for IoT.
- To gain knowledge on the IoT concepts for localization, robotic and other applications.

Course Outcomes (CO): Student will be able to

- Learn about IoT, Sensors, IoT devices and their applications.
- Gain knowledge about the operating systems and networking concepts used in IIoT deployments.
- Implement the data driven analytics and protocols for IoT.
- Apply the IoT concepts for localization, robotic and other applications.

UNIT - I Lecture Hrs:

Introduction IIoT; Market Size and Potential: Definition, IoT v IIoT, Next Generation Sensors, Sensor's calibration and validate sensor measurements, placement of IoT devices, sensors, low-cost communication system design, Top application areas include manufacturing, oil & gas, Embedded systems in the Automotive and Transportation market segment

UNIT - II Lecture Hrs:

IIoT Methodology: Top operating systems used in IIoT deployments, Networking and wireless communication protocols used in IIoT deployments. Smart Remote Monitoring Unit, components of monitoring system, control and management, Wireless Sensor Network (WSN)

UNIT – III Lecture Hrs:

Data driven Analytics of IIoT: Implementing of industrial IoT Data flow, big data and how to prepare data for machine learning algorithms, Machine Learning algorithms, supervised learning & Un-supervised learning algorithms, Basics of neural network, activation functions, back-propagation

UNIT - IV Lecture Hrs:

IP and Non-IP Protocols for IoT: WPAN, IEEE 802.15.4, Bluetooth, NFC, 6LoWPAN; RFID, Zigbee Wireless HART Protocol, MQTT, IP and Non-IP Protocols, REST, CoAP

UNIT - V Lecture Hrs:

IoT Clouds and Data Analytics: Develops a physics-based and data-driven digital equipment model to monitor assets and systems, Introduction to device localization and tracking; different types of localization techniques, Radio-Frequency Identification (RFID) and fingerprinting, Device diversity/heterogeneity issue in IIoT networks

Internet of Robotic Things (IoRT): Introduction to stationary and mobile robots, Brief introduction to localization, mapping, planning, and control of robotic systems; Introduction to cloud-enabled robotics; Applications of IIoT in robotics; Architectures for IoRT, Examples and case studies: Open issues and challenges.

Textbooks:

1. —Industry 4.0: The Industrial Internet of Things‖, Alasdair Gilchrist, Apress, 2016—
2. Introduction to Industrial Internet of Things and Industry 4.0‖,Sudip Misra, Chandana Roy, Anadarup Mukherjee, CRC Press,2021

Reference Books:

1. —Hands on Industrial Internet of Things‖, Giacomo Veneri,Antonio Capasso, Packt Press, 2018.

Course Code	ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING Program Elective – V	L	T	P	C
C43819c		3	0	0	3
Semester		III			

Course Objectives:

- To learn the difference between optimal reasoning vs human like reasoning
- To understand the notions of state space representation, exhaustive search, heuristic search along with the time and space complexities
- To learn different knowledge representation techniques
- To understand the applications of Al: namely Game Playing, Theorem Proving, Expert Systems, Machine Learning and Natural. Language Processing

Course Outcomes (CO): Student will be able to

- Possess the ability to formulate an efficient problem space for a problem expressed in English.
- Possess the ability to select a search algorithm for a problem and characterize its time and space complexities.
- Possess the skill for representing knowledge using the appropriate technique.
- Possess the ability to apply Al techniques to solve problems of Game Playing, Expert Systems, Machine Learning and Natural Language Processing.

UNIT - I Lecture Hrs:

Introduction, History, Intelligent Systems, Foundations of AI, Sub areas of AI, Applications. Problem Solving – State-Space Search and Control Strategies: Introduction, General Problem Solving, Characteristics of Problem, Exhaustive Searches, Heuristic Search Techniques, Iterative-Deepening A*, Constraint Satisfaction. Game Playing, Bounded Look-ahead Strategy and use of Evaluation Functions, Alpha-Beta Pruning

UNIT - II Lecture Hrs:

Logic Concepts and Logic Programming

Introduction, Propositional Calculus, Propositional Logic, Natural Deduction System, Axiomatic System, Semantic Tableau System in Propositional Logic, Resolution Refutation in Propositional Logic, Predicate Logic, Logic Programming. Knowledge Representation: Introduction, Approaches to Knowledge Representation, Knowledge Representation using Semantic Network, Extended Semantic Networks for KR, Knowledge Representation using Frames.

UNIT - III Lecture Hrs:

Expert System and Applications

Introduction, Phases in Building Expert Systems, Expert System Architecture, Expert Systems Vs Traditional Systems, Truth Maintenance Systems, Application of Expert Systems, List of Shells and Tools. Uncertainty Measure – Probability Theory: Introduction, Probability Theory, Bayesian Belief Networks, Certainty Factor Theory, Dempster-Shafer Theory.

UNIT - IV Lecture Hrs:

Machine-Learning Paradigms

Introduction. Machine Learning Systems. Supervised and Unsupervised Learning. Inductive Learning. Learning Decision Trees (Text Book 2), Deductive Learning. Clustering, Support Vector Machines. Artificial Neural Networks: Introduction, Artificial Neural Networks, Single- Layer Feed-Forward Networks, Multi-Layer Feed-Forward Networks, Radial- Basis Function Networks, Design Issues of Artificial Neural Networks, Recurrent Networks.

UNIT - V Lecture Hrs:

Advanced Knowledge Representation Techniques

Case Grammars, Semantic Web Natural Language Processing: Introduction, Sentence Analysis Phases, Grammars and Parsers, Types of Parsers, Semantic Analysis, Universal Networking Knowledge.

Textbooks:

1. Saroj Kaushik. Artificial Intelligence. Cengage Learning, 2011.
2. Russell, Norvig: Artificial intelligence, A Modern Approach, Pearson Education, Second Edition. 2004.

Reference Books:

1. Rich, Knight, Nair: Artificial intelligence, Tata McGraw Hill, Third Edition 2009.

OPEN ELECTIVES

Course Code	GREEN BUILDINGS	L	T	P	C
C42051	(Open Elective - I)	3	0	0	3

Course Objectives (COs)

The objectives of this course are:

1. **To understand** the fundamental concepts of green buildings, their necessity, and sustainable features. (Understanding - Level 2)
2. **To analyze** green building concepts, rating systems, and their benefits in India. (Analyzing - Level 4)
3. **To apply** green building design principles, energy efficiency measures, and renewable energy sources. (Applying - Level 3)
4. **To evaluate** air conditioning systems, HVAC designs, and energy modeling for sustainable buildings. (Evaluating - Level 5)
5. **To assess** material conservation strategies, waste management, and indoor environmental quality in green buildings. (Evaluating - Level 5)

Course Outcomes (COs)

Upon successful completion of the course, students will be able to:

1. **Understand** the importance of green buildings, their necessity, and sustainable features. (Understanding - Level 2)
2. **Analyze** various green building practices, rating systems, and their impact on environmental sustainability. (Analyzing - Level 4)
3. **Apply** principles of green building design to enhance energy efficiency and incorporate renewable energy sources. (Applying - Level 3)
4. **Evaluate** HVAC systems, energy-efficient air conditioning techniques, and their role in sustainable building design. (Evaluating - Level 5)
5. **Assess** material conservation techniques, waste reduction strategies, and indoor air quality management in green buildings. (Evaluating - Level 5)

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO -1	3	-	-	-	-	2	3	-	-	-	-	-	3	3
CO -2	-	3	-	-	2	-	3	-	-	-	-	2	3	3
CO -3	-	-	3	3	3	-	3	-	-	-	-	-	3	3
CO -4	-	-	3	3	3	-	3	-	-	-	-	-	3	3
CO -5	-	-	-	-	-	3	3	3	2	-	-	-	-	3

UNIT-I

Introduction to Green Building – Necessity of Green Buildings, Benefits of Green Buildings, Green Building Materials and Equipment in India, Key Requisites for Constructing a Green Building, Important Sustainable Features for Green Buildings.

UNIT-II

Green Building Concepts and Practices – Indian Green Building Council, Green Building Movement in India, Benefits Experienced in Green Buildings, Launch of Green Building Rating Systems, Residential Sector, Market Transformation; Green Building Opportunities and Benefits: Opportunities of Green Buildings, Green Building Features, Material and Resources, Water Efficiency, Optimum Energy Efficiency, Typical Energy-Saving Approaches in Buildings, LEED India Rating System, and

Energy Efficiency.

UNIT-III

Green Building Design – Introduction, Reduction in Energy Demand, Onsite Sources and Sinks, Maximizing System Efficiency, Steps to Reduce Energy Demand and Use Onsite Sources and Sinks, Use of Renewable Energy Sources, Eco-friendly Captive Power Generation for Factories, Building Requirements.

UNIT-IV

Air Conditioning – Introduction, CII Godrej Green Business Centre, Design Philosophy, Design Interventions, Energy Modeling, HVAC System Design, Chiller Selection, Pump Selection, Selection of Cooling Towers, Selection of Air Handling Units, Pre-cooling of Fresh Air, Interior Lighting Systems, Key Features of the Building, Eco-friendly Captive Power Generation for Factories, Building Requirements.

UNIT-V

Material Conservation – Handling of Non-Process Waste, Waste Reduction During Construction, Materials with Recycled Content, Local Materials, Material Reuse, Certified Wood, Rapidly Renewable Building Materials and Furniture. Indoor Environment Quality and Occupational Health – Air Conditioning, Indoor Air Quality, Sick Building Syndrome, Tobacco Smoke.

Text Books:

1. Handbook on Green Practices published by Indian Society of Heating Refrigerating and Air conditioning Engineers, 2009.
2. Green Building Hand Book by Tomwoolley and Samkimings, 2009.

Reference :-

1. Complete Guide to Green Buildings by Trish riley
2. Standard for the design for High Performance Green Buildings by Kent Peterson, 2009
3. Energy Conservation Building Code –ECBC-2020, published by BEE

Course Code	ROAD SAFETY ENGINEERING	L	T	P	C
C42052	(Open Elective - I)	3	0	0	3

Course Objectives: This Course has the following objectives:

- Discusses the fundamentals causes of road accidents & some of the statistical methods toanalyzethe traffic safety.
- The accident investigation and risk management are dealt.
- Introduction of Road Safety as an integral part of Road Design is emphasized.

Course Outcomes (CO): After completion of the course the student will be able

- To understand the basic causes of road accidents
- To conduct accident investigations and identify black spots
- To design & plan road geometrics incorporating road safety
- To understand the importance of Road Signs and Markings
- To conduct Road Safety Audit

UNIT - I — Lecture Hrs:10

Accident Investigations and Risk Management, Collection of Accident Data, Assessment of Road Safety, Methods to Identify and Prioritize Hazardous Locations and Elements, Determine Possible Causes of Crashes, Crash Reduction Capabilities and Countermeasures, Effectiveness of Safety Design Features, Accident Reconstruction, Condition and Collision Diagram.

UNIT - II — Lecture Hrs:10

Traffic Engineering Studies; Statistical Methods In Traffic Safety Analysis –Regression Methods, Poisson Distribution, Chi- Squared Distribution, Statistical Comparisons- Traffic Management Measures And Their Influence On Accident Prevention.

UNIT - III — Lecture Hrs:10

Road Safety in ` Transport Planning and Geometric Design: Vehicle and Human Characteristics, Road Design and Safety Elements, Redesigning Junctions, Cross Section Improvements, Traffic Control, Traffic Calming Measures, Road Safety Furniture

UNIT - IV — Lecture Hrs:9

**Role of Signs and Markings in ` Safety**: Types of Signs – Design Specifications – Guidelines for Installation – Role of Signs in `Safety; Types of Road Markings – Design Specifications – Role of Road Markings in `Safety.

UNIT - V — Lecture Hrs:9

Traffic Management Systems for Safety, Road Safety Audits and Tools for Safety Management Systems, Road Safety Audit Process, Road Safety Improvement Strategies, ITS and Safety.

Textbooks:

1. Traffic Engineering and Transportation Planning – L.R. Kadiyali, Khanna Publishers
2. Fundamentals of Transportation Engineering - C.S.Papacostas, Prentice Hall India.
3. Road Safety by NCHRP

Reference Books:

1. Transportation Engineering – An Introduction, C.Jotin Khisty, B. Kent Lall
2. Fundamentals of Traffic Engineering, Richardo G Sigua
3. Handbook of Road Safety Measures, Second Edition, Rune Elvik, Alena Hoye, TrulsVaa, Michael Sorenson

Course Code	ADVANCED DATA STRUCTURES AND ALGORITHMS (Open Elective - I)	L	T	P	C
C45851		3	0	0	3

Course Objectives:

The course aims to:

1. Introduce fundamental data structures including linked lists, stacks, queues, trees, graphs, dictionaries, and hashing techniques.
2. Develop algorithmic skills for designing and analyzing searching, sorting, and traversal methods.
3. Teach implementation of priority queues, binary search trees, and balanced trees (AVL, Red-Black, Splay, B-Trees).
4. Enable students to select and apply appropriate data structures for solving computational problems efficiently.
5. Foster understanding of the performance analysis and comparative evaluation of data structures and algorithms.

Course Outcomes:

After completing this course, students will be able to:

CO1: Implement and manipulate linear data structures like singly/doubly linked lists, circular lists, stacks, and queues using dynamic memory allocation.
CO2: Apply and analyze searching and sorting algorithms including linear, binary search, bubble, selection, insertion, quick, and merge sort.
CO3: Design and implement dictionaries and hashing techniques to efficiently store and retrieve data. **CO4:** Construct and operate on trees and priority queues, performing insertion, deletion, and traversal operations.
CO5: Compare and implement balanced search trees (AVL, Red-Black, Splay, B-Trees) for optimized data access and storage.

UNIT I: Introduction
Introduction to Data Structures, Singly Linked Lists, Doubly Linked Lists, Circular Lists-Algorithms. Stacks and Queues: Algorithm Implementation using Linked Lists.

UNIT II: Searching and Sorting:
Linear and Binary Search Methods, Sorting: -Basic sorting techniques, Radix Sort, Bucket Sort, Shell Sort Trees- Binary trees, Properties, Representation and Traversals, Expression Trees (Infix, prefix, postfix). Graphs-Basic Concepts, Storage structures and Traversals.

UNIT III: :Dictionaries and Hashing

Dictionaries: Definition, Dictionary Abstract Data Type, Implementation of Dictionaries.
Hashing: Review of Hashing, Hash Function, Collision Resolution Techniques in Hashing, Separate Chaining, Open Addressing, Linear Probing, Quadratic Probing, Double Hashing, Rehashing, Extendible Hashing

UNIT IV: Priority queues
Definition, ADT, Realizing a Priority Queue Using Heaps, Definition, Insertion, Deletion .Search Trees-Binary Search Trees, Definition, ADT, Implementation, Operations-Searching,

Insertion, Deletion.

UNIT V: Search Trees-

AVL Trees, Definition, Height of AVL Tree, Operations-, Insertion, Deletion and Searching, Introduction to Red-Black and Splay Trees, B-Trees, Height of B-Tree, Insertion, Deletion and Searching, Comparison of Search Trees.

Text Books:

1. Data Structures: A Pseudo Code Approach, 2/e, Richard F.Gilberg, Behrouz A. Forouzon and Cengage
2. Data Structures, Algorithms and Applications in java, 2/e, SartajSahni, University Press

Reference Books:

1. Data Structures and Algorithm Analysis, 2/e, Mark Allen Weiss, Pearson.
2. Data Structures and Algorithms, 3/e, Adam Drozdek, Cengage
3. C and Data Structures: A Snap Shot Oriented Treatise Using Live Engineering Examples, N.B.Venkateswarulu, E.V.Prasad and S Chand & Co.

Course Code	CLOUD COMPUTING	L	T	P	C
C45852	(Open Elective - I)	3	0	0	3

Course Objectives:

- Analyze the trade-offs between deploying applications in the cloud and over the local infrastructure. Compare the advantages and disadvantages of various cloud computing platforms.
- Investigate how a global storage solution can be optimized so that it can be delivered successfully from the cloud
- Evaluate information storage management design in a cloud environment and how it relates to the business objectives of an organization
- Analyze how best to provide reliable access to information both locally and remotely using storage technologies
- Critically appraise the opportunities and challenges of information management in complex business environments.

Course Outcomes:

After the completion of the course, student will be able to

- Deploy applications over commercial cloud computing infrastructures such as Amazon Web Services, Windows Azure, and Google App Engine.
- Program data intensive parallel applications in the cloud.
- Analyze the performance, scalability, and availability of the underlying cloud technologies and software.
- Identify security and privacy issues in cloud computing.
- Solve a real-world problem using cloud computing through group collaboration.

UNIT–I:

Definition, characteristics, components, Cloud service provider, the role of networks in Cloud computing, Cloud deployment models- private, public & hybrid, Cloud service models, multitenancy, Cloud economics and benefits, Cloud computing platforms - IaaS: Amazon EC2, PaaS: Google App Engine, Microsoft Azure, SaaS.

UNIT–II:

Virtualization concepts, Server virtualization, Storage virtualization, Storage services, Network virtualization, Service virtualization, Virtualization management, Virtualization technologies and architectures, virtual machine, Measurement and profiling of virtualized applications. Hypervisors: KVM, Xen, VMware hypervisors and their features

UNIT–III: Relational databases, Cloud file systems: GFS and HDFS, Bigtable, HBase and Dynamo. MapReduce and extensions: Parallel computing, the map -Reduce model, Parallel efficiency of Map Reduce.

UNIT–IV: Cloud security fundamentals, Vulnerability assessment tool for cloud, Privacy and Security in cloud. Cloud computing security architecture: General Issues, Trusted Cloud computing, Secure Execution Environments and Communications, Micro - architectures; Identity Management and Access control, Autonomic security.

UNIT–V: Issues in cloud computing Implementing real time application over cloud platform, Issues in Inter - cloud environments, QOS Issues in Cloud, Dependability, data migration, streaming in Cloud. Quality of Service (QoS) monitoring in a Cloud computing environment. Cloud Middleware.

TEXT BOOKS:

1. Enterprise Cloud Computing by Gautam Shroff, Cambridge publication

2. Gautam Shroff, —Enterprise Cloud Computing Technology Architecture Applications‖, Cambridge University Press; 1 edition, [ISBN: 978-0521137355], 2010.

REFERENCE BOOKS:

1. Cloud Security by Ronald Krutz and Russell Dean Vines, Wiley -India

2. Dr. Kumar Saurabh, —Cloud Computing‖, Wiley Publication

3. Dimitris N. Chorafas, —Cloud Computing Strategies‖ CRC Press; 1 edition [ISBN: 1439834539],2010 4. Toby Velte, Anthony Velte, Robert Elsenpeter, —Cloud Computing, A Practical Approach‖ McGraw Hill Osborne Media; 1 edition [ISBN: 0071626948], 200

5. RajkumarBuyya, James Broberg, Andrzej M. Goscinski, —Cloud Computing: Principles and Paradigms‖, Wiley Publication, 2011

6. Tim Mather, SubraKumaraswamy, Shahed Latif, —Cloud Security and Privacy: An Enterprise Perspective on Risks and Compliance‖, O'ReillyMediaInc, 2009

Course Code	AI TOOLS	L	T	P	C
C45853	(Open Elective - I)	3	0	0	3

COURSE OUTCOMES (COs)

After completing the course, the student will be able to:

- CO1: Explain the fundamentals and evolution of AI tools
- CO2: Use AI tools for text, language, and communication tasks
- CO3: Apply AI tools for image, audio, and video generation
- CO4: Utilize AI tools for coding, research, and productivity enhancement
- CO5: Analyze ethical, security, and application-oriented aspects of AI tools

COURSE OBJECTIVES (COBJ)

After completing this course, students will be able to:

- Understand the fundamentals and evolution of AI tools
- Explore popular AI tools for text, image, video, and code generation
- Apply AI tools in education, research, and industry use cases
- Analyze ethical, security, and societal implications of AI tools
- Develop practical skills to effectively use AI tools for productivity and innovation

UNIT–I: Introduction to AI Tools

Definition of Artificial Intelligence, Evolution of AI and Intelligent Systems, Categories of AI Tools (Generative, Analytical, Assistive), Rule-based vs Learning-based AI Tools, Overview of Machine Learning & Deep Learning Tools, AI Tool Ecosystem (OpenAI, Google, Meta, Microsoft), Cloud-based AI Tools, Future Trends in AI Tool Development

UNIT–II: Text & Language AI Tools

Natural Language Processing (NLP) Basics, ChatGPT – Architecture and Capabilities, Prompt Engineering Concepts, AI Tools for Content Writing, AI Tools for Email, Resume & Report Generation, AI-based Translation and Summarization Tools, AI Chatbots and Virtual Assistants, Limitations and Bias in Language AI Tools.

UNIT–III: Image, Audio & Video AI Tools

Image Generation Tools (DALL·E, Midjourney, Stable Diffusion), Image Editing and Enhancement using AI, AI Tools for Graphic Design & Posters, Text-to-Speech AI Tools (ElevenLabs, Google TTS), Speech-to-Text AI Tools, AI-based Video Creation Tools, Avatar and Animation AI Tools, Applications in Media, Education & Healthcare

UNIT–IV: AI Tools for Coding, Research & Productivity

AI Tools for Programming Assistance, Code Generation and Debugging using AI, AI Tools for Data Analysis, AI Tools for Research Paper Writing, AI Tools for Literature Survey and Citations, AI in Project Management, AI Tools for Presentation Creation, AI Tools for Automation and Workflow Optimization

UNIT–V: Ethical, Security & Applied AI Tools

Ethical Issues in AI Tool Usage, Data Privacy and Security Concerns, AI Tool Regulations and Policies, AI Tools in Education, AI Tools in Healthcare, AI Tools in Finance and Business, AI Tools in Smart Cities and Governance, Responsible and Sustainable AI Practices

TEXT BOOKS

1. Stuart Russell and Peter Norvig, Artificial Intelligence: A Modern Approach, 4th Edition, Pearson Education, 2021.
2. Michael Miller, AI for Everyone, Pearson, 2020.
3. Liam Ottley, Artificial Intelligence for Business, Wiley, 2022.

REFERENCE BOOKS

1. **Kai-Fu Lee**, *AI Superpowers: China, Silicon Valley, and the New World Order*, Houghton Mifflin Harcourt, 2018.
2. **Bernard Marr**, *Artificial Intelligence in Practice*, Wiley, 2020.

3. **Ethical Guidelines for Trustworthy AI**, European Commission, 2019.

Course Code	IOT AND ITS APPLICATIONS	L	T	P	C
C45853	(Open Elective - I)	3	0	0	3

Course Objectives:

- To apply the Knowledge in IOT Technologies and Data management.
- To determine the values chains Perspective of M2M to IOT.
- To implement the state of the Architecture of an IOT.
- To compare IOT Applications in Industrial & real world.
- To demonstrate knowledge and understand the security and ethical issues of an IOT.

Course Outcomes (CO): Student will be able to

- Apply the Knowledge in IOT Technologies and Data management.
- Determine the values chains Perspective of M2M to IOT.
- Implement the state of the Architecture of an IOT.
- Compare IOT Applications in Industrial & real world.
- Demonstrate knowledge and understand the security and ethical issues of an IOT.

UNIT - I		Lecture Hrs:

Fundamentals of IoT: Evolution of Internet of Things, Enabling Technologies, IoT Architectures, oneM2M, IoT World Forum (IoTWF) and Alternative IoT models, Simplified IoT Architecture and Core IoT Functional Stack, Fog, Edge and Cloud in IoT, Functional blocks of an IoT ecosystem, Sensors, Actuators, Smart Objects and Connecting Smart Objects.
IoT Platform overview: Overview of IoT supported Hardware platforms such as: Raspberry pi, ARM Cortex Processors, Arduino and Intel Galileo boards.

UNIT - II		Lecture Hrs:

IoT Protocols: IT Access Technologies: Physical and MAC layers, topology and Security of IEEE 802.15.4, 802.15.4g, 802.15.4e, 1901.2a, 802.11ah and Lora WAN, Network Layer: IP versions, Constrained Nodes and Constrained Networks, Optimizing IP for IoT: From 6LoWPAN to 6Lo, Routing over Low Power and Lossy Networks, Application Transport Methods: Supervisory Control and Data Acquisition, Application Layer Protocols: CoAP and MQTT.

UNIT - III		Lecture Hrs:

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

UNIT - IV		Lecture Hrs:

Data Analytics and Supporting Services: Structured Vs Unstructured Data and Data in Motion Vs Data in Rest, Role of Machine Learning – No SQL Databases, Hadoop Ecosystem, Apache Kafka, Apache Spark, Edge Streaming Analytics and Network Analytics, Xively Cloud for IoT, Python Web Application Framework, Django, AWS for IoT, System Management with NETCONF-YANG.

UNIT - V		Lecture Hrs:

Case Studies/Industrial Applications: IoT applications in home, infrastructures, buildings, security, Industries, Home appliances, other IoT electronic equipments. Use of Big Data and Visualization in IoT, Industry 4.0 concepts. Sensors and sensor Node and interfacing using any Embedded target boards (Raspberry Pi / Intel Galileo/ARM Cortex/ Arduino).

Textbooks:

1. IoT Fundamentals: Networking Technologies, Protocols and Use Cases for Internet of Things, David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Rob Barton and Jerome Henry, Cisco Press, 2017.
2. Internet of Things – A hands-on approach, Arshdeep Bahga, Vijay Madisetti, Universities Press,2015

Reference Books:

1. The Internet of Things – Key applications and Protocols, Olivier Hersent, David Boswarthick, Omar Elloumi and Wiley, 2012 (for Unit 2).
2. —From Machine-to-Machine to the Internet of Things – Introduction to a New Age of Intelligence‖, Jan Holler, Vlasios Tsiatsis, Catherine Mulligan, Stamatis, Karnouskos, Stefan Avesand. David Boyle and Elsevier, 2014.
3. Architecting the Internet of Things, Dieter Uckelmann, Mark Harrison, Michahelles and Florian (Eds), Springer, 2011.

Course Code	PHOTOVOLTAIC SYSTEMS	L	T	P	C
C40751	(Open Elective - I)	3	0	0	3

Course Objectives:

- To introduce photovoltaic systems.
- To deal with various technologies of solar PV cells.
- To understand details about manufacture, sizing and operating techniques.
- To have knowledge of design considerations.

Course Outcomes (CO): Student will be able to

- Identify photovoltaic system components and system types. L2
- Calculate electrical energy and power. L2
- Correctly size system components, design considerations of solar equipment. L3
- Design a basic grid-tie PV system. L5

UNIT - I	SOLAR ENERGY	Lecture Hrs:10

Sun and Earth, Solar Spectrum, Solar Geometry, Solar radiation on horizontal and inclined planes, Instruments for measurement of solar radiation, Solar cell, Equivalent circuit, V-I characteristics, Performance improvement.

UNIT - II	SOLAR CELLS	Lecture Hrs:8

Manufacture of Solar Cells-Technologies, Design of Solar cells, Photovoltaic modules, Design requirements, Encapsulation systems, Manufacture, Power rating, Hotspot effect, Design qualifications.

UNIT - III	PROTECTION AND MEASUREMENTS	Lecture Hrs:12

Flat plate arrays, Support structures, Module interconnection and cabling, Lightning protection, Performance measurement using natural sun light and simulator, Determination of temperature coefficients, Internal series resistance, Curve correction factor.

UNIT - IV	PHOTOVOLTAIC SYSTEMS	Lecture Hrs:8

Photovoltaic systems, Types, General design considerations, System sizing, Battery sizing, Inverter sizing, Design examples, Balance of PV systems.

UNIT - V	MAXIMUM POWER POINT TRACKERS	Lecture Hrs:10

Maximum power point trackers, Perturb and observe, Incremental conductance method, Hill climbing method,
Hybrid and complex methods, Data based and other approximate methods, Instrument design, Other MPP techniques, Grid interactive PV system.

Textbooks:

1. F.C.Treble, —Generating electricity from Sun‖, Pergamon Press.
2. A.K.Mukherjee, Nivedita Thakur,‖ Photovoltaic systems: Analysis and design‖, PHI, 2011.

Reference Books:

1. C.S.Solanki,‖ Solar Photovoltaic's: Fundamentals, Technologies and applications‖, PHI, 2009.

Online Learning Resources:

1. https://nptel.ac.in/courses/117108141

Course Code	INTEGRATED PRODUCT DESIGN AND DEVELOMENT Open Elective-I	L	T	P	C
C41551		3	0	0	3

Course Objectives:

- To know the design concepts, product development planning and customer requirements
- To generate the concept using creative problem solving methods, concept generation and testing
- To understand product teardown, specifications, portfolios and Architecture, configurations and detailed design with prototyping
- To acquaint DFN process and know design aspects for risk, reliability and safety and environments
- To do industrial design, intellectual property and robust design and product development economics

Course Outcomes (CO): Student will be able to

- Understand To know the design concepts, product development planning and customer requirements
- Generate the concept using creative problem solving methods, concept generation and testing
- Realize Product Teardown, Specifications, Portfolios and Architecture, configurations and prototyping
- Demonstrate and classify The Design aspects for Risk, Reliability and Safety and environments
- Do industrial design, understand intellectual property, robust design and product development economics

UNIT - I	PRODUCT DEVELOPMENT CONCEPTS	Lecture Hrs:09

Design Concepts: Design process – Considerations of a good design – Description of good design process – Design codes and standards. Product Development and Planning Process: Characteristics and challenges of product development – Concept development – Generic product development – Product development process flows –Tyco product development – Product development organizations – Organizational structure and design – Product and process cycles – Technological innovation – Structure of opportunity – Opportunity identification – Product planning process – Types of product development projects. **Identifying Customer Needs**: Process of identifying customer needs – Customer requirements.

UNIT - II	CONCEPT SELECTION, GENERATION AND TESTING	Lecture Hrs:09

Concept Generation: Activity – Concept generation process – Creativity and problem solving – Creative thinking methods and design – Functional decomposition and synthesis – Morphological methods – Axiomatic design.

Concept Selection and Testing: Development process – Choosing a concept – Concept screening and scoring – Decision making and evaluation – Methods for testing product concepts.

UNIT - III	EMBODIMENT AND DETAIL DESIGN	Lecture Hrs:09

Product Teardown, Specifications, Portfolios and Architecture: Teardown process, methods and applications – Post teardown report – Benchmarking approach and support tools for benchmarking process – Product portfolios architecture – Architecture type – Platform architecture – Target Specifications – Setting the final specifications – Modularity – Implications of the architecture – Establishing the architecture – Delayed differentiation – Platform planning – Related system-level design.

Configuration and Detail Design: Generating, analyzing and evaluating configuration design – Best practices for configuration design – Design for X – Design and manufacturing information – Final design review – Activities beyond detail design.

Prototyping: Principles, types and technologies – Understanding prototypes and planning.

UNIT - IV	**DESIGN FOR ENVIRONMENT, MANUFACTURING AND SAFETY**	Lecture Hrs:09

Design for Manufacture and Environment: Cross-functional team – Overview of DFM process – Life cycles – Environmental impacts – Design for environment process.

Design for Risk, Reliability and Safety: Classification of societal hazards – Standards – Risk assessment – Design for reliability – Causes of unreliability – Minimizing failure – FMEA – Fault tree analysis – Defects and failure modes – Potential dangers – Guidelines for design for safety – Warning labels.

UNIT - V	**INDUSTRIAL DESIGN AND PRODUCT DEVELOPMENT ECONOMICS**	Lecture Hrs:09

Industrial Design: Need – Impact – Industrial design process – Management of the industrial design process –Assessing the quality of industrial design. **Robust Design:** Robust design process. **Intellectual Property:** Disclosure – Process of pursuing a patent.

Product Development Economics: Elements of economic analysis and process.

Managing Projects: Understanding and representing tasks – Baseline project planning – Accelerating projects – Project execution – Postmortem project evaluation - Project Portfolio Management (PPM) - Earned Value Management (EVM) - Sustainability and ESG in Project Management.

Textbooks:

1. Product Design and Development, Karl T Ulrich, Steven D Eppinger and Maria C. Yang, 7/e, 2020,McGraw-Hill Education Pvt.Ltd., Noida.
2. Engineering Design, George E.Dieter and Linda C.Schmidt, 4/e, 2013, McGraw-Hill Education Pvt.Ltd.,Noida.

Reference Books:

1. Product Design, Kevin Otto and Kristin Wood, 1/e, 2003, Pearson Education, India.
2. Product Development, Anil Mital, Anoop Desai, Anand Subramanian and Aashi Mital, 1/e, 2007, Butterworth-Heinemann, Elsevier.
3. Integrated Product and Process Design and Development: the Product Realization Process (Special Indian Edition), Edward B. Magrab, Satyandra K. Gupta, F. Patrick McCluskey and Peter A. Sandborn, 2/e, 2010, CRC Press, Taylor & Francis Group, LLC.
4. Product Design for Engineers, Devdas Shetty, 1/e, 2016, Cengage Learning, India.
5. Introduction to Product Design and Development for Engineers, Ali Jamnia, 2018, CRC Press,Taylor & Francis Group, LLC.

Online Learning Resources:

1. **https://onlinecourses.nptel.ac.in/noc25_me121/preview**
2. **https://onlinecourses.swayam2.ac.in/imb25_mg123/preview**

Couse Code	ADVANCED NUMERICAL METHODS AND COMPUTATIONAL MATHEMATICS (Open Elective - I)	L	T	P	C
C41051		3	0	0	3

Program Outcomes (as per NBA for PG Engineering Programs)

- **PO1:** An ability to independently carry out research/investigation and development work to solve practical problems.
- **PO2:**An ability to write and present a substantial technical report/document.
- **PO3:** Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program; the mastery should be at a level higher than the requirements of the bachelor program.

Course Objectives:

- Equip students to analyze, design, and implement stable, accurate, and efficient numerical algorithms for large‑ scale models across engineering domains.
- Develop mastery in discretization, linear algebra, and optimization techniques, supported by modern scientific computing tools and reproducible workflows.
- Integrate high‑ performance computing paradigms to solve realistic, data‑ and compute‑ intensive problems.

Course Outcomes (COs):

- CO1: Analyze conditioning, stability, and error behavior of numerical linear algebra routines for dense and sparse problems (L3, L4).
- CO2: Derive and apply finite difference for BVP for linear and nonlinear models (L3, L4, L5).
- CO3: Derive and apply finite difference for PDE models; assess consistency and stability with Lax equivalence and CFL ideas(L3, L4).
- CO4: Optimize engineering models via unconstrained/constrained methods; justify algorithm selection and tuning using theory and diagnostics (L4, L5).
- CO5: Integrate GPU/MPI paradigms and the SciPy stack to build scalable, reproducible computational workflows; profile and validate results (L4, L5).

CO–PO Articulation Matrix

	PO1	PO2	PO3
CO1	2	1	2
CO2	3	1	3
CO3	3	1	3
CO4	3	2	3
CO5	3	3	3
1 = low, 2 = moderate, 3 = high			

Course Contents:

Unit I — Numerical Linear Algebra

- Floating‑ point arithmetic, conditioning, stability, backward/forward error.
- Direct solvers: LU/Cholesky/QR; pivoting and orthogonality.
- SVD, low‑ rank approximations, pseudoinverses.
- Iterative solvers: Jacobi/Gauss–Seidel/CG/GMRES; basic preconditioning.
- Sparse matrix formats and operations for large‑ scale systems.
- Krylov subspace and Arnoldi/Lanczos overviews.

Unit II — Discretization of linear and nonlinear ODEs

- Numerical solutions of initial value problems: (single step and multi -step methods)
- Stability of the numerical methods for initial value problems.
- Boundary value problems; shooting method.
- Finite difference for BVP (second and higher order methods), for linear and nonlinear problems

- Consistency–stability–convergence

Unit III — Discretization of linear and nonlinear PDEs

- Finite difference methods for parabolic problems explicit and implicit methods,
- Finite difference for hyperbolic explicit and implicit methods
- Elliptic PDE.
- Consistency, Stability and convergence.
- Lax equivalence and CFL (Courant–Friedrichs–Lewy) ideas.
- Iterative solvers and multigrid overview for discretized systems.

Unit IV — Numerical Optimization and Inverse Problems

- Unconstrained methods: gradient, Newton, quasi− Newton, trust− region.
- Constrained methods: KKT conditions, interior− point, SQP principles.
- Nonlinear least squares: Gauss–Newton and Levenberg–Marquardt.
- Regularization (Tikhonov/L1) and model selection concepts.
- Scientific Python stack:scipy.optimize.minimize, scipy.optimize.linprog, and scipy.optimize.curve_fit; solver choice and diagnostics.

Unit V — High- Performance Scientific Computing

- Parallel paradigms: data/task parallelism; domain decomposition fundamentals.
- GPU programming model: threads/warps/memory hierarchy; CUDA libraries.
- MPI and PETSc for scalable sparse linear algebra and time− steppers.
- Performance engineering: profiling, locality, and roofline− style thinking.
- Python at scale: NumPy/SciPy sparse andvectorization; brief Numba/CuPy ecosystem.
- End− to− end case sketches in CFD/structures/machine learning numerics.

Textbooks:

1. Trefethen, L. N., and D. Bau III, Numerical Linear Algebra, Twenty− Fifth Anniversary Edition, SIAM, 2023.
2. LeVeque, R. J., Finite Difference Methods for Ordinary and Partial Differential Equations: Steady− State and Time− Dependent Problems, SIAM, 2007.
3. Nocedal, J., and S. J. Wright, Numerical Optimization, 2nd ed., Springer, 2006.

References:

1. Hwu, W.− M. W., and D. B. Kirk, Programming Massively Parallel Processors: A Hands− on Approach, 4th ed., Elsevier, 2022.
2. B. N. dutta, —Numerical linera algebra and Application, - Springer Publications
3. SciPy Project. —Optimization (scipy.optimize) — SciPy Manual‖ and —Optimization and Root Finding — SciPy 1.16.2 (stable) Reference.‖
4. Balay, S., et al. PETSc/TAO Users Manual. Argonne National Laboratory, ANL-21/39 Rev 3.18release documentation.
5. Logg, A., K.− A. Mardal, and G. N. Wells (eds.). Automated Solution of Differential Equations by the Finite Element Method: The FEniCS Book. Berlin: Springer, 2012.
6. David Kincaid Ward Chenery, — Numerical analysis Mathematics of scientific computing, - AMS Book publishers.
7. M. K. Jain, S. R. K. Iyengar and R. K. Jain, — Computational Methods for Partial Differential Equations, - New Age publications.

Couse Code	MATHEMATICS FOR MACHINE LEARNING AND DATA SCIENCE (Open Elective - I)	L	T	P	C
C41052		3	0	0	3

Program Outcomes(as per NBA for PG Engineering Programs)

- **PO1:** Ability to independently carry out research/investigation and development work to solve practical problems
- **PO2:** Ability to write and present a substantial technical report/document
- **PO3:** Demonstrate mastery in the program specialization at a level higher than the bachelor's program requirements

Course Objectives

- Equip students with rigorous linear algebra, optimization, and probabilistic tools that underpin modern ML and data science across engineering domains.
- Enable cross‑ disciplinary modeling, inference, and decision‑ making using mathematically principled methods and uncertainty quantification.
- Develop capability to analyze, formulate, and validate algorithms with provable properties and computational efficiency for real‑ world applications.

Course Outcomes (COs)

- **CO1:** Analyze linear models and matrix factorizations for dimensionality reduction and feature representation (L3, L4)
- **CO2:** Formulate and solve convex and constrained optimization problems; compare first‑ and second‑ order methods (L4,L5)
- **CO3:** Apply probabilistic modeling, Bayesian inference, and information‑ theoretic measures to estimation and generalization (L3, L4, L5)
- **CO4:** Prove convergence properties or error bounds for selected learning algorithms such as SGD and regularized estimators (L4, L5)
- **CO5:** Evaluate and integrate methods into applications such as PCA, SVMs, and neural networks with appropriate regularization (L3, L4, L5)

CO–PO Articulation Matrix (1–3 scale)

	PO1	PO2	PO3
CO1	2	1	3
CO2	3	1	3
CO3	3	2	3
CO4	3	2	3
CO5	2	2	3
1 = low, 2 = moderate, 3 = high			

Course Contents

Unit I — Linear Algebra Foundations

- Vector spaces, norms, inner products, orthogonality, and projections
- Eigenvalues/eigenvectors, spectral theorem, and invariant subspaces

- Singular value decomposition, low− rank approximations, and Eckart–Young
- Matrix calculus for ML; gradients/Jacobians/Hessians in matrix form
- Numerical linear algebra: conditioning, stability, power/QR methods
- Feature whitening and centering; PCA link to covariance eigenstructure

Unit II — Optimization for Learning

- Unconstrained methods: gradient descent, line search, Newton/quasi− Newton
- Constrained optimization: Lagrange multipliers, projected and barrier methods
- Convex sets/functions, KKT conditions for nonlinear programing problems.
- Regularization: l_1/l_2penalties, bias–variance trade− offs in risk minimization
- Convergence rates and step− size strategies in deterministic models.

Unit III — Probability and Statistical Learning

- Random variables, expectations, covariance; exponential family basics
- Bayesian inference: conjugacy, MAP vs. MLE, posterior predictive analysis
- Hypothesis testing and confidence intervals for model comparison
- Information measures: entropy, KL divergence, mutual information in learning
- Generalization, overfitting, and model selection criteria(e.g., AIC/BIC/VC-style capacity).
- Concentration and uncertainty quantification for predictions

Unit IV — Models and Algorithms

- Linear and kernel methods: least squares, logistic regression, and SVMs
- Dimensionality reduction: PCA, kernel PCA, and manifold intuition
- Probabilistic models: Naive Bayes, Gaussian mixtures, EM overview
- Neural network mathematics: backpropagation, initialization, normalization
- Regularization schemes: weight decay, early stopping, dropout perspectives

Unit V — Integrative Applications and Worked Examples

- End− to− end ML pipelines: preprocessing, scaling/whitening, and feature engineering
- PCA− based exploration and anomaly detection in high− dimensional data
- SVMs and convex models for fault diagnosis and predictive maintenance
- Bayesian A/B testing and decision− making under uncertainty
- Neural network design trade− offs: capacity, optimization, and generalization
- Model evaluation: calibration, ROC/PR analysis, and uncertainty reporting

Textbooks

1. Deisenroth, M. P., Faisal, A. A., & Ong, C. S. Mathematics for Machine Learning. Cambridge University Press, 2020
2. Murphy, K. P. Probabilistic Machine Learning: An Introduction. MIT Press, 2022
3. Boyd, S., & Vandenberghe, L. Convex Optimization. Cambridge University Press, 2004

References

1. Goodfellow, I., Bengio, Y., & Courville, A. Deep Learning. MIT Press, 2016
2. Shalev− Shwartz, S., & Ben− David, S. Understanding Machine Learning: From Theory to Algorithms. Cambridge University Press, 2014
3. Jolliffe, I. T., & Cadima, J. Principal component analysis: a review and recent developments. Phil. Trans. R. Soc. A, 2016
4. Cover, T. M., & Thomas, J. A. Elements of Information Theory, 2nd ed. Wiley, 2006
5. Murphy, K. P. Probabilistic Machine Learning: Advanced Topics. MIT Press, 2023.

Course Code	STATISTICAL LEARNING THEORY AND MATHEMATICAL FOUNDATIONS OF AI (Open Elective - I)	L	T	P	C
C41053		3	0	0	3

Program Outcomes (as per NBA for PG Engineering Programs)

- **PO1:** An ability to independently carry out research/investigation and development work to solve practical problems.
- **PO2:**An ability to write and present a substantial technical report/document.
- **PO3:** Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program; the mastery should be at a level higher than the requirements in the appropriate bachelor program.

Course Objectives:

- Build rigorous probabilistic, information-theoretic, and optimization foundations that support modern AI across engineering domains.
- Unify theory and algorithms to enable principled design and analysis of learning systems for cross− disciplinary problems.
- Connect generalization theory with practice through concise formulations and proofs suited to PG research contexts.

Course Outcomes (COs):

- **CO1:** Analyze probabilistic models, convergence theorems, and stochastic processes underlying learning algorithms (L3, L4).
- **CO2:** Formulate and prove generalization bounds using VC dimension, Rademacher complexity, and stability (L4, L5).
- **CO3:** Derive and optimize loss/regularization for linear, kernel, and deep models; justify selections by convexity and smoothness properties (L4, L5).
- **CO4:** Evaluate algorithms via bias–variance, PAC guarantees, and information− theoretic criteria such as KL and mutual information (L4, L5).
- **CO5:** Integrate theory to design robust AI solutions for multi− domain engineering applications and communicate findings effectively (L5).

CO–PO Articulation Matrix (1–3 scale):

	PO1	PO2	PO3
CO1	2	1	2
CO2	3	2	3
CO3	2	1	3
CO4	1	3	2
CO5	3	2	3
1 = low, 2 = moderate, 3 = high			

Course Contents:

Unit I — Probability and Measure Foundations

- Probability spaces, σ− algebras, random variables; expectation and conditional expectation.
- Inequalities and concentration: Markov, Chebyshev, Hoeffding; LLN and CLT.
- Modes of convergence and Borel–Cantelli; almost sure vs in− probability convergence.
- Random processes and martingale basics; optional stopping; Doob's inequality

(overview).

- Markov chains: ergodicity, mixing, stationary distributions for modeling sequences.

Unit II — Statistical Learning Theory

- PAC learning model, realizable/agnostic cases; sample complexity and no− free− lunch.
- VC dimension, shattering, Sauer's lemma; uniform convergence guarantees.
- Empirical risk minimization and structural risk minimization; capacity control.
- Rademacher/Gaussian complexities and symmetrization for data− dependent bounds.
- Algorithmic stability and generalization; regularization and early stopping as capacity control.
- PAC− Bayes bounds and posterior− based generalization certificates.

Unit III — Optimization for Learning

- Convex analysis: Lipschitzness, smoothness, strong convexity; implications for rates.
- Gradient, stochastic, and variance− reduced methods; step− size and convergence trade− offs.
- Proximal methods and projected gradients; sparsity via ℓ_1 (Lasso) and shrinkage via ℓ_2 (ridge).
- Duality and KKT conditions; constrained learning formulations.
- Nonconvex landscapes in deep networks—saddle points, over-parameterization, and implicit regularization.
- Generalization–optimization interplay: implicit bias of optimizers.

Unit IV — Kernel and Probabilistic Models

- Reproducing kernel Hilbert spaces, kernel trick, representer theorem.
- Large− margin methods: SVMs, soft margins, hinge loss; primal–dual views.
- Gaussian processes: kernels as priors; posterior prediction and uncertainty quantification.
- Graphical models—Bayesian networks and Markov/conditional random fields for structured prediction; exact inference (variable elimination, junction tree) and approximate methods (loopy belief propagation, variational).
- Hidden Markov models; EM for latent− variable learning.
- Variational inference and message passing for scalable probabilistic AI.

Unit V — Deep Learning and Information Theory

- Backpropagation (chain rule), initialization, normalization, and activation design.
- Loss functions and calibration; cross− entropy, margin losses, and robust objectives.
- Generalization in deep nets: margins, flat minima, compression, and stability views.
- Information− theoretic tools: entropy, mutual information, KL divergence.
- Information bottleneck and representation learning, with links to PAC− Bayes.
- Worked examples: applying theory to vision, language, and control tasks in engineering.

Textbooks:

1. Shalev− Shwartz, S., Ben− David, S., Understanding Machine Learning: From Theory to Algorithms, Cambridge University Press, first edition, 2014.
2. Goodfellow, I., Bengio, Y., Courville, A., Deep Learning, MIT Press, 2016.
3. Bishop, C. M., Pattern Recognition and Machine Learning, Springer, 2006.

References:

1. Vapnik, V. N., The Nature of Statistical Learning Theory, Springer, 1995/1998.
2. Cover, T. M., Thomas, J. A., Elements of Information Theory, 2nd ed., Wiley, 2006.
3. Mohri, M., Rostamizadeh, A., Talwalkar, A., Foundations of Machine Learning, 2nd ed., MIT

Press, 2018.
4. Schölkopf, B., Smola, A. J., Learning with Kernels: Support Vector Machines, Regularization, Optimization, and Beyond, MIT Press, 2002.
5. Rasmussen, C. E., Williams, C. K. I., Gaussian Processes for Machine Learning, MIT Press, 2006.

Course Code	CHEMISTRY OF NANOMATERIALS AND APPLICATIONS IN ENGINEERING (Open Elective - I)	L	T	P	C
C41054		3	0	0	3

Unit – I

Basics of Nanomaterials: Introduction**,** Scope of nanoscience and nanotechnology, nanoscience in nature, classification of nanostructured materials, importance of nanomaterials.

Unit – II

Synthesis of nanomaterials: Top-Down approach**,**Inert gas condensation, arc discharge method, aerosol synthesis, plasma arc technique, ion sputtering, laser ablation, laser pyrolysis, and chemical vapor deposition method, electrode position method, high-energy ball milling method.

Synthetic Methods**:** Bottom-Up approach**,** Sol-gel synthesis, microemulsions or reverse micelles, co-precipitation method, solvothermal synthesis, hydrothermal synthesis, microwave heating synthesis and sonochemical synthesis.

UNIT-III

Techniques for characterization: Diffraction techniques, spectroscopy techniques, electron microscopy techniques for the characterization of nanomaterials, BET method for surface area analysis, dynamic light scattering for particle size determination.

UNIT-IV

Studies of Nano-structured Materials: Synthesis, properties and applications of the following nanomaterials: fullerenes, carbon nanotubes, 2D-nanomaterial (Graphene), core-shell, magnetic nanoparticles, thermoelectric materials, non-linear optical materials.

UNIT-V

Advanced Engineering Applications of Nanomaterials: Applications of nanoparticles, nanorods, nano wires inWater treatment, sensors, electronic devices, medical domain, civil engineering, chemical engineering, metallurgy and mechanical engineering, food science, agriculture, pollutants degradation.

TEXT BOOKS:

1. **NANO: The Essentials:**T Pradeep, MaGraw-Hill, 2007.
2. **Textbook of Nanoscience and nanotechnology:** B S Murty, P Shankar, Baldev Rai,BB Rath and James Murday, Univ. Press, 2012.

REFERENCE BOOKS:

1. Concepts of Nano chemistry; LudovicoCademrtiri and Geoffrey A. Ozin& Geoffrey A. Ozin, Wiley-VCH, 2011.
2. **Nanostructures &Nanomaterials; Synthesis, Properties & Applications:** Guozhong Cao, Imperial College Press, 2007.
3. **Nanomaterials Chemistry**, C. N. R. Rao, Achim Muller, K.Cheetham, Wiley-VCH, 2007.

Course Code	PHOTONICS FOR ENGINEERS	L	T	P	C
C41055	(Open Elective - I)	3	0	0	3

Course Objectives (CO)

The objectives of this course are to:

CO 1. To understand the basic nature and behaviour of light and its propagation in optical media and fibers..
CO 2. To introduce the principles of absorption and emission in optical materials, and to understand the operation of semiconductor light sources and photodetectors..
CO 3. To provide an understanding of nonlinear optical phenomena and the principles of electro-optic, magneto-optic, and acousto-optic modulation used in modern optical devices..
CO 4. To introduce optical fiber characteristics and outline the components and technologies used in modern fiber-optic communication systems.
CO 5. To familiarize students with advanced photonic technologies, including sensors, quantum photonics, plasmonics, metamaterials, and ultrafast/THz systems.

Sl.No.		No. of hours
1.	**Unit I – Fundamentals of Photonics:** Nature of light: wave-particle duality, polarization, coherence. Maxwell's equations and wave propagation in dielectric media. Reflection, refraction, (vector notation) interference, diffraction, dispersion and birefringence.	9
2.	**Unit II – Photonic Devices and Components – I :**Absorption, spontaneous and stimulated emission. Einstein coefficients, population inversion, optical gain. Semiconductor light sources: LEDs, laser diodes, quantum well lasers. Photodetectors: PIN, avalanche photodiodes, photomultiplier tubes.	9
3.	**Unit III – Photonic Devices and Components – II :**Nonlinear optical effects – second-harmonic generation, Kerr effect, four-wave mixing. Electro-optic Magneto optic and acousto-optic modulation principles. Optical modulators and switches (Mach ZehnderInterferometer).	9
4.	**Unit IV – Optical Waveguides and Applications:** Optical fibers – numerical aperture, V-number, modes, attenuation, dispersion.Fiber-optic communication systems: transmitters, receivers, multiplexing (WDM), optical couplers, ring resonators.	9
5.	**Unit V – Photonic Systems and Applications:** Photonic sensors – interferometric, fiber Bragg gratings, biosensing. Optical signal processing and computing. Introduction to quantum photonics: single-photon sources, entanglement, and photonic qubits.Plasmonics and metamaterials, Ultrafast and terahertz photonics.	9

Textbooks:

1. B.E.A. Saleh& M.C. Teich — *Fundamentals of Photonics* (Wiley)
2. J. Singh — *Semiconductor Optoelectronics: Physics and Technology*

3. A. Yariv& P. Yeh — *Photonics: Optical Electronics in Modern Communications*
4. G. Keiser — *Optical Fiber Communications*

References:

1. J. Wilson & J.F.B. Hawkes — *Optoelectronics: An Introduction*
2. R.W. Boyd — *Nonlinear Optics*
3. Electromagnetic waves and radiating systems------- E. Jordan

Course Outcomes:

After studying this course, students will be able to

1. gain the ability to describe how light behaves and propagates in optical media.
2. explain light–matter interaction mechanisms and analyze the working, characteristics, and applications of LEDs, laser diodes, quantum well lasers and various photodetectors.
3. explain key nonlinear effects and analyze the operation of optical modulators and switches such as the Mach–Zehnder Interferometer.
4. analyzefiber parameters and explain the functioning of transmitters, receivers, WDM systems, couplers and resonator-based communication devices.
5. describe the working of photonic sensors and emerging quantum and ultrafast photonic technologies used in sensing, computation and communication.

COURSE STRUCTURE

IV - SEMESTER

PROGRAMME CURRICULUM STRUCTURE UNDER R25 REGULATIONS

M. TECH - DIGITAL ELECTRONICS & COMMUNICATION SYSTEMS

SEMESTER – IV

S.No.	Course codes	Course Name	Category	Hours per week			Credits	Scheme of Examination		
				L	T	P		Internal	External	Total
1.	**C43823**	Dissertation Phase – II	PR	0	0	32	16	100	100	200
Total							**16**	**100**	**100**	**200**