G. Pullaiah College of Engineering and Technology

(Autonomous)

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

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

MASTER OF TECHNOLOGY
Electrical Power 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 fulfilment 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 practicals 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 or has the tendency to disrupt the orderly conduct of the examination.	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.
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 fulfil 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 (CIV, ECE & EEE) | Affiliated to JNTUA)

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

M.TECH IN ELECTRICAL POWER SYSTEMS

COURSE STRUCTURE & SYLLABI

SEMESTER – I

S.No.	Course codes	Course Name	Category	Hours per week			Credits	Scheme of Examination Maximum Marks		
				L	T	P	C	Internal	External	Total
1	C40701	Advanced Power System Protection	PC	3	0	0	3	40	60	100
2	C40702	Power System Security and State	PC	3	0	0	3	40	60	100
3	C40703a C40703b C40703c	**Program Elective – I** Energy Auditing and Management Modelling and Analysis of HVDC Systems Power System Optimization	PE	3	0	0	3	40	60	100
4	C40704a C40704b C40704c	**Program Elective – II** Solar & Wind Energy Conversion Systems Smart Grid Technologies E-Mobility	PE	3	0	0	3	40	60	100
5	C40705	Power System Analysis and Protection Lab	PC	0	0	4	2	40	60	100
6	C40706	Power Systems Simulation Lab	PC	0	0	4	2	40	60	100
7	C40707	Research Methodology and IPR	MC	2	0	0	2	40	60	100
8	C40708	**Skill Enhancement Course** AI Techniques in Electrical Engineering	SE	2	0	0	2	40	60	100
9.	C40709a C40709b C40709c	**Audit Course – I** English for Research Paper Writing Disaster Management Essence of Indian Traditional Knowledge	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.	C40710	Power System Stability and Control	PC	3	0	0	3	40	60	100
2.	C40711	FACTS Controllers	PC	3	0	0	3	40	60	100
3.	C40712a C40712b C40712c	**Program Elective – III** Reactive power Compensation & Management Modern Control Theory Evolutionary Algorithms Applications in Power Engineering	PE	3	0	0	3	40	60	100
4.	C40713a C40713b C40713c	**Program Elective – IV** Power Quality EV Charging Infrastructure & Technology EHVAC Transmission systems	PE	3	0	0	3	40	60	100
5.	C40714	Renewable Energy Sources Lab	PC	0	0	4	2	40	60	100
6.	C40715	FACTS Devices Simulation Lab	PC	0	0	4	2	40	60	100
7.	C40716	Quantum Technologies and Applications	MC	2	0	0	2	40	60	100
8.	C40717	Comprehensive Viva Voce	PC	0	0	0	2	100	-	100
9.	C40718	**Audit Course – II**	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.	C40719a C40719b C40719c	**Program Elective – V** Restructured Power Systems Machine Learning Applications in Power Engineering Distributed Generation and Micro grid Control	PE	3	0	0	3	40	60	100
2.	**C45853**	**Open Elective -I** IOT AND ITS APPLICATIONS	OE	3	0	0	3	40	60	100
3.	C40720	Dissertation Phase – I	PR	0	0	20	10	100	-	100
	C40721	Industry Internship		0	0	0	2	100	-	100
4.	C40722	Co-curricular Activities		0	0	0	1	Grad		
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
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.	C40723	Dissertation Phase – II	PR	0	0	32	16	100	100	200
Total							**16**	**100**	**100**	**200**

COURSE STRUCTURE

I - SEMESTER

Course Code	ADVANCED POWER SYSTEM PROTECTION	L	T	P	C
C40701		3	0	0	3
	Semester	I			

Course Objectives:

- To know construction of static relays, the operation of microprocessor based protective relays and Artificial Intelligence based numerical protection.
- To understand the operation of amplitude and phase comparators.
- To comprehend the concepts of Static over current, static differential and static distance relays.
- To understand multi-input comparators and concept of power swings on the distance relays.

Course Outcomes (CO): Student will be able to

- Understand the construction of static relay and identify the advantages of static relay over electromagnetic relay and analyze the importance of reliability in various fields.
- Explore the operation of rectifier bridge comparators, instantaneous comparators, phase comparators, multi-input comparators, static differential and distance relays.
- Analyse over current relays, microprocessor-based relays and power swings on distance relays.
- Apply the concept of Artificial Intelligence in power system protection.

UNIT - I		Lecture Hrs:8

STATIC RELAYS & COMPARATORS: Introduction to Static relays, Basic construction of Static relays, Level detectors, Replica Impedance, Mixing circuits, General equation for two input Phase and Amplitude Comparators, Duality between Amplitude and Phase Comparator.

Comparators: Types of Amplitude Comparators and Phase Comparators, Multi –Input Comparators: Conic section characteristics Three input amplitude comparator, Hybrid comparator, switched distance schemes, Polyphase distance schemes, Phase fault scheme, three phase scheme, Combined and ground fault scheme.

UNIT - II		Lecture Hrs:

STATIC OVER CURRENT AND DIFFERENTIAL RELAYS: Introduction, Instantaneous over current relay, Time over current relays, Definite time and Inverse definite time over current relays, Directional over current relays, Static Differential Relays, Analysis of static differential relays, Static relay schemes, Dual bias transformer differential protection, Harmonic restraint relay.

UNIT - III		Lecture Hrs:

STATIC DISTANCE RELAYS AND POWER SWINGS: Static Distance Relays: Static Impedance, Reactance, MHO and Angle Impedance relay Sampling comparator, Realization of reactance and MHO relay using a sampling comparator.

Power Swings: Effect of power swings on the performance of Distance relays, Power swing analysis, Principle of out of step tripping and blocking relays, Effect of line length and source impedance on distance relays.

UNIT - IV		Lecture Hrs:

MICROPROCESSOR BASED PROTECTIVE RELAYS: Over current relays, Impedance relays, Directional relay, Reactance relay (Block diagram and flow chart approach only). Generalized mathematical expression for Distance relays, Measurement of R and X, MHO and offset MHO relays, Realization of MHO characteristics, Realization of Offset MHO characteristics (Block diagram and flow chart approach only), Quadrilateral Relay , Basic principle of Digital computer relaying.

UNIT - V		Lecture Hrs:

ARTIFICIAL INTELLIGENCE BASED NUMERICAL PROTECTION : Application of Artificial Intelligence to Power System Protection, Application of ANN to Overcurrent Protection, Application of ANN to Transmission Line Protection, Neural Network Based Directional Relay, ANN Modular Approach for Fault Detection, Classification and Location, Wavelet Fuzzy Combined Approach for Fault Classification, Application of ANN to Power Transformer, Power Transformer Protection Based on

Neural Network and Fuzzy Logic, Power Transformer Protection Based Upon Combined Wavelet Transform and Neural Network, Application of ANN to Generator Protection.
Textbooks:
1.T.S. Madhava Rao, Power system Protection static relay, Tata McGrawHill Publishing Company limited, 2nd Edition, 2004. 2.Badri Ram and D.N. Vishwakarma, Power system Protection and Switchgear, Tata McGraw Hill Publication Company limited, 2nd Edition, 2013.
Reference Books:
1.Bhavesh Bhalja, R. P. Maheshwari, N. G. Chothani, Protection and Switchgear, Oxford University Press, 2nd Edition, New Delhi, India, 2018. 2. Oza, B. A., N. C. Nair, R. P. Mehta, et al., Power System Protection & Switchgear, Tata McGraw Hill, New Delhi, 1st Edition, 2011.

Course Code	POWER SYSTEM SECURITY AND STATE ESTIMATION	L	T	P	C
C40702		3	0	0	3
Semester		I			

Course Objectives:

- Understand the basic concepts of network matrices, power flow methods, state estimation, and applications of power system state estimation and structure of deregulated power system.
- Analyze about admittance/impedance matrices, factors influencing power system security, network problems and power wheeling transactions.
- Implement the methods for determining the bus matrices, optimal ordering, DC power flow, AC power flow, estimating a value and Available Transfer Capability (ATC).
- Develop the algorithm for orthogonal matrix, method to identify network problems and congestion management methods and electricity sector structure

Course Outcomes (CO):

- Understand the concepts of network matrices, power flow methods, contingency analysis, state estimation, and need and conditions for deregulation. L2
- Analyze the bus admittance/impedance matrices methods, power system security, sensitivity factors, state estimation and electricity structure model. L4
- Apply the methods for evaluating the bus matrices, sparsity, DC power flow, AC power flow, estimating a value and Available Transfer Capability (ATC). L3
- Develop the methods for state estimation, method to identify network problems and methods for congestion management. L5

UNIT - I		Lecture Hrs:

POWER SYSTEM NETWORK MATRICES: Formation of bus admittance matrices by direct inspection method and singular transformation method, Algorithm for formation of Bus impedance matrix: addition of a branch and addition of a link, removal element in Bus impedance matrix, Sparsity programming and Optimal Ordering, Numerical problems, ∏-representation of off-nominal tap transformers.

UNIT - II		Lecture Hrs:

POWER SYSTEM SECURITY-I: Review of power flow methods (qualitative treatment only), DC power flow method, Introduction to power system security, Factors influencing power system security**.**

UNIT - III		Lecture Hrs:

POWER SYSTEM SECURITY-II: Introduction to contingency analysis, Contingency analysis: Detection of Network problems, linear sensitivity factors, AC power flow methods, Contingency selection.

UNIT - IV		Lecture Hrs:

STATE ESTIMATION IN POWER SYSTEM: Power system state estimation, SCADA, EMS center, Methods of state estimation, Method of least squares, Orthogonal matrix–Properties, Givens rotation–Orthogonal decomposition, Bad data detection, Pseudo measurements and applications of power system state estimation, Simple problems.

UNIT - V		Lecture Hrs:

SECURITY IN DEREGULATED ENVIRONMENT: Need and conditions for deregulation, Electricity sector structure model, Power wheeling transactions, Congestion management methods, Available Transfer Capability (ATC), System security in deregulation.

Textbooks:

1. Allen J. Wood and Wollenberg B.F, Power Generation Operation and control, John Wiley & Sons, 3rd edition, 2013.
2. P. Venkatesh, B.V. Manikandan, S. Charles Raja and A. Srinivasan, Electrical power systems analysis, security, and deregulation, PHI learning private limited, Delhi, 1st edition 2014.

Reference Books:

1.Nagrath I.J. and Kothari D.P., Modern Power System Analysis, TMH, New Delhi, 3rd Edition, 2004.
2.John J. Grainger and William D. Stevenson, Power System Analysis, Tata McGraw-Hill, 1st edition.

Course Code	ENERGY AUDITING AND MANAGEMENT	L	T	P	C
C40703a	(PE-I)	3	0	0	3
	Semester	I			

Course Objectives:

- To understand the current energy scenario and importance of energy conservation.
- To acquire knowledge about different energy efficient devices.
- To measure thermal efficiency and other renewable resources.
- To design suitable energy monitoring system to analyze and optimize the energy consumption in an electrical system.

Course Outcomes (CO): Student will be able to

- Understand the current energy scenario and importance of energy conservation. L2
- Acquire knowledge about different energy efficient devices. L2
- Measure efficiency in renewable energy resources. L3
- Identify the equipment and areas of a system where energy conservation and Audit is necessary. L3

UNIT - I	Lecture Hrs:

ENERGY AUDIT AND DEMAND SIDE MANAGEMENT (DSM) IN POWER UTILITIES: Energy Scenario & Conservation, Demand Forecasting Techniques, Integrated Optimal Strategy for Reduction of T&D Losses, DSM Techniques and Methodologies, Loss Reduction in Primary and Secondary Distribution system and capacitors, Energy Management, Role of Energy Managers, Energy Audit, Metering.

UNIT - II	Lecture Hrs:

ENERGY AUDIT: Energy audit concepts, Basic elements and measurements, Mass and energy balances, Scope of energy auditing in industries, Evaluation of energy conserving opportunities and environmental management, Preparation and presentation of energy audit reports, case studies and potential energy savings.

UNIT - III	Lecture Hrs:

INSTRUMENTATION: General Audit Instrumentation, Measuring building losses, Applications of IR thermography, Measurement of electrical system performance, Measurement of heating, ventilation, air conditioning system performance, Measurement of combustion systems.

UNIT - IV	Lecture Hrs:

ENERGY CONSERVATION: Energy conservation in HVAC systems and thermal power plants, Solar systems, Fan and Lighting Systems, Different light sources and luminous efficiency.

UNIT - V	Lecture Hrs:

ECONOMIC EVALUATION OF ENERGY CONSERVATION: Energy conservation in electrical devices and systems, Economic evaluation of energy conservation measures, Electric motors and transformers, Inverters and UPS, Voltage stabilizers.

Textbooks:

1.Frank kreith and D. Yogi goswamy/ Editors, “Energy Management and conservation handbook”. NewYork,2008.
2.WC Turner: Energy Management Handbook, Seventh Edition, (Fairmont Press Inc., 2007)
3.YP Abbi and Shashank Jain: Handbook on Energy Audit and Environment Management, (TERIPress, 2006)

Reference Books:

1.Albert Thumann, and William J. Younger, “Handbook of Energy Audits”, Marcel Dekker, Inc., Newyork, 6th edition, 2003.
2.D.A.Reay, Industrial Energy Conservation-Pergamon Press, 1980.
3.T.L.Boten, LiptakB.G.,(Ed)Instrument Engineers Handbook, Chinton Book Company, 2--2004.
4.Hodge B.K, Analysis and Design of Energy Systems, Prentice Hall, 2002.
5.Larry C.Witte, Schmidt & Brown, Industrial energy management and utilization. Hemisphere publishing, Co.NewYork,1988.

Course Code	MODELLING AND ANALYSIS OF HVDC SYSTEMS (PE-I)	L	T	P	C
C40703B		3	0	0	3
	Semester	I			

Course Objectives:

- To understand the concept, planning of DC power transmission.
- To analyze HVDC converters, Transient and Dynamic Stability.
- To apply modeling of power flow analysis.
- To design digital dynamic simulation of converters and DC systems.

Course Outcomes (CO):

- To identify the electrical requirements for HVDC lines. L3
- Analyze the different modes of operation for six pulse & twelve pulse converter unit in the context of HVDC system. L4
- Apply the knowledge of HVDC transmission in Power networks. L3
- Determine the appropriate HVDC transmission line parameters under different physical conditions. L2

UNIT - I		Lecture Hrs:

HVDC CONVERTERS AND SYSTEM CONTROL: Analysis of HVDC Converters: Pulse number, choice of converter configuration, simplified analysis of Graetz circuit, converter bridge characteristics. Converter and HVDC system control: Principles of DC link control, converter control characteristics, system control hierarchy, firing angle control, current and extinction angle control, starting and stopping of DC link power control.

UNIT - II		Lecture Hrs:

MODELING FOR POWER FLOW ANALYSIS OF AC/DC SYSTEMS: Modeling of HVDC Components: HVDC Converter model, Converter control, Modeling of DC network, Modeling of AC Network.
Power flow analysis in AC/DC systems: Modeling of DC links, Multi terminal DC links, Solution of DC load flow, per unit system for DC qualities, Solution of AC/DC power flow.

UNIT - III		Lecture Hrs:

TRANSIENT AND DYNAMIC STABILITY ANALYSIS: Transient stability Analysis, Converter model, Converter control models, DC network models, solution methodology, Direct methods for stability Evaluation.
Dynamic Stability and power modulation, Power modulation for damping low frequency oscillations, Basic principles, practical consideration in the application of power modulation controllers, Gamma or reactive power modulation, power modulation in MTDC system, voltage stability in AC/DC system.

UNIT - IV		Lecture Hrs:

HARMONIC AND TORSIONAL INTERACTIONS: Harmonic and Torsional Interactions: Harmonic Interactions, Torsion Interactions, Torsional interactions with HVDC systems, counter measures to torsion interactions with DC systems.
Simulation of HVDC systems: System simulation, philosophy & Tools, HVDC system simulation, modeling of HVDC systems Digital dynamic simulation.

UNIT – V		Lecture Hrs:

MODELING OF HVDC SYSTEMS: Digital dynamic simulation of converters and DC systems: Valve model, Gate pulse generation, generation of
control voltage, transformer model, converter model, transient simulation of DC and AC systems. HVDC Breakers, Monopolar Operation.

Textbooks:

1.K.R. Padiyar, HVDC Power Transmission Systems – Technology & System Interactions, New Age International Publishers,3rd Edition, 2017
2.S Kamakshaiah and V Kamaraju, HVDC Transmission, Tata Mc Graw Hill, New Delhi, 2nd Edition, 2021

Reference Books:
1.E.W. Kimbark, Direct current transmission, Wiely Inter Science – New York, 1st Edition, 1971 2.J. Arillaga, HVDC Transmission, Peter Peregrinus Ltd., London UK 2nd Edition, 1998 3.E. Uhlman, Power transmission by direct current, Springer Verlag, Berlin Helberg, 1st Edition, 1985

Course Code	POWER SYSTEM OPTIMIZATION	L	T	P	C
C40703c	(PE-I)	3	0	0	3
	Semester	I			

Course Objectives:

- Understand the fundamental concepts of Optimization Techniques.
- Analyze the importance of optimizations in real life scenarios.
- Apply the concepts of various classical and modern methods for constrained and unconstrained problems in both single and multivariable.
- Design the algorithms for different optimizations techniques

Course Outcomes (CO): Student will be able to

- Understand the concept of optimality criteria for various type of optimization problems.
- Analyze the concept of different optimization techniques in real world applications.
- Solve various constrained and unconstrained problems in single variable as well as multivariable.
- Design the methods of optimization for real life situations.

UNIT - I		Lecture Hrs:

CONVENTIONAL OPTIMIZATION TECHNIQUES: Concepts & Terms related to Optimization , Quadratic optimization problem, Karush - Kuhn - Tucker (KKT) necessary and sufficient conditions for quadratic programming problem, Interior point method for convex optimization, linear programming.

UNIT - II		Lecture Hrs:

FUNDAMENTALS OF PARTICLE SWARM OPTIMIZATION (PSO) TECHNIQUE: Background of PSO, Original PSO, Variation of PSO, Discrete PSO, PSO for MINLPs, Constriction Factor Approach (CFA), Hybrid PSO (HPSO), L best Model, Adaptive PSO (APSO) Evolutionary PSO (EPSO), Applications. Problem formulation of VVC, VVC using PSO

UNIT - III		Lecture Hrs:

FUNDAMENTALS OF ANT COLONY SEARCH ALGORITHMS : Ant Colony Search Algorithm, Behavior of Real Ants, Ant Colony Algorithms, The Ant System, The Ant Colony System, The Max-Min Ant System, Major Characteristics of Ant Colony Search Algorithm, Distributed Computation: Avoid Premature Convergence, Positive Feedback: Rapid Discovery of Good Solution, Use of Greedy Search and Constructive Heuristic Information: Find Acceptable Solutions in the Early Stage of the Process.

UNIT - IV		Lecture Hrs:

FUNDAMENTALS OF TABU SEARCH : Overview of the Tabu Search Approach, Problem Formulation, Coding and Representation, Neighborhood Structure, Characterization of the Neighborhood, Functions and Strategies in Tabu Search, Recency-Based Tabu Search, Basic Tabu Search Algorithm, Candidate List Strategies, Tabu tenure, Aspiration Criteria, The Use of Long Term Memory in Tabu Search, Frequency-Based Memory, Intensification, Diversification, Other TS Strategies, Path Relinking, Strategic Oscillation, Applications of Tabu Search.

UNIT - V		Lecture Hrs:

APPLICATION TO POWER SYSTEMS: Introduction to power system applications, Model identifications, Dynamic load modeling, short term load forecasting, Distribution system applications, Network reconfiguration for loss reduction, Optimal protection and switching devices placements, Examples.

Textbooks:

1. A Ravindran, K.M. Ragsdell, and G.V. Reklaitis, “Engineering optimization : Methods and applications”, Wiley India Edition.
2. Kwang Y. Lee and Mohamed A. EI- Sharkawi “Modern Heuristic Optimization Techniques Theory and Applications to Power Systems”, A John Wiley & Sons. INC. Publication, 1st edition, 2020
3. D. P. Kothari and J. S. Dhillon, “Power System Optimization”, PHI Learning Private Limited, 2nd Edition, 2011.

Reference Books:

1. Jizhong Zhu, “Optimization of power system operation”, IEEE Press, John Wiley & Sons, Inc., Publication, 2nd edition, 2015.
2. Joshua adam Taylor, “Convex optimization of power systems’’, Cambridge University Press, 1st edition, 2015.

Course Code	SOLAR & WIND ENERGY CONVERSION SYSTEM (PE-II)	L	T	P	C
C40704a		3	0	0	3
	Semester	I			

Course Objectives:

- To introduce photovoltaic systems and principle of wind turbines.
- To deal with various technologies of solar PV cells.
- To understand details about manufacture, sizing and operating techniques in solar energy conversion systems.
- Understand the concepts of fixed speed and variable speed, wind energy conversion systems, knowledge of design considerations and analyze grid integration issues.

Course Outcomes (CO):

Upon completion of the course students will be able to:

- Understand the fundamentals of solar cell, Solar PV Modules from solar cells, system types, Standalone PV system configuration, Maximum Power Point tracking (MPPT) and fundamentals the concepts of fixed speed and variable speed, wind energy conversion systems. L2
- Apply the concept of various technologies of solar PV cells, manufacture, sizing and operating techniques. L3
- Analyze the concept of Effect of series and shunt resistance on efficiency, Effect of solar radiation on efficiency, Analytical techniques, Hot spots in the module, Algorithms for MPPT. L4
- Design of PV powered DC fan without battery, Standalone system with DC load using MPPT, PV powered DC pump, standalone system with battery and AC/DC load and control principles of Wind turbine. L5

UNIT - I		Lecture Hrs:

SOLAR & WIND FUNDAMENTALS: Need for sustainable energy sources, solar radiation, the sun and earth movement, angle of sunrays on solar collectors, sun tracking, estimating solar radiation, measurement of solar radiation. Types of wind energy conversion devices, definition, solidity, tip speed ratio, power coefficient, wind turbine ratings and specifications, aerodynamics of wind rotors, design of the wind turbine rotor, Issues due to integration of solar and wind energy systems.

UNIT - II		Lecture Hrs:

SOLAR PHOTOVOLTAIC MODULES : Solar PV Modules from solar cells, model of a solar cell, effect of series and shunt resistance on efficiency, effect of solar radiation on efficiency, series and parallel connection of cells, mismatch in module, mismatch in series connection, hot spots in the module, bypass diode, mismatching in parallel diode, design and structure of PV modules, number of solar cells in a module, wattage of modules, fabrication of PV module, PV module power output.

UNIT - III		Lecture Hrs:

PV SYSTEM DESIGN AND APPLICATIONS : Introduction to solar PV systems, standalone PV system configuration, design methodology of PV systems, design of PV powered DC fan without battery, standalone system with DC load using MPPT, design of PV powered DC pump, design of standalone system with battery and AC/DC load, wire sizing in PV system, precise sizing of PV systems, Hybrid PV systems, grid connected PV systems.

UNIT - IV		Lecture Hrs:

WIND TURBINE CONTROL SYSTEMS & SITE ANALYSIS: Wind Turbine, Torque speed characteristics, Modelling of wind turbines, Pitch angle control, stall control, power electronic control, Yaw control, Control strategy, Wind speed measurements, Wind speed statistics, Site and turbine selection. Constant voltage & constant frequency, single output system, double output system with current converter & voltage source inverter, equivalent circuits, reactive power and harmonics, reactive

power compensation, variable voltage, variable frequency, the self-excitation process, circuit model for the self-excited induction generator, analysis of steady state operation, the excitation requirement, effect of a wind generator on the network.

UNIT - V		Lecture Hrs:

WIND GENERATION WITH VARIABLE SPEED TURBINES AND APPLICATIONS: Classification of schemes, operating area, induction generators, doubly fed induction generator, wound field synchronous generator, the permanent magnet generator, Merits and limitations of wind energy conversion systems, application in hybrid energy systems, diesel generator and photovoltaic systems, wind and photovoltaic systems.

Textbooks:

1. "Solar Photovoltaics Fundamentals, Technologies and Applications" by Chetan Singh Solanki, PHI publications, 3rd edition, 2015
2. S.N.Bhadra, D.Kastha, S.Banerjee, " wind electrical systems" Oxford University Press, 1st edition, 2013
3. Banshi D. Shukla, "Engineering of Wind Energy", Jain Brothers, 1st edition, 2018

Reference Books:

1. H.P. Garg, J. Prakash, Solar Energy Fundamentals and applications Tata McGraw- Hill publishers 1st edition, 2000
2. S.Rao & B.B.Parulekar, Energy Technology, Khanna publishers, 4th edition, 2005.
3. N.K.Bansal, M. Kleemann, Michael Meliss, Renewable Energy sources & Conversion Technology, Tata Mcgraw Hill Publishers & Co., 1st edition, 1990

Course Code	SMART GRID TECHNOLOGIES (PE-II)	L	T	P	C
C40704b		3	0	0	3
	Semester	I			

Course Objectives:

- To know the importance of smart grid technology functions over the present grid.
- To get the knowledge about the measurement system and communication technology of Smart grid.
- To enhance the quality, efficiency and security of power supply.
- To impart an understanding of economics, policies and technical regulations for DG integration.

Course Outcomes (CO):

- Understand the importance of smart grid technology functions over the present grid. L2
- Apply the knowledge about the measurement system and communication technology of Smart grid. L3
- Determine the quality, efficiency and security of power supply. L3
- Impart an understanding of economics, policies and technical regulations for DG integration. L2

UNIT - I		Lecture Hrs:

SMART GRIDS: Smart grid overview, ageing assets and lack of circuit capacity, thermal constraints, operational constraints, security of supply, national initiatives, early smart grid initiatives, active distribution networks, virtual power plant, other initiatives and demonstrations, overview of the technologies required for the smart grid.

UNIT - II		Lecture Hrs:

TRANSMISSION AND DISTRIBUTION MANAGEMENT : Data Sources, Energy Management System-Wide Area Applications, Visualization Techniques, Data Sources and Associated External Systems, SCADA, Customer Information System, Modeling and Analysis Tools, Distribution System Modeling, Topology Analysis, Load Forecasting, Power Flow Analysis, Fault Calculations, State Estimation, Applications, System Monitoring, Operation, Management, Outage Management System, Overview of energy storage technologies.

UNIT - III		Lecture Hrs:

SMART METERING AND DEMAND SIDE INTEGRATION : Overview, Smart metering, Evolution of electricity metering, key components of smart metering- smart meters: an overview of the hardware used, signal acquisition, signal conditioning, analogue to digital conversion, computation, input/ output and communication. Communication infrastructure and protocols for smart metering, Home area network, Neighborhood Area Network, Data Concentrator, meter data management system, Protocols for communication. Demand Side Integration, Services Provided by DSI-Implementation of DSI, Hardware Support, Flexibility Delivered by consumers from the Demand Side, System Support from DSI.

UNIT - IV		Lecture Hrs:

COMMUNICATION TECHNOLOGIES FOR THE SMART GRID: Data Communications: Dedicated and Shared Communication Channels, Switching Techniques, Circuit Switching, Message Switching, Packet Switching, Communication Channels, Introduction to TCP/IP. Communication Technologies: IEEE 802 Series, Mobile Communications, Multi-Protocol Label Switching, Power line Communication.

UNIT - V		Lecture Hrs:

INFORMATION SECURITY FOR THE SMART GRID: Overview, Encryption and Decryption, Symmetric Key Encryption, Public Key Encryption, Authentication, Authentication Based on Shared Secret Key, Authentication Based on Key Distribution Center, Digital Signatures, Secret Key Signature, Public Key Signature, Message Digest.

Textbooks:

1. Janaka Ekanayake, Kithsiri Liyanage, et.al., Smart Grid Technology and Applications, Wiley Publications, 1st edition, 2012.
2. James Momoh, Smart Grid: Fundamentals of Design and Analysis, Wiley, IEEE Press, 1st edition, 2012.
3. Bharat Modi, Anuprakash, Yogesh Kumar, Fundamentals of Smart Grid Technology, S.K Kataria& Sons, 1st edition, 2019.

Reference Books:

1. Eric D. Knapp, Raj Samani, Applied Cyber Security and the Smart Grid-Implementing Security Controls into the Modern Power Infrastructure, Syngress Publishers, 1st edition, 2013.
2. Nouredine Hadjsaid, Jean Claude Sabonnadiere, Smart Grids, Wiley Blackwell Publications, 1st edition, 2012.
3. Peter-Fox Penner, Smart Power: Climate Changes, the Smart Grid and the future of electric utilities, Island Press, 1st edition, 2010.

Course Code	E-MOBILITY (PE-II)	L	T	P	C
C40704c		3	0	0	3
Semester		I			

Course Objectives:

- Remember and understand the differences between conventional Vehicle and Electric Vehicles, electro mobility and environmental issues of EVs.
- Analyze various EV configurations, parameters of EV systems and Electric vehicle dynamics.
- Analyze the basic construction, operation and characteristics of fuel cells and battery charging techniques in HEV systems.
- Design and analyze the various control structures for Electric vehicle

Course Outcomes (CO):

- To understand and differentiate between Conventional Vehicle and Electric Vehicles, electro mobility and environmental issues of EVs. L2
- To remember and understand various configurations in parameters of EV system and dynamic aspects of EV. L1
- To analyze fuel cell technologies in EV and HEV systems. L4
- To analyze the battery charging and controls required of EVs. L4

UNIT - I		Lecture Hrs:

INTRODUCTION TO EV SYSTEMS AND ENERGY SOURCES: Past, Present and Future of EV, EV Concept, EV Technology, State-of-the Art of EVs, EV configuration, EV system, Fixed and Variable gearing, Single and multiple motor drive, In-wheel drives, EV parameters: Weight, size, force and energy, performance parameters. Electro mobility and the environment, History of Electric power trains, Carbon emissions from fuels, Green houses and pollutants, Comparison of conventional, battery, hybrid and fuel cell electric systems.

UNIT - II		Lecture Hrs:

EV PROPULSION AND DYNAMICS: Choice of electric propulsion system, Block diagram, Concept of EV Motors, Single and multi-motor configurations, Fixed and variable geared transmission, In-wheel motor configuration, Classification, Electric motors used in current vehicle applications, Recent EV Motors, Linear Induction Motors Vehicle load factors, Vehicle acceleration.

UNIT - III		Lecture Hrs:

FUEL CELLS: Introduction of fuel cells, Basic operation, Model, Voltage, power and efficiency, Power plant system, Characteristics, Sizing, Example of fuel cell electric vehicle.
Introduction to HEV, Brake specific fuel consumption, Comparison of Series-Parallel hybrid systems, Examples.

UNIT - IV		Lecture Hrs:

BATTERY CHARGING AND CONTROL: Battery charging: Basic requirements, Charger architecture, Charger functions, Wireless charging, Power factor correction. Control: Introduction, Modeling of electromechanical system, Feedback controller design approach, PI controllers designing, Torque-loop, Speed control loop compensation, Acceleration of battery electric vehicle.

UNIT - V		Lecture Hrs:

ENERGY STORAGE TECHNOLOGIES: Role of Energy Storage Systems, Thermal, Mechanical, Chemical, Electrochemical, Electrical, Efficiency of energy storage systems, Super capacitors, Superconducting Magnetic Energy Storage (SMES), SoC, SoH, fuel cells, G2V, V2G, Energy storage in Micro-grid and Smart grid, Energy Management with storage systems, Hybrid energy storage systems, Battery SCADA.

Textbooks:

1.C.C Chan, K.T Chau: Modern Electric Vehicle Technology, Oxford University Press Inc., New York 2001,1st Edition
2.Francisco Díaz-González, Andreas Sumper, Oriol Gomis-Bellmunt," Energy Storage in Power Systems" Wiley Publication, ISBN: 978-1-118-97130-7, Mar 2016,1st Edition

Reference Books:
1.Electric and Hybrid Vehicles Design Fundamentals, Iqbal Husain, CRC Press 2021,3rd Edition. 2.Ali Emadi, Advanced Electric Drive Vehicles, CRC Press, 2015,1st Edition 3.A.G.Ter-Gazarian, “Energy Storage for Power Systems”, the Institution of Engineering and Technology (IET) Publication, UK, (ISBN – 978-1-84919-219-4), Second Edition, 2011. 3.Mehrdad Ehsani, Yimi Gao, Sebastian E. Gay, Ali Emadi, “Modern Elelctric, Hybrid Elelctric and Fuel Cell Vehicles: Fundamentals, Theory and Design”, CRC Press, 2004,1st Edition 4.James Larminie, John Lowry, “Electric Vehicle Technology Explained”, Wiley, 2003,2nd Edition.

Course Code	POWER SYSTEM ANALYSIS AND PROTECTION LAB	L	T	P	C
C40705		0	0	4	2
Semester		I			

Course Objectives:

- Understand the experiments ensuring the safety of equipment and personnel.
- Analyze the power system data fault studies.
- Interpret the experimental results and correlating them with the practical power system.
- Design the relays for power system protection purpose.

Course Outcomes (CO):

- Understand the concept of different experiments. L2
- Analyze the data for and compute the data to obtain results. L4
- Apply the computational results to solve the original power system problems. L4
- Develop advanced relays to identify various faults. L5

List of Experiments:

1.Determination of Subtransient Reactance and Time Constant of a Salient Pole Machine

2.Determination of Sequence Impedances of a Cylindrical Rotor Synchronous Machine

3.Fault Analysis

i)LG Fault

ii)LL Fault

iii)LLG Fault

iv)LLLG Fault

4.Equivalent Circuit of a Three Winding Transformer

5.Separation of No Load losses of a Three Phase Squirrel Cage Induction Motor

6.Power Angle Characteristics of a Salient Pole Synchronous Machine

7.Characteristics of Static/Numeric Over Current Relay

8.Characteristics of Static Negative Sequence Relay

9.Characteristics of Static/Numeric Over Voltage Relay

10.Characteristics of Static/Numeric Percentage Biased Differential Relay

11.Testing of Buchholz Relay

12.Testing of Frequency Relay

13.Testing of Reverse Power Relay

14.Testing of Earth fault Relay

15.Microprocessor Based Relay

Course Code	POWER SYSTEMS SIMULATION LAB	L	T	P	C
C40706		0	0	4	2
	Semester	I			

Course Objectives:

- Understand how to write the coding in simulation.
- Analyze the data related to load flows, economic dispatch problem and transient stability analysis.
- Apply the computational results in real life power system problems.
- Have the capabilities to develop new software's to optimize the results.

Course Outcomes (CO):

- Understand the coding in simulation. L2
- Analyze the power system data for load-flow and stability studies. L4
- Apply computational methods for large scale power system studies. L3
- Develop software for power system industry to solve various issues. L5

List of Experiments:

1.Y - Bus Formation
2.Z- Bus Formation
3.Gauss – Seidel Load Flow Analysis
4.Newton-Raphson Method for Load Flow Analysis
5.Fast Decoupled Load Flow Analysis
6.Fast Decoupled Load Flow Analysis for Distribution Systems
7.Point by Point Method
8.Computation of Available Transfer Capabilities
9.Contingency analysis
10.State estimation using Weighted Least Square, linear and non-linear methods
11.Simulation of power quality problems (Sag/Swell, interruption, transients, harmonics, flickers etc.)
12.Harmonic analysis and Single tuned filter design to mitigate harmonics
13.Harmonic analysis and Double tuned filter design to mitigate harmonics

Course Code	AI TECHNIQUES IN ELECTRICAL ENGINEERING (SE)	L	T	P	C
C40708		2	0	0	2
	Semester	I			

Course Objectives:

- To locate soft commanding methodologies, such as artificial neural networks, Fuzzy logic and genetic Algorithms.
- To observe the concepts of feed forward neural networks and about feedback neural networks.
- To practice the concept of fuzziness involved in various systems and comprehensive knowledge of fuzzy logic control and to design the fuzzy control.
- To analyze genetic algorithm, genetic operations and genetic mutations.

Course Outcomes (CO): Student will be able to

- Understand feed forward neural networks, feedback neural networks and learning techniques. L2
- Apply selected basic AI techniques; judge applicability of more advanced techniques. L3
- Analyze &Develop fuzzy logic control for applications in electrical engineering. L4
- Develop genetic algorithm for applications in electrical engineering. L5

UNIT - I		Lecture Hrs:

ARTIFICIAL NEURAL NETWORKS: Introduction-Models of Neural Network, Architectures, Knowledge representation, Artificial Intelligence and Neural networks, Learning process, Error correction learning, Hebbian learning, Competitive learning, Boltzmann learning, Supervised learning, Unsupervised learning, Reinforcement learning, learning tasks.

UNIT - II		Lecture Hrs:

ANN PARADIGMS: Multi, layer perceptron using Back propagation Algorithm-Self, organizing Map, Radial Basis Function Network, Functional link network, Hopfield Network.

UNIT - III		Lecture Hrs:

FUZZY LOGIC: Introduction, Fuzzy versus crisp, Fuzzy sets, Membership function, Basic Fuzzy set operations, Properties of Fuzzy sets, Fuzzy Cartesian Product, Operations on Fuzzy relations, Fuzzy logic, Fuzzy Quantifiers-Fuzzy Inference, Fuzzy Rule based system, Defuzzification methods.

UNIT - IV		Lecture Hrs:

GENETIC ALGORITHMS: Introduction-Encoding, Fitness Function, Reproduction operators, Genetic Modeling, Genetic operators, Crossover, Single–site crossover, Two-point crossover, Multi point crossover, Uniform crossover, Matrix crossover, Crossover Rate-Inversion & Deletion–Mutation operator, Mutation–Mutation Rate-Bit-wise operators, Generational cycle, convergence of Genetic Algorithm.

UNIT - V		Lecture Hrs:

APPLICATIONS OF AI TECHNIQUES: Load forecasting, Load flow studies, Economic load dispatch, Load frequency control, Single area system and two area system, Small Signal Stability (Dynamic stability), Reactive power control, speed control of DC and AC Motors.

Textbooks:

1.S. Rajasekaran and G.A.V.Pai, “Neural Networks, Fuzzy Logic & Genetic Algorithms” PHI,New Delhi, 2nd edition,2017.
2.Sudarshan K. Valluru and T. Nageswara Rao, “introduction to Neural Networks, Fuzzy Logic & Genetic Algorithms”, Jaico Publishing House, 1st edition, 2010.

Reference Books:

1.P.D.Wasserman, VanNostrand Reinhold,“ NeuralComputingTheory&Practice”,NewYork,1st . Eddition ,1989
2.Bart Kosko,“Neural Network & Fuzzy System”, Prentice Hall,1992.
3.G.J.Klir and T.A.Folger, “Fuzzy sets, Uncertainty and Information”, Pearson, 1st edition, 2015.
4.D.E.Goldberg, “Genetic Algorithms”, Pearson Education India, 1st edition, 2008

Course Code	ENGLISH FOR RESEARCH PAPER WRITING	L	T	P	C
C40709a	(Audit Course-I)	2	0	0	0

Course Objectives:

- To equip students with the fundamentals of academic English for research paper writing.
- To develop students' advanced reading skills for analyzing and evaluating research articles.
- To refine students' grammar and language skills for clarity and precision in research writing.
- To master the skills of revising, editing, and proofreading research papers.
- 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

- Recall the key language aspects and structural elements of academic writing in research papers.
- Explain the importance of clarity, precision, and objectivity in research writing.
- Apply critical reading strategies and advanced grammar skills to analyze and write research papers.
- Analyze research articles and identify the strengths and limitations of different methodologies.
- Evaluate research papers to check for plagiarism, structure, clarity, and language accuracy.
- Evaluate the effectiveness of different language and technology tools in research writing, including AI-assisted tools and plagiarism detection software.
- 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:

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

Online Learning Resources:
• https://nptel.ac.in/noc/courses/noc20/SEM1/noc20-ge04/ • https://onlinecourses.swayam2.ac.in/ntr24_ed15/preview • "Writing in the Sciences" – Stanford University (MOOC on Coursera) https://www.coursera.org/learn/sciwrite • Academic Phrasebank – University of Manchester • http://www.phrasebank.manchester.ac.uk • OWL (Online Writing Lab) – Purdue University, https://owl.purdue.edu • *(Resources on APA/MLA formats, grammar, structure, paraphrasing)* • Zotero or Mendeley (Reference Management Tools) – Useful for managing citations and sources

Course Code	DISASTER MANAGEMENT (Audit Course-I)	L	T	P	C
C40709b		2	0	0	0
	Semester	I			

Course Objectives:

- To enable the students to understand the fundamental concepts of disasters, hazards, their factors, and significance with special reference to India.
- To prepare them to classify and analyze different types of natural and man-made disasters, their causes, magnitude, and impacts.
- To foster them develop understanding of disaster preparedness, monitoring systems, and the role of government, community, and media.
- To equip them in learning risk assessment techniques, disaster risk reduction strategies, and the importance of global and national cooperation.
- 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 (CO): Student will be able to

- Define and distinguish between hazards and disasters, and explain their types, nature, and impacts.
- Identify and map disaster-prone areas in India and understand the epidemiological consequences of disasters.
- Assess the economic, social, and ecological repercussions of major natural and man-made disasters.
- Demonstrate knowledge of disaster preparedness tools such as remote sensing, meteorological data, risk evaluation, and community awareness.
- Apply risk assessment methods and propose disaster risk reduction strategies at local, national, and global levels.
- Formulate and evaluate structural and non-structural disaster mitigation strategies, with emphasis on Indian programs and emerging trends.

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 – Emerging Trends 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.

Course Code	ESSENCE OF INDIAN TRADITIONAL KNOWLEDGE (Audit Course-I)	L	T	P	C
C40709c		2	0	0	0

COURSE OBJECTIVES : The objective of this course is

- To facilitate the students with the concepts of Indian traditional knowledge and to make them understand the importance of roots of knowledge system.
- To make them understand the need for protecting traditional knowledge and its significance in the global economy.
- To make them understand the legal frame work and policies related to traditional knowledge protection.
- To enable them to understand the relationship between traditional knowledge and intellectual property rights.
- To make them explore the applications of traditional knowledge in different sectors, such as engineering, medicine, agriculture, and biotechnology.

COURSE OUTCOMES: At the end of the course, students will be able to

- Define and explain the concept of traditional knowledge, its nature, characteristics, and scope
- Understand the need for protecting traditional knowledge and its significance in the global economy
- Explain the legal framework and policies related to traditional knowledge protection
- Apply traditional knowledge in different sectors, such as engineering, medicine, agriculture, and biotechnology
- Analyze the importance of traditional knowledge in various contexts, including its historical impact and social change
- Analyze the relationship between traditional knowledge and intellectual property rights, including patents and non-IPR mechanisms

UNIT - I		Lecture Hrs:

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

UNIT - II		Lecture Hrs:

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.

UNIT - III		Lecture Hrs:

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.

UNIT - IV		Lecture Hrs:

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

UNIT - V		Lecture Hrs:

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

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. 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

E-Resources:

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

COURSE STRUCTURE

II - SEMESTER

SEMESTER – II

S.No.	Course codes	Course Name	Category	Hours per week			Credits	Scheme of Examination		
				L	T	P		Internal	External	Total
1.	C40710	Power System Stability and Control	PC	3	0	0	3	40	60	100
2.	C40711	FACTS Controllers	PC	3	0	0	3	40	60	100
3.	C40712a C40712b C40712c	**Program Elective – III** Reactive power Compensation & Management Modern Control Theory Evolutionary Algorithms Applications in Power Engineering	PE	3	0	0	3	40	60	100
4.	C40713a C40713b C40713c	**Program Elective – IV** Power Quality EV Charging Infrastructure & Technology EHVAC Transmission systems	PE	3	0	0	3	40	60	100
5.	C40714	Renewable Energy Sources Lab	PC	0	0	4	2	40	60	100
6.	C40715	FACTS Devices Simulation Lab	PC	0	0	4	2	40	60	100
7.	C40716	Quantum Technologies and Applications	MC	2	0	0	2	40	60	100
8.	C40717	Comprehensive Viva Voce	PC	0	0	0	2	100	-	100
9.	C40718	**Audit Course – II**	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	POWER SYSTEM STABILITY & CONTROL	L	T	P	C
C40710		2	0	0	2
II Semester		I			

Course Objectives:

- Understand about linear and nonlinear models of multi-machine power systems.
- Analyze various types of stability properties of power systems.
- Identify power system models from dynamic data and simulate excitation mechanisms in synchronous machines.
- Design excitation systems and their state space model equations for further stability applications.

Course Outcomes (CO): Student will be able to

- Understand the concepts of single and multi-machine systems connected to infinite bus bar. L2
- Analyze system responses to small disturbances and concept of dynamic stability and power system stabilizers. L4
- Apply the various stability methods to evaluate the stability of the system. L3
- Design the state space model equations for excitation systems and methods for finding voltage and angle instability. L5

UNIT - I	THE ELEMENTARY MATHEMATICAL MODEL	Lecture Hrs:10

Introduction to equal area criteria – Power Angle curve of a Synchronous Machine – Model of single machine connected to an infinite bus – Model of multimachine system – Problems – Classical Stability Study of multimachine system – Effect of the excitation system on Transient stability.

UNIT - II	SYSTEM RESPONSE TO SMALL DISTURBANCES AND DYNAMIC STABILITY	Lecture Hrs:08

The unregulated synchronous Machine – Modes of oscillation of an unregulated multimachine system – Regulated synchronous machine – Voltage regulator with one time lag – Governor with one time lag – Problems - Concept of Dynamic stability – State-space model of single machine system connected to infinite bus – Effect of excitation on Dynamic stability – Examination of dynamic stability by Routh-Hurwitz criterion.

UNIT - III	POWER SYSTEM STABILIZERS	Lecture Hrs:10

Introduction to supplementary stabilizing signals – Block diagram of the linear system – Approximate model of the complete exciter – Generator system – Lead compensation – Stability analysis using eigen value approach.

UNIT - IV	EXCITATION SYSTEMS	Lecture Hrs:10

Introduction to excitation systems – Non-continuously, Continuously regulated systems – Excitation system compensation – State-space description of the excitation system – Simplified linear model – Effect of excitation on generator power limits. Type-2, Type-3 and Type-4 excitation systems and their state-space modeling equations.

UNIT - V	STABILITY ANALYSIS	Lecture Hrs:10

Review of Lyapunov's stability of non-liner systems using energy concept – Method based on first concept – Method based on first integrals –Lyapunov function for single machine connected to infinite bus – Voltage stability – Factors affecting voltage instability and collapse – Comparison of Angle and Voltage stability – Analysis of voltage instability and collapse – Control of voltage instability.

Textbooks:

1. Vijay Vittal, James D. McCalley, Paul M. Anderson "Power System Control and Stability", Jhon Willey and Sons, 3rd edition, 2019.
2. Prabha Kundur, "Power System Control and Stability", McGraw Hill Education India, 1st edition, 5th reprint, 2008.

Course Code	FACTS CONTROLLERS	L	T	P	C
C40711		2	0	0	2
II Semester		I			

Course Objectives:

- To understand the fundamentals of FACTS Controllers, Importance of controllable parameters and types of FACTS controllers & their benefits.
- To explain control of STATCOM and SVC and their comparison and the regulation of STATCOM.
- To remember the objectives of Shunt and Series compensation.
- To analyze the functioning and control of GCSC, TSSC and TCSC.

Course Outcomes (CO): Student will be able to

Understand various control techniques for the purpose of identifying the scope and for selection of specific FACTS controllers. L2

- Remember different types of controllable VAR generation and variable impedance techniques. L1
- Design simple converters using FACTS controllers. L5
- Understand the operation of Unified Power Controller and Hybrid Arrangements. L1

UNIT - I	FACTS CONCEPTS, VSI AND CSI	Lecture Hrs:10

Transmission interconnections power flow in an AC system, loading capability limits, Dynamic stability considerations, importance of controllable parameters basic types of FACTS controllers, benefits from FACTS controllers. Single phase three phase full wave bridge converters transformer connections for 12 pulse 24 and 48 pulse operation. Three level voltage source converter, pulse width modulation converter, basic concept of current source Converters, and comparison of current source converters with voltage source converters.

UNIT - II	SHUNT COMPENSATION	Lecture Hrs:08

Objectives of shunt compensation - Methods of controllable var generation - Variable impedance type static var generators - switching converter type var generators - hybrid var generators – Comparison of SVC and STATCOM.

UNIT - III	SERIES COMPENSATION	Lecture Hrs:10

Objectives of series compensation – GTO Thyristor Controlled Series Capacitor (GCSC) - Thyristor Switched Series Capacitor (TSSC) - Thyristor Controlled Series Capacitor (TCSC) - Control schemes for TCSC, TSSC and TCSC.

UNIT - IV	UNIFIED POWER FLOW CONTROLLER (UPFC) & INTERLINE POWER FLOW CONTROLLER (IPFC)	Lecture Hrs:10

Introduction - The Unified Power Flow Controller - Basic Operating Principles - Conventional Transmission Control Capabilities - Independent Real and Reactive Power Flow Control - Control Structure - Basic Control System for P and Q Control - Hybrid Arrangements: UPFC With a Phase Shifting Transformer.
Introduction, basic operating principle and characteristics of IPFC, control structure, practical and application considerations, generalized and multifunctional fact controllers.

UNIT - V	SPECIAL FACTS DEVICES	Lecture Hrs:10

TCPAR: Thyristor controlled phase angle regulator, NGH sub-synchronous reactance damper, TCBR: thyristor controlled breaking resistor, D-STATCOM: Distribution STATCOM, UPQC: Unified power quality controller.

Textbooks:

1. Understanding FACTS – Concepts and technology of Flexible AC Transmission systems, Narain G. Hingorani, Laszlo Gyugyi, IEEE Press, WILEY, 1st Edition, 2000, Reprint 2015.
2. FACTS Controllers in Power Transmission and Distribution, Padiyar K.R., New Age International Publishers, 1st Edition, 2007.

Reference Books:

1.Flexible AC Transmission Systems: Modelling and Control, Xiao – Ping Zhang, Christian Rehtanz, Bikash Pal, Springer, 2012, First Indian Reprint, 2015.
2. FACTS – Modelling and Simulation in Power Networks, Enrigue Acha, Claudio R. Fuerte – Esquival, Huge Ambriz – perez, Cesar Angeles – Camacho, WILEY, 1st edition, 2004

Course Code	REACTIVE POWER COMPENSATION & MANAGEMENT (PE– III)	L	T	P	C
C40712a		3	0	0	3
	II Semester	II			

Course Objectives: To make the student

- To identify the necessity of reactive power compensation.
- To describe load compensation and various types of reactive power compensation in transmission systems.
- To illustrate reactive power coordination system.
- To characterize distribution side and utility side reactive power management.

Course Outcomes (CO): Student will be able to

- Understand the importance of load compensation in symmetrical as well as unsymmetrical loads. L2
- Analyze various compensation methods in transmission lines. L4
- Design model for reactive power coordination. L5
- Distinguish demand side reactive power management & user side reactive power management. L3

UNIT - I	LOAD COMPENSATION	Lecture Hrs: 10

Objectives – specifications of a load compensator – Reactive power characteristics – Reactive power bias – Load compensator as a voltage regulator – Phase balancing and power factor correction of unsymmetrical loads.

UNIT - II	STEADY STATE & TRANSIENT STATE REACTIVE POWER COMPENSATION IN TRANSMISSION SYSTEM	Lecture Hrs: 8

Uncompensated line - Electrical parameters, fundamental transmission line equation, surge impedance and natural loading, basic concepts no-load and under load conditions – Types of compensation – Passive shunt and series and dynamic shunt compensation – Characteristic time periods – Passive shunt compensation – Static compensation - Series capacitor compensation – Compensation using synchronous condensers.

UNIT - III	REACTIVE POWER COORDINATION & DEMAND SIDE MANAGEMENT	Lecture Hrs:

Objective - Basic concepts of quality of power supply – Disturbances - Steady – state variations – Effects of under voltages – Frequency – Harmonics, radio frequency and electromagnetic interferences. Load patterns – Basic methods - load shaping – Power tariffs - KVAR based tariffs - penalties for voltage flickers and Harmonic voltage levels.

UNIT - IV	DISTRIBUTION & USER SIDE REACTIVE POWER MANAGEMENT	Lecture Hrs:

System losses – Loss reduction methods – Examples – Reactive power planning – Objectives – Economics - Planning capacitor placement – Retrofitting of capacitor banks - KVAR requirements for domestic appliances – Purpose of using capacitors – Selection of capacitors – Deciding factors – Types of capacitors, characteristics and Limitations.

UNIT - V	REACTIVE POWER MANAGEMENT IN ELECTRIC TRACTION SYSTEMS AND ARC FURNACES	Lecture Hrs:

Typical layout of traction systems – Reactive power control requirements – Distribution transformers - Electric arc furnaces – Furnaces transformer – Filter requirements – Remedial measures – Power factor of an arc furnace.

Textbooks:

1. T.J.E.Miller, —Reactive Power Control in Electric Systems ‖ , John Wiley and Sons, 5th edition, 2017.
2. D.M.Tagare, Reactive power Management, Tata Mc Graw Hill, 1st edition, 2004.

Reference Books:

1. Dr. Hidaia alassouli, —"Reactive Power Compensation", Kindle Edition.2018.
2. Wolfgang Hofmann, Jurgen Schlabbach, Wolfgang Just —"Reactive Power Compensation": A Practical Guide, Wiely publication, 4th edition, April, 2012.

Course Code	MODERN CONTROL THEORY (PE-III)	L	T	P	C
C40712b		3	0	0	3
	II Semester		I		

Course Objectives:

- Remember and understand the concept of state space representation, Solution of state equation, STM, linearization of nonlinear systems, controllability and observability concepts, principles of duality, concepts of optimal and Lyapunov stability.
- Apply the above concepts to analyze controllability, Observability and pole placement by state feedback.
- Analyze the concept of regulator, stability and sensitivity using various methods and disturbance rejection.
- Design Full order observer and reduced order observer

Course Outcomes (CO): Student will be able to

- Understand the state space representation, controllability and observability concepts, principles of duality, concepts of optimal and Lyapunov stability. L2
- Apply the state equations, pole placement by state feedback. L3
- Analyze controllability & observability of state models. L4
- Design full order observer and reduced order observer. L5

UNIT - I	STATE VARIABLE DESCRIPTION	Lecture Hrs: 10

Introductory matrix algebra and linear Vector Space, State space representation of systems- Linearization of a non-linear System- Solution of state equations- Evaluation of State Transition Matrix (STM).

UNIT - II	TRANSFORMATION, POLEPLACEMENT ANDCONTROLLABILITY	Lecture Hrs: 8

Similarity transformation and invariance of system properties due to similarity transformations. Minimal realization of SISO, SIMO and MISO transfer functions. Discretization of a continuous time state space modelConversion of state space model to transfer function model using Fadeeva algorithm- Fundamental theorem of feedback control - Controllability and Controllable canonical form - Pole assignment by state feedback using Ackermann's formula– Eigen structure assignment problem.

UNIT - III	OPTIMAL CONTROL	Lecture Hrs: 10

Linear Quadratic Regulator (LQR) problem and solution of algebraic Riccati equation using Eigen value and Eigen vector methods- iterative method- Controller design using output feedback.

UNIT - IV	OBSERVERS	Lecture Hrs:10

Observability and observable canonical form-Design of full order observer using Ackermann's formula -Bass Gura algorithm- Duality between controllability and observability- Full order Observer based controller designReduced order observer design.

UNIT - V	STABILITY ANALYSIS AND SENSITIVITY	Lecture Hrs:10

Internal stability of a system- Stability in the sense of Lyapunov- Asymptotic stability of linear time invariant continuous and discrete time systems- Solution of Lyapunov type equation- Model decomposition and decoupling by state feedback- Disturbance rejection- sensitivity and complementary sensitivity functions.

Textbooks:

1. K. Ogata, "Modern Control Engineering", Prentice Hall, India, 5th edition, 2010
2. T. Kailath, "Linear Systems", Prentice Hall, 2016.
3. N.K. Sinha, "Control Systems", New Age International, 4th edition, 2013.

Reference Books:

1. Panos J Antsaklis, and Anthony N.Michel, “Linear Systems”, New-age international (P)LTD. Publishers, 2009.
2. John JD Azzoand C. H. Houpis, “Linear Control System Analysis and Design conventional and Modern”, Mc Graw- Hill Book Company, 3rd edition, 1988.
3. B.N.Dutta, “Numerical Methods for linear Control Systems”, Elsevier Publication, 2007.
4. C.T. Chen “Linear System Theory and Design-PHI, India,1984.
5. Richard C. Dorf and Robert H. Bishop, “Modern Control Systems”, 11th Edition, Pearson Edu.,India, 2009

Online Learning Resources:

1. http://www.digimat.in/nptel/courses/video/108103007/L01.html.

Course Code	EVOLUTIONARY ALGORITHMS APPLICATIONS IN POWER ENGINEERING (PE-III)	L	T	P	C
C40712c		3	0	0	3
	II Semester		I		

Course Objectives: To make the student

- Understand the fundamentals of optimization and soft computing techniques with emphasis on swarm Intelligence and meta-heuristic approaches for solving real-world engineering problems.
- Explore the principles and working mechanisms of evolutionary algorithms such as Genetic Algorithms, Particle Swarm Optimization, Artificial Bee Colony, Differential Evolution, Bat algorithm, and Shuffled Frog Leaping Algorithm.
- Develop the ability to apply evolutionary algorithms to power engineering problems, including economic load dispatch, optimal placement and sizing of distributed generation, and control of power converters.
- Analyze the role of exploration and exploitation strategies in evolutionary algorithms for achieving near global optimal solutions in constrained and unconstrained optimization problems. multi-objective optimization methods and understand Pareto optimality concepts to address trade-offs in complex power engineering applications.

Course Outcomes (CO): S student will be able to

- Discriminate the capabilities of bio-inspired system and conventional methods in solving optimization problems. L3
- Examine the importance of exploration and exploitation of evolutionary algorithm to attain near global optimal solution. L2
- Distinguish the functioning of various evolutionary algorithms. L3
- Employ various bio-inspired algorithms for Power Engineering applications. L3

UNIT - I	FUNDAMENTALS OF SOFT COMPUTING TECHNIQUES	Lecture Hrs: 10

Definition-Classification of optimization problems- Unconstrained and Constrained optimization Optimality conditions- Introduction to intelligent systems- Soft computing techniques- Conventional Computing versus Swarm Computing - Classification of meta-heuristic techniques - Single solution based and population based algorithms – Exploitation and exploration in population based algorithms - Properties of Swarm intelligent Systems - Application domain - Discrete and continuous problems - Single objective and multi-objective problems.

UNIT - II	GENETIC ALGORITHM AND PARTICLE SWARM OPTIMIZATION	Lecture Hrs: 8

Genetic Algorithm versus Conventional Optimization Techniques - Genetic representations and selection mechanisms; Genetic operators- different types of crossover and mutation operators -Bird flocking and Fish Schooling – anatomy of a particle- equations based on velocity and positions -PSO topologies - control parameters – GA and PSO algorithms for solving ELD problem.

UNIT - III	ARTIFICIAL BEE COLONY ALGORITHM AND DIFFERENTIAL EVOLUTION	Lecture Hrs: 10

Artificial bee colony (ABC) algorithms-binary ABC algorithms – ACO and ABC algorithms for solving Economic Dispatch of thermal units. The Motivation for Differential Evolution (DE), Introduction to Parameter Optimization, Single-Point, Derivative-Based Optimization, Local Versus Global Optimization, Differential Mutation, Recombination, Selection, Benchmarking Differential Evolution, DE Versus Other Optimizers, DE on Parallel Processors.

UNIT - IV	SHUFFLED FROG-LEAPING ALGORITHM AND BAT OPTIMIZATION ALGORITHM	Lecture Hrs:10

Bat Algorithm- Echolocation of bats- Behaviour of microbats- Acoustics of Echolocation- Movement of Virtual Bats- Loudness and Pulse Emission- Shuffled frog algorithm-virtual population of frogs- comparison of memes and genes -memeplex formation- memeplex updation- BA and SFLA

algorithms for solving ELD and optimal placement and sizing of the DG problem.		
UNIT - V	MULTI OBJECTIVE OPTIMIZATION	Lecture Hrs:10
Multi-Objective optimization Introduction- Concept of Pareto optimality - Non-dominant sorting techniquePareto fronts-best compromise solution- min-max method-NSGA-II algorithm and applications – Control of Power Converters.		
Textbooks:		
1.Xin-She Yang, Recent Advances in Swarm Intelligence and Evolutionary Computation, Springer International Publishing, Switzerland, 2015. 2.Kalyanmoy Deb, Multi-Objective Optimization using Evolutionary Algorithms, John Wiley & Sons,2001. 3.Altaf Q. H. Badar, Evolutionary Optimization Algorithms, CRC Press, 2022		
Reference Books:		
1.James Kennedy and Russel E Eberheart, Swarm Intelligence, The Morgan Kaufmann Series inEvolutionary Computation, 20012. 2.N P Padhy, Artificial Intelligence and Intelligent Systems, Oxford University Press, 2005		
Online Learning Resources:		
1. https://www.youtube.com/playlist?list=PLwNx-fzXuQ9ZKLp0Vvj5OYt5xXZA4aALj		

Course Code	POWER QUALITY (PE– IV)	L	T	P	C
C40713a		3	0	0	3
II Semester		I			

Course Objectives:

- To understand power quality definitions, terminology, and standards.
- To explain power frequency disturbances and transient phenomena.
- To apply concepts of harmonics, electromagnetic interference, and mitigation techniques.
- To analyze grounding, bonding, and power quality measurement techniques.

Course Outcomes (CO): Student will be able to

- Understand the fundamentals and terminology of power quality. L2
- Apply concepts of power frequency disturbances and transient analysis. L3
- Analyze harmonics and electromagnetic interference in power systems. L4
- Remember the necessity of grounding and various grounding methods. L1

UNIT - I	INTRODUCTION TO POWER QUALITY	Lecture Hrs:08

Definition of Power Quality, Power Quality Progression, Power Quality Terminology, Power Quality Issues, Voltage Swells, Voltage Sags, Flicker, Responsibilities of Power Suppliers and Users, Power Quality Standards.

UNIT - II	POWER FREQUENCY DISTURBANCES & TRANSIENTS	Lecture Hrs:08

Introduction to Power Frequency Disturbance, Common Power Frequency Disturbances, Characteristics of Low Frequency Disturbances, Voltage Tolerance Criteria, ITIC Graph, Introduction to Transients, Transient System Models, Power System Transient Modeling, Types and Causes of Transients, Examples of Transient Waveforms.

UNIT - III	HARMONICS & ELECTROMAGNETIC INTERFERENCE	Lecture Hrs:10

Definition of Harmonics, Harmonic Number, Odd and Even Order Harmonics, Harmonic Phase Rotation, Voltage and Current Harmonics, Individual and Total Harmonic Distortion, Harmonic Signatures, Effects of Harmonics, Harmonic Current Mitigation, Introduction to EMI, Electrical Fields, Magnetic Fields, EMI Mitigation, Cable Shielding, Health Concerns.

UNIT - IV	GROUNDING AND BONDING	Lecture Hrs:10

Introduction to Grounding and Bonding, Shock and Fire Hazards, NEC Grounding Requirements, Ground Electrodes, Earth Resistance Tests, Ground Grid Systems, Power Ground System, Signal Reference Ground, Ground Loops, Electrochemical Reaction, Grounding Anomalies.

UNIT - V	MEASURING AND SOLVING POWER QUALITY PROBLEMS	Lecture Hrs:10

Power Quality Measurements, Measurement Devices, Test Locations, Test Duration, Instrument Setup, Instrument Guidelines, Power Quality Mitigation Concepts and Devices.

Textbooks:

1. C. Sankaran, Power Quality, CRC Press, 1st Edition, 2001.
2. Roger C. Dugan, Mark F. McGranaghan, Surya Santoso, H. Wayne Beaty, Electrical Power Systems Quality, 2nd Edition, TMH..

Reference Books:

1. Math H.J. Bollen, Understanding Power Quality Problems, IEEE Press.
2. Arindam Ghosh & Gerard Ledwich, Power Quality Enhancement Using Custom Power Devices, Kluwer Academic Publishers.

Course Code	EV CHARGING INFRASTRUCTURE & TECHNOLOGY (PE– IV)	L	T	P	C
C40713b		3	0	0	3
II Semester		I			

Course Objectives:

- Understand EV charging infrastructure and charging standards.
- Learn location planning and land allocation for charging stations.
- Understand electricity supply regulations and DISCOM roles.
- Analyze EV-grid integration and charging implementation models.

Course Outcomes (CO): Student will be able to

- Differentiate AC and DC charging systems and standards. L2
- Apply location planning methodologies for EV charging stations. L3
- Analyze EV-grid integration and smart charging concepts. L4
- Compare EV charging implementation models in India. L2

UNIT - I	AN OVERVIEW OF EV CHARGING INFRASTRUCTURE	Lecture Hrs:08

Orientation to EV Charging Infrastructure, Electric Vehicle Supply Equipment, AC Charging, DC Charging, Power Ratings, Charging Standards.

UNIT - II	LOCATION PLANNING AND LAND ALLOCATION	Lecture Hrs:10

Location Planning, Site Planning, Spatial Allocation of Charging Demand, Urban Planning, Public Charging Infrastructure, Policies.

UNIT - III	CONNECTING EVs TO THE ELECTRICITY GRID	Lecture Hrs:10

Electricity Supply for Charging Infrastructure, Electricity Regulations, Role of DISCOMs, Charging Connections, Methods of Power Supply.

UNIT - IV	ACHIEVING EFFECTIVE EV-GRID INTEGRATION	Lecture Hrs:10

Site-Level Considerations, Grid-Level Impact Assessment, Smart Charging, Load Management, Grid Integration.

UNIT - V	MODELS OF EV CHARGING IMPLEMENTATION	Lecture Hrs:10

Government-Driven Model, Consumer-Driven Model, Charge Point Operator Model, EV Charging Infrastructure Implementation.

Textbooks:

1. Handbook of Electric Vehicle Charging Infrastructure Implementation, Version-1.
2. Vahid Vahidinasab, Behnam Mohammadi, 2022.

Reference Books:

1. Relevant publications on EV Charging Infrastructure and Smart Grid Technologies.

Course Code	EHVAC TRANSMISSION SYSTEMS (PE– IV)	L	T	P	C
C40713c		3	0	0	3
II Semester		I			

Course Objectives:

- Understand the basic concepts of EHVAC transmission.
- Identify factors affecting AC and DC transmission.
- Analyze travelling waves and corona effects.
- Estimate electric field intensity in EHV systems.

Course Outcomes (CO): Student will be able to

- Understand basic concepts of EHVAC transmission. L2
- Identify factors affecting AC-DC transmission. L3
- Analyze travelling waves and corona effects. L4
- Estimate electric field intensity using computational methods. L2

UNIT - I	PRELIMINARIES	Lecture Hrs:08

Need for EHV AC Transmission, Advantages, Power Handling Capacity, Mechanical Considerations, Resistance of Conductors, Bundled Conductors, Bundle Spacing, Bundle Radius.

UNIT - II	LINE AND GROUND REACTIVE PARAMETERS	Lecture Hrs:10

Line Inductance, Capacitance, Sequence Parameters, Modes of Propagation, Ground Return, Electrostatics, Surface Voltage Gradient, Bundle Conductors.

UNIT - III	CORONA EFFECTS	Lecture Hrs:10

Corona Power Loss, Audible Noise, Corona Loss Formulae, Radio Interference, Corona Pulses, Frequency Spectrum, Measurement of RIV.

UNIT - IV	ELECTROSTATIC FIELD & TRAVELLING WAVE THEORY	Lecture Hrs:10

Electrostatic Field Calculation, Effects on Humans and Environment, Electromagnetic Interference, Travelling Wave Theory, Reflection, Refraction, Charging Current.

UNIT - V	VOLTAGE CONTROL	Lecture Hrs:10

Power Circle Diagram, Voltage Control Using Synchronous Condensers, Series and Shunt Compensation, Static VAR Compensator, Sub-Synchronous Resonance.

Textbooks:

1. Sanjay Kumar Sharma, AC, HVDC Transmission and Distribution Engineering, 2nd Edition, 2016.
2. M.G. Dwek, EHV Transmission, Elsevier Science, 3rd Edition, 1992.

Reference Books:

1. Relevant publications on EV Charging Infrastructure and Smart Grid Technologies.

Course Code	RENEWABLE ENERGY SOURCES LAB	L	T	P	C
C40714		0	0	4	2
II Semester		I			

Course Objectives:

- Understand the characteristics and behavior of renewable energy sources such as solar PVpanels, wind Generators, and batteries under different operating conditions.
- Develop practical skills in configuring, testing, and analyzing renewable energy systems,including PV arrays, MPPT controllers, inverters, and battery management.
- Gain experience in modeling and simulating renewable energy components, studying the effects of environmental factors like irradiation, temperature, and wind speed on system performance.
- Apply control and power electronics techniques (such as MPPT algorithms and DC-DCconverters) for enhancing the efficiency, stability, and integration of renewable energy systemsinto the grid.

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Course Outcomes (CO): Student will be able to

- To observe the I-V and P-V curves and Series and Parallel connection of Solar systems. L3
- To study the sun tracking and MPPT Charge Controllers of Solar systems. L2
- To analyze Power, Voltage & Frequency Measurement of Wind Generator. L4
- To Understand the Effect of temperature variation and Irradiation on Photovoltaic Array. L2

List of Experiments:

1. Draw the I-V and P-V curves of Solar Panel using PV Panel
2. Study of Series and Parallel connection of Solar Panels
3. Study of Sun tracking system
4. Maximum Power Point Tracking Charge Controllers
5. Inverter control for Solar PV based systems
6. Power, Voltage & Frequency Measurement of output of Wind Generator
7. Impact of load and wind speed on power output and its quality
8. Performance of frequency drop characteristics of induction generator at different loadingcondition
9. Charging and Discharging characteristics of Battery

Simulation Experiments

1. Modelling of PV Cell
2. Effect of temperature variation on Photovoltaic Array
3. Effect of Irradiation on a Photovoltaic Array
4. Design of solar PV boost converter using P&O MPPT technique

Web Sources: https://www.vlab.co.in

Course Code	FACTS DEVICES SIMULATION LAB	L	T	P	C
C40715		0	0	4	2

II Semester

Course Objectives:

- Understand how to write the coding in simulation.
- Apply the SVC, STATCOM for voltage profile improvements & UPFC in power system networks.
- Analyze the data related to load flows incorporating SVC & STATCOM.
- Analyze operation of TCSC, STATCOM & SSSC for a transmission line fed by an AC supply.

Course Outcomes (CO): Student will be able to

- Understand Load balancing using compensators. L2
- Apply load balancing using Compensators. L3
- Analyse load flow incorporating SVC & STATCOM. L4
- Develop a Simulation model for STATCOM & UPFC. L5

List of Experiments:

1. Voltage regulation using shunt and series compensation
2. Load balancing in power system network using compensators
3. Simulation of TCSC
4. Voltage profile improvement using SVC
5. Voltage profile improvement using STATCOM
6. Transient Stability enhancement using STATCOM.
7. Simulation of UPFC with mathematical models
8. Load flow incorporating SVC
9. Load flow incorporating STATCOM
10. Simulation of DVR
11. Transmission Line Characteristics (P vs δ, Q vs δ, P vs Distance, Q vs Distance and V vs Distance) with and without Compensation
12. Sizing- simulation and operation of TCR and FC-TCR for a transmission line fed by an ac supply and feeding
    (a) Resistive/inductive/capacitive load one at a time
    (b) A load which can have leading as well as lagging behaviour
13. Sizing- simulation and operation of TCSC for a transmission line fed by an ac supply and feeding
    (a) Resistive/inductive/capacitive load one at a time
    (b) A load which can have leading as well as lagging behaviour
14. Sizing- simulation and operation of STATCOM for a transmission line fed by an ac supply and feeding
    (a) Resistive/inductive/capacitive load one at a time
    (b) A load which can have leading as well as lagging behaviour
15. Sizing- simulation and operation of SSSC for a transmission line fed by an ac supply and feeding
    (a) Resistive/inductive/capacitive load one at a time
    (b) A load which can have leading as well as lagging behaviour

Web Sources: https://www.vlab.co.in

Course Code	QUANTUM TECHNOLOGIES AND APPLICATIONS	L	T	P	C
C40716		2	0	0	2
II Semester		I			

Course Objectives:

- To understand the fundamental principles of quantum mechanics including superposition, entanglement, uncertainty, and wave-particle duality.
- To explain the concepts of qubits, quantum states, and quantum information systems.
- To understand the challenges involved in building scalable quantum computers.
- To introduce quantum communication, quantum computing, and their practical applications.
- To familiarize students with emerging quantum technologies, industrial applications, and future research opportunities.

Course Outcomes (CO): Student will be able to

- Understand the fundamental concepts of quantum theory and technologies. L2
- Differentiate classical information systems from quantum information frameworks. L2
- Identify the theoretical limitations and challenges involved in building quantum computers. L3
- Explain the conceptual principles of quantum communication and quantum computing. L2
- Analyze the applications, industrial developments, and future directions of quantum technologies. L4

UNIT - I	FOUNDATIONS OF QUANTUM THEORY AND TECHNOLOGIES	Lecture Hrs:08

Transition from classical to quantum physics. Key conceptual principles: Superposition, Entanglement, Uncertainty Principle, Wave-particle duality. Quantum states and measurement. Role of the observer. Representative quantum systems: electrons, photons, atoms. Concept of quantization and discrete energy levels. Strategic importance of quantum technologies. Overview of quantum computing, quantum communication and quantum sensing. Global quantum initiatives including India's National Quantum Mission, EU Quantum Flagship, USA and China.

UNIT - II	CONCEPTUAL STRUCTURE OF QUANTUM INFORMATION	Lecture Hrs:10

Concept of qubits using spin and polarization. Classical bits versus quantum bits. Quantum systems including trapped ions, superconducting qubits and photonic systems. Quantum coherence and decoherence. Quantum states and measurement operators. Hilbert space interpretation without mathematical formalism. Entanglement and non-locality. Quantum information principles and philosophical foundations.

UNIT - III	BUILDING A QUANTUM COMPUTER: CHALLENGES AND REQUIREMENTS	Lecture Hrs:10

Conceptual requirements for quantum hardware. Fragility of quantum states. Decoherence, quantum noise and stability issues. Isolation techniques. Error resilience and scalability. Quantum control mechanisms. Importance of maintaining entanglement. Introduction to quantum error correction. Comparative study of superconducting circuits, trapped ions and photonic quantum computers. Present status of quantum computing research.

UNIT - IV	QUANTUM COMMUNICATION AND COMPUTING	Lecture Hrs:10

Quantum versus classical communication. Fundamentals of Quantum Key Distribution (QKD). Secure communication through entanglement. Quantum Internet. Introduction to quantum computing and quantum parallelism. Classical and quantum gate operations. Challenges including decoherence, quantum noise and error correction.

UNIT - V	APPLICATIONS, INDUSTRY AND FUTURE DIRECTIONS	Lecture Hrs:10

Applications in healthcare, drug discovery, material science, chemistry, optimization, logistics, quantum sensing and precision timing. Industrial case studies including IBM, Google, Microsoft and PsiQuantum. Ethical, societal and policy issues. Challenges in commercialization including cost, skilled manpower and standards. Emerging research opportunities and career prospects in quantum technologies.

Textbooks:

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

Reference Books:

1. David McMahon, Quantum Computing Explained, Wiley, 2008.
2. Kaye, Laflamme and Mosca, An Introduction to Quantum Computing, Oxford University Press, 2007.
3. Scott Aaronson, Quantum Computing Since Democritus, Cambridge University Press, 2013.
4. Leonard Susskind and Art Friedman, Quantum Mechanics: The Theoretical Minimum, Basic Books, 2014.
5. Bruce Rosenblum and Fred Kuttner, Quantum Enigma, Oxford University Press, 2011.
6. Benenti, Casati and Strini, Principles of Quantum Computation and Information, World Scientific, 2004.
7. DST India & MeitY, National Quantum Mission Reports.
8. Quantum Flagship (European Union) Roadmap and Strategy Documents.

Online Learning Resources:

1. IBM Quantum Experience and Qiskit Learning Platform.
2. Coursera – Quantum Mechanics and Quantum Computation (University of California, Berkeley).
3. edX – Quantum Internet and Quantum Computing.
4. Michael Nielsen's Quantum Computing for the Determined (YouTube).

Course Code	PEDAGOGY STUDIES	L	T	P	C
C40718a		2	0	0	2
II Semester		I			

Course Objectives:

- To understand the aims, rationale, policy background, and conceptual frameworks in pedagogy, curriculum, and teacher education research.
- To develop an understanding of diverse pedagogical practices and teaching-learning approaches.
- To learn methodologies for assessing the effectiveness of pedagogical practices and teacher education models.
- To understand professional development strategies, including peer support, community engagement, and curriculum alignment.
- To encourage research in pedagogy, curriculum, and teacher education for improving educational practices.

Course Outcomes (CO): Student will be able to

- Define and explain the key concepts, frameworks, and methodologies in pedagogy and teacher education research. L1
- Analyze pedagogical practices used in diverse classroom settings with reference to curriculum design and teacher education. L4
- Evaluate the effectiveness of pedagogical approaches using quality assessment tools and theory of change models. L5
- Apply evidence-based strategies to improve classroom practices, curriculum alignment, and teacher professional development. L3
- Identify barriers to learning and recommend innovative pedagogical strategies for inclusive education. L3
- Design research studies addressing gaps in pedagogy, curriculum, and teacher education. L5

UNIT - I	FOUNDATIONS OF PEDAGOGY	Lecture Hrs:08

Introduction to pedagogy and its importance in education. Historical and philosophical foundations of pedagogy. Theories of learning and teaching: Behaviorist, Cognitive and Constructivist approaches. Role of pedagogy in shaping educational practices. Role of technology in modern pedagogy including ICT, e-learning and blended learning.

UNIT - II	TEACHING–LEARNING PROCESSES	Lecture Hrs:10

Understanding the teaching-learning process. Lesson planning and curriculum design. Strategies for effective teaching and learning including expository, collaborative and experiential learning. Integration of technology through multimedia, simulations and gamification to enhance classroom learning.

UNIT - III	TECHNOLOGY INTEGRATION IN EDUCATION	Lecture Hrs:10

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

UNIT - IV	PEDAGOGY AND ASSESSMENT	Lecture Hrs:10

Pedagogy, pedagogical analysis and assessment. Types of assessment: Placement, Formative, Diagnostic and Summative assessment. Technology-based assessment tools including online quizzes, polls and discussion forums. Rubrics for self and peer evaluation. Reflective teaching practices for continuous improvement.

UNIT - V	CONTEMPORARY ISSUES AND TRENDS	Lecture Hrs:10

Inclusive education and assistive technologies. Change management and innovation in education. Quality assurance and evaluation using Total Quality Management (TQM) and Six Sigma. Future trends in pedagogy including Artificial Intelligence (AI), Augmented Reality (AR), Virtual Reality (VR), 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 Learning Resources

1. UNESCO Education Resources – https://www.unesco.org/education
2. OECD Education and Skills – https://www.oecd.org/education
3. ERIC (Education Resources Information Center) – https://eric.ed.gov
4. World Bank Education – https://www.worldbank.org/en/topic/education
5. NPTEL / SWAYAM – Teacher Education and Pedagogy Courses.
6. Google Scholar Alerts – Latest research on pedagogical practices, teacher education and curriculum research.

Course Code	PERSONALITY DEVELOPMENT THROUGH LIFE ENLIGHTENMENT SKILLS	L	T	P	C
C40718b		2	0	0	2
II Semester		I			

Course Objectives:

- To enable students to develop self-awareness by identifying their strengths, weaknesses, opportunities, and challenges through SWOC analysis.
- 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 public speaking and professional presentation skills.
- To develop leadership qualities, teamwork, and collaborative problem-solving skills for personal and professional growth.

Course Outcomes (CO): Student will be able to

- Define and explain the concepts of self-awareness, personality, and personal growth. L1
- Apply emotional intelligence strategies to regulate emotions and build effective interpersonal relationships. L3
- Demonstrate positive thinking, gratitude, and resilience in overcoming personal and professional challenges. L2
- Analyze barriers to effective communication and apply verbal and non-verbal communication techniques in diverse situations. L4
- Prepare and deliver effective presentations and public speeches with confidence. L5
- Develop leadership and teamwork skills for collaboration, negotiation, and problem-solving in professional environments. L3

UNIT - I	SELF-AWARENESS AND PERSONAL GROWTH	Lecture Hrs:08

Understanding personality and personality development. Identifying strengths, weaknesses, opportunities, and challenges through SWOC analysis. Setting personal and professional goals. Practicing self-reflection and journaling. Activities include personality assessment, self-reflection exercises, group discussions, SWOC analysis, SMART goal setting, action planning, reflective journaling, and self-care planning.

UNIT - II	EMOTIONAL INTELLIGENCE AND INTERPERSONAL SKILLS	Lecture Hrs:10

Understanding emotional intelligence and its importance. Developing self-awareness, self-regulation, motivation, empathy, and interpersonal skills. Effective communication techniques. Conflict resolution and negotiation strategies. Activities include emotional intelligence assessment, mindfulness exercises, positive self-talk, active listening, role-play, feedback sessions, case studies, and group activities.

UNIT - III	POSITIVE THINKING AND ATTITUDE	Lecture Hrs:10

Understanding the importance of positive thinking. Developing a growth mindset and resilience. Practicing gratitude and mindfulness. Overcoming negative thoughts and behaviours. Activities include positive thinking exercises, resilience-building activities, mindfulness practices, gratitude exercises, and preparation of self-care plans.

UNIT - IV	EFFECTIVE COMMUNICATION AND PRESENTATION SKILLS	Lecture Hrs:10

Importance of effective communication. Development of verbal and non-verbal communication skills. Preparation and delivery of effective presentations. Building confidence in public speaking. Activities include group discussions, role-plays, case studies, storytelling, debates, practice presentations, peer evaluation, and public speaking exercises.

UNIT - V	LEADERSHIP AND TEAMWORK	Lecture Hrs:10

Leadership styles and leadership qualities. Developing leadership competencies. Team building and teamwork strategies. Collaboration, negotiation, and problem-solving techniques. Activities include leadership role-play, team-building exercises, collaborative projects, group discussions, case studies, debates, and feedback sessions.

Textbooks:

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 Learning Resources

1. Coursera – Personal Development Specialization.
2. edX – Leadership and Emotional Intelligence Courses.
3. FutureLearn – Mindfulness and Resilience Training.
4. MindTools – Leadership, Communication, and Emotional Intelligence Resources.
5. Positive Psychology – Articles and Tools on Resilience, Gratitude, and Well-being.
6. TED Talks – Leadership, Communication, and Self-Growth.
7. Harvard Business Review (HBR) – Leadership, Negotiation, and Workplace Communication.

Course Code	YOGA FOR STRESS MANAGEMENT	L	T	P	C
C40718c		2	0	0	0
II Semester		I			

Course Objectives:

- To understand the foundational concepts of Yoga, including the eight limbs (Ashtanga Yoga) as prescribed in classical texts.
- To explain the principles of Yama and Niyama and their significance in ethical, personal, and social development.
- To understand the values of Ahimsa, Satya, Asteya, Brahmacharya, Aparigraha, Shaucha, Santosha, Tapa, Swadhyaya, and Ishwar Pranidhana in daily life.
- To practice selected Asanas and Pranayama techniques for physical fitness, mental balance, and spiritual well-being.
- To promote a holistic lifestyle through regular Yoga practice for stress management and personality development.

Course Outcomes (CO): Student will be able to

- Understand the concepts of Ashtanga Yoga and explain the interrelationship among its eight limbs. L2
- Explain the principles of Yama and Niyama and apply them in personal and professional life. L2
- Demonstrate the ethical values of Yoga such as Ahimsa, Satya, Asteya, Brahmacharya, Aparigraha, Shaucha, Santosha, Tapa, Swadhyaya, and Ishwar Pranidhana. L3
- Perform selected Asanas and Pranayama techniques with correct posture and breathing practices. L3
- Evaluate the physical, mental, and emotional benefits of Yoga in stress reduction, concentration, and self-discipline. L5
- Adopt Yoga philosophy and practices as a regular routine for sustainable health, well-being, and personality development. L3

UNIT - I	FOUNDATIONS OF ASHTANGA YOGA	Lecture Hrs:08

Introduction to Yoga. Definition, meaning, scope, and importance of Yoga. Concept of Ashtanga Yoga (Eight Limbs of Yoga): Yama, Niyama, Asana, Pranayama, Pratyahara, Dharana, Dhyana, and Samadhi. Benefits of Yoga for physical, mental, emotional, and spiritual well-being.

UNIT - II	YAMA AND NIYAMA	Lecture Hrs:10

Concept and significance of Yama and Niyama. Ethical disciplines and personal observances. Role of Yama and Niyama in character building, self-discipline, social harmony, and stress management..

UNIT - III	ETHICAL VALUES OF YOGA	Lecture Hrs:10

Study and application of:

- Yama: Ahimsa, Satya, Asteya, Brahmacharya, Aparigraha.
- Niyama: Shaucha, Santosha, Tapa, Swadhyaya, Ishwar Pranidhana.

Application of these principles in personal, academic, professional, and social life..

UNIT - IV	ASANAS AND PRANAYAMA	Lecture Hrs:10

Introduction to Yoga Asanas and their classifications. Practice of selected Yoga postures for flexibility, strength, posture correction, and stress reduction. Fundamentals of Pranayama. Breathing techniques, posture, awareness, precautions, and health benefits.

UNIT - V	YOGA FOR STRESS MANAGEMENT	Lecture Hrs:10

Various Yoga postures and their benefits for mind and body. Regularization of breathing techniques. Types of Pranayama and their effects on physical health, mental relaxation, emotional stability, concentration, and overall personality development. Role of Yoga in maintaining a healthy lifestyle and managing stress.

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 Publications, 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 Learning Resources

1. NPTEL / SWAYAM – Yoga and Physical Education Courses.
2. AYUSH Ministry – Official Yoga Resources, Protocols, and Research.
3. Yoga Journal – Practical Guides, Research Updates, and Asana Tutorials.
4. Art of Living Foundation – Pranayama, Meditation, and Wellness Practices.
5. Sivananda Yoga Vedanta Centre – Yoga Learning Resources.
6. Yoga with Adriene (YouTube) – Practical Yoga Asanas and Guided Sessions.

COURSE STRUCTURE

III - SEMESTER

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.	C40719a C40719b C40719c	**Program Elective – V** Restructured Power Systems Machine Learning Applications in Power Engineering Distributed Generation and Micro grid Control	PE	3	0	0	3	40	60	100
2.	**C45853**	**Open Elective -I** IOT AND ITS APPLICATIONS	OE	3	0	0	3	40	60	100
3.	C40720	Dissertation Phase – I	PR	0	0	20	10	100	-	100
	C40721	Industry Internship		0	0	0	2	100	-	100
4.	C40722	Co-curricular Activities		0	0	0	1	Grad		
Total							**19**	**280**	**120**	**400**

Course Code	Restructured Power Systems PE – V	L	T	P	C
C40719a		3	0	0	3
III Semester		II			

Course Objectives:

- To understand the basic concepts of restructuring of the power industry and various electricity market models.
- To analyze the concepts of congestion management, transfer capability, and ancillary service management in competitive power markets.
- To apply transmission cost allocation methods for evaluating transmission pricing.
- To develop operational planning strategies in different competitive electricity market environments.

Course Outcomes (CO): Student will be able to

- Understand the differences between conventional and restructured power system operation, market power, electricity pricing, and competitive environments. L2
- Analyze the concepts of Independent System Operator (ISO) and Open Access Same-Time Information System (OASIS). L4
- Apply methods for determining Available Transfer Capability (ATC) and transmission cost allocation. L3
- Develop power market structures, market architecture, and short-term electricity price forecasting techniques. L5

UNIT - I	KEY ISSUES IN ELECTRIC UTILITIES	Lecture Hrs:08

Introduction to power industry restructuring. Restructuring models. Independent System Operator (ISO). Power exchange. Market operations. Market power. Standard cost. Transmission pricing. Congestion pricing. Management of inter-zonal and intra-zonal congestion.

UNIT - II	POWER SYSTEM OPERATION IN COMPETITIVE ENVIRONMENT	Lecture Hrs:10

Introduction to competitive electricity markets. Operational planning activities of Independent System Operator (ISO). ISO functions in Pool Markets. ISO functions in Bilateral Markets. Operational planning activities of Generation Companies (GENCOs).

UNIT - III	AVAILABLE TRANSFER CAPABILITY (ATC) & ELECTRICITY PRICING	Lecture Hrs:10

Transfer capability issues. Available Transfer Capability (ATC). Total Transfer Capability (TTC). Transmission Reliability Margin (TRM). Capacity Benefit Margin (CBM). ATC calculation using power flow methods. Introduction to electricity pricing. Electricity price volatility. Electricity price indices. Challenges in electricity pricing. Construction of forward price curves. Short-term electricity price forecasting.

UNIT - IV	OPEN ACCESS SAME-TIME INFORMATION SYSTEM (OASIS) & MARKET POWER	Lecture Hrs:10

Structure of Open Access Same-Time Information System (OASIS). Information posting procedures. Transfer capability information through OASIS. Introduction to market power. Types of market power. Market power mitigation techniques. Illustrative examples.

UNIT - V	TRANSMISSION COST ALLOCATION METHODS & ANCILLARY SERVICES MANAGEMENT	Lecture Hrs:10

Transmission cost allocation methods: Postage Stamp Rate Method, Contract Path Method, MW-Mile Method, Unused Transmission Capacity Method, MVA-Mile Method. Comparison of transmission cost allocation methods. Ancillary services management. Reactive power as an ancillary service. Synchronous generators as ancillary service providers.

Textbooks:

1. Kankar Bhattacharya, Math H. J. Bollen and Jaap E. Daalder, Operation of Restructured Power Systems, Kluwer Academic Publishers, 1st Edition, 2001.
2. Mohammad Shahidehpour and Muwaffaq Alomoush, Restructured Electrical Power Systems, Marcel Dekker Inc., 1st Edition, 2001.

Reference Books:

1. Loi Lei Lai, Power System Restructuring and Deregulation, John Wiley & Sons Ltd., England, 2001.

Online Learning Resources:

1. NPTEL: Power System Deregulation / Restructured Power Systems https://nptel.ac.in/courses/108101005

Course Code	MACHINE LEARNING APPLICATIONS IN POWER ENGINEERING	L	T	P	C
C40719b	PE – V	3	0	0	3
III Semester		II			

Course Objectives:

- To understand the fundamental concepts of neural networks and machine learning, including supervised, unsupervised, and reinforcement learning techniques.
- To understand the theoretical foundations of learning such as Bayesian inference, bias-variance trade-off, generalization, and model complexity.
- To develop the ability to apply machine learning algorithms including regression, classification, clustering, support vector machines, tree ensembles, dimensionality reduction, and reinforcement learning.
- To apply machine learning techniques to power engineering applications such as load forecasting, renewable energy forecasting, fault detection, and power converter control.

Course Outcomes (CO): Student will be able to

- Understand the basic concepts and principles of Machine Learning techniques. L2
- Distinguish between supervised, unsupervised, and reinforcement learning approaches. L2
- Develop machine learning models using suitable software tools for solving practical engineering problems. L5
- Apply machine learning algorithms to solve problems in electrical and power engineering. L3

UNIT - I	LEARNING THEORY	Lecture Hrs:08

Introduction to Machine Learning. Learning concepts and objectives. Data requirements for learning. Bayesian inference and learning. Bayes theorem. Naïve Bayes classifier. Regularization. Bias-Variance decomposition and trade-off. Concentration inequalities. Generalization and uniform convergence. VC Dimension. Types of learning: Supervised Learning, Unsupervised Learning, and Reinforcement Learning.

UNIT - II	SUPERVISED LEARNING	Lecture Hrs:10

Simple Linear Regression. Multiple Linear Regression. Logistic Regression. Exponential Family and Generalized Linear Models. Generative Models: Gaussian Discriminant Analysis and Naïve Bayes. Kernel Methods. Support Vector Machine (SVM). Kernel Functions. Kernel SVM. Gaussian Process. Tree Ensemble Methods. Decision Trees. Random Forests. Boosting and Gradient Boosting.

UNIT - III	UNSUPERVISED LEARNING	Lecture Hrs:10

Introduction to Unsupervised Learning. Clustering Techniques. K-Means Clustering Algorithm. Gaussian Mixture Models (GMM). Expectation Maximization (EM) Algorithm. Variational Auto Encoder (VAE). Factor Analysis. Principal Component Analysis (PCA). Independent Component Analysis (ICA).

UNIT - IV	REINFORCEMENT LEARNING	Lecture Hrs:10

Introduction to Reinforcement Learning. Markov Decision Processes (MDP). Value Iteration. Policy Iteration. Value Function Approximation. Q-Learning Algorithm. Reinforcement Learning applications in engineering systems.

UNIT - V	APPLICATIONS OF MACHINE LEARNING IN POWER ENGINEERING	Lecture Hrs:10

Load Forecasting. Energy Market Forecasting. Renewable Energy Forecasting. Fault Identification and Localization. Renewable Energy Uncertainty Estimation. Machine Learning for Solar Power Maximum Power Point Tracking (MPPT). False Data Injection Attack Detection. Machine Learning based Control of Power Converters.

Textbooks:

1. Christopher M. Bishop, Pattern Recognition and Machine Learning, Springer, 2011.
2. Ethem Alpaydin, Machine Learning, MIT Press, 2010.
3. Anuradha Srinivasaraghavan and Vincy Joseph, Machine Learning, Wiley, 2019..

Reference Books:

1. Giuseppe Bonaccorso, Machine Learning Algorithms, Packt Publishing, 2nd Edition, 2018.
2. Tom M. Mitchell, Machine Learning, McGraw-Hill International Edition, 2013.

Online Learning Resources:

1. NPTEL: Machine Learning https://onlinecourses.nptel.ac.in/noc22_cs24
2. NPTEL: Machine Learning Techniques https://nptel.ac.in/courses/106106198

Course Code	DISTRIBUTED GENERATION & MICROGRID CONTROL Program Elective – V	L	T	P	C
C40719c		3	0	0	3
III Semester		II			

Course Objectives:

- To understand the concepts of Distributed Generation (DG), Active Distribution Networks, and Microgrids, including their configuration, advantages, limitations, and operational issues.
- To understand the fundamentals of Combined Heat and Power (CHP), Wind Energy Conversion Systems (WECS), Solar Photovoltaic (PV) Systems, energy storage devices, and other renewable energy resources.
- To analyze the impact of Microgrids and Active Distribution Network Management Systems on distribution systems, markets, communication, and environmental aspects.
- To understand SCADA systems, communication architectures, power quality disturbances, and the impact of Distributed Generation integration on power quality and reliability.

Course Outcomes (CO): Student will be able to

- Understand the concepts of Distributed Generation, Active Distribution Networks, and Microgrids, including their configuration, advantages, limitations, and operational challenges. L2
- Understand the principles of Combined Heat and Power (CHP), Wind Energy Conversion Systems (WECS), Solar Photovoltaic (PV) Systems, and other Distributed Energy Resources. L2
- Analyze the impact of Microgrids and Active Distribution Network Management Systems on technical, economic, environmental, and communication aspects of power systems. L3
- Understand the role of SCADA systems, communication technologies, power quality improvement techniques, and the impact of Distributed Generation integration on system reliability. L2

UNIT - I	INTRODUCTION TO DISTRIBUTED GENERATION AND MICROGRID CONCEPT	Lecture Hrs:08

Introduction to Distributed Generation (DG). Active Distribution Network. Concept of Microgrid. Microgrid configuration. Interconnection of Microgrids. Technical and economic advantages of Microgrids. Challenges and limitations of Microgrid development. Management and operational issues of Microgrids. Dynamic interaction of Microgrids with the main grid. Low Voltage DC (LVDC) Grid.

UNIT - II	DISTRIBUTED ENERGY RESOURCES	Lecture Hrs:10

Introduction to Distributed Energy Resources (DER). Combined Heat and Power (CHP) Systems. Micro-CHP Systems. Wind Energy Conversion Systems (WECS). Wind turbine operating systems. Solar Photovoltaic (PV) Systems. Classification of PV Cells. Small-scale Hydroelectric Power Generation. Other Renewable Energy Sources. Energy Storage Devices.

UNIT - III	MICROGRID AND ACTIVE DISTRIBUTION NETWORK MANAGEMENT SYSTEM	Lecture Hrs:10

Introduction to Active Distribution Network Management. Impact on heat utilization. Impact on process optimization. Impact on electricity markets. Environmental impact. Impact on distribution systems. Communication standards and protocols. Network management requirements of Microgrids. Micro Source Controller. Central Controller.

UNIT - IV	SCADA AND ACTIVE DISTRIBUTION NETWORKS	Lecture Hrs:10

Introduction to SCADA Systems. Existing Distribution Network Operator (DNO) SCADA Systems. Control of DNO SCADA Systems. SCADA in Microgrids. Human Machine Interface (HMI). Hardware Components. Communication Trends in SCADA. Distributed Control Systems (DCS). Substation Communication Standardization. SCADA Communication and Control Architectures. Communication Devices.

UNIT - V	IMPACT OF DISTRIBUTED GENERATION INTEGRATION ON POWER QUALITY AND RELIABILITY	Lecture Hrs:10

Introduction. Power Quality Disturbances. Power Quality Sensitive Customers. Power Quality Improvement Technologies. Impact of Distributed Generation Integration. Reliability Improvement. Issues of Premium Power in Distributed Generation Integration.

Textbooks:

1. S. Chowdhury, S. P. Chowdhury and P. Crossley, Microgrids and Active Distribution Networks, Institution of Engineering and Technology (IET), 2009.

2. Nikos Hatziargyriou, Microgrids: Architectures and Control, Wiley-IEEE Press, 1st Edition, 2014.

Reference Books:

1. Math H. J. Bollen and Fainan Hassan, Integration of Distributed Generation in the Power System, Wiley-IEEE Press, 2011.
2. Joc Hayton, Distributed Generation Systems, 1st Edition, 2016.

Online Learning Resources:

1. NPTEL – Distributed Generation and Smart Grid https://nptel.ac.in/courses/108107143
2. Microgrid and Distributed Generation Video Lectures https://www.youtube.com/watch?v=4PdkdUNU4n8&list=PLLy_2iUCG87CVEavUXzRbiBihLRkjKcSY

OPEN ELECTIVES - I

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)

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.
4.

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	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).

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)

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).

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.