PONDICHERRY UNIVERSITY

Bachelor of Technology
Electrical and Electronics Engineering (EEE)

for Affiliated Colleges

REGULATIONS, CURRICULUM AND SYLLABUS
(for Affiliated Colleges)

(2023- 24)

PONDICHERRY UNIVERSITY

BACHELOR OF TECHNOLOGY PROGRAMMES

(EIGHT SEMESTERS)

REGULATIONS 2023-24

1. Conditions for Admission:

(a) **Candidates for admission to the first semester of the 8 semester B.Tech. degree programme should be required to have passed :**

The Higher Secondary Examination of the (10+2) curriculum (Academic Stream) prescribed by the different State Boards/ Central Boards or any other examination equivalent there to with minimum of 45% marks (40% marks in case of candidates belonging to reserved category) in aggregate of subjects – Mathematics, Physics and any one of the following optional subjects: Chemistry / Biotechnology/ Computer Science / IT and equivalent/ Electronics/ Biology (Botany & Zoology) or Passed D.Voc Stream in the same or allied sector or an Examination of any University or Authority recognized by the Executive Council of the Pondicherry University as equivalent thereto.

b) Candidates for admission through Lateral entry into second year (third semester) of the 8 semester B.Tech. degree programme should be required to have passed :

Passed Minimum THREE years / TWO years (Lateral Entry) Diploma examination with at least 45% marks (40% marks in case of candidates belonging to reserved category) in ANY branch of Engineering and Technology.

OR

Passed B.Sc. Degree from a recognized University as defined by UGC, with at least 45% marks (40% marks in case of candidates belonging to reserved category) and passed 10+2 examination with Mathematics as a subject.

OR

Passed D.Voc. Stream in the same or allied sector.

(The Universities/colleges will offer suitable bridge courses such as Mathematics, Physics, Engineering drawing, etc., for the students coming from diverse backgrounds to achieve desired learning outcomes of the programme)

2. Age Limit :

As per applicable AICTE norms.

3. Duration of Programme:

The Bachelor of Technology degree programme shall extend over a period of 8 semesters spread over 4 academic years – two semesters constituting one academic year. The duration of each semester shall normally be 15 weeks excluding examinations.

4. Program Structure

The medium of instruction is English.

A student admitted to the B.Tech. programme in a particular branch of engineering will earn the degree in that branch by fulfilling all the requirements prescribed in the regulations during the course of study.

The student is also permitted to opt for earning an **Honors degree in the same discipline of Engineering or a Minor degree** in another discipline of engineering in addition to the degree in his own discipline of engineering. The student will be allowed to exercise this option at the end of first year based on his academic performance in the first year. The students admitted through lateral entry can exercise this option at the end of third semester, based on the GPA scored in the third semester examination.

The student opting for B.Tech. degree with **Honors or B.Tech. degree with Minor** is required to earn additional 20 credits starting from the third semester. The students admitted in the second year through lateral entry and opting for Honors / Minor degree will earn the additional 20 credits starting from the fourth semester.

5. Eligibility for the award of B.Tech. Degree:

No candidate shall be eligible for the award of the degree of Bachelor of Technology, unless he/she has undergone the course for a period of 8 semesters (4 academic years) / 6 semesters (3 academic years for Lateral Entry candidates) in the Faculty of Engineering and has passed the prescribed examinations in all the semesters. Details regarding the possible exit for a B.Tech. student – in line with one of the goals of the National Education Policy (NEP) 2020 are provided in section 13.

6. Branches of Study:

Branch I - Civil Engineering

Branch II – Mechanical Engineering

Branch III - Electronics & Communication Engineering

Branch IV - Computer Science & Engineering

Branch V – Electrical & Electronics Engineering

Branch VI – Chemical Engineering

Branch VII - Electronics & Instrumentation Engineering

Branch VIII – Information Technology

Branch IX - Instrumentation & Control Engineering

Branch X – Biomedical Engineering

Branch XI - Robotics and Automation

Branch XII – Food Technology

Branch XIII- CSE (Internet of Things & Cyber security including Block chain Technology)

Branch XIV – Artificial Intelligence and Machine Learning

Branch XV - Artificial Intelligence and Data Science

or any other branch of study as and when offered. The branch allocation shall be ordinarily done at the time of admission of the candidate to the first semester.

7. Course Structure and Subjects of Study:

Definition of Credit:

1 Hour Lecture (L) per week	1 Credit
1 Hour Tutorial (T) per week	1 Credit
2 Hours Practical (P) per week	1 Credit

Range of Credits: The total credits of all the branches for the four-year B. Tech. degree Programme shall be in the range of 160 to 172 (Minor variation is allowed as per AICTE guidelines). "Minor Degree or Honors will cumulatively require additional 20 credits in the specified area in addition to the credits essential for obtaining the Under Graduate Degree in Major Discipline".

The subjects of study shall include theory, practical courses and project work/internships as given in the curriculum and shall be in accordance with the prescribed syllabus.

The curriculum of every programme will have courses that are categorized as follows:

(i) Humanities, Social Sciences and Management Courses (HSM)

(ii) Basic Science Courses (BSC)

(iii) Engineering Science Courses (ESC)

(iv) Professional Core Courses (PCC)

(v) Professional Elective Courses (PEC)

(vi) Open Elective Courses (OEC)

(vii) Professional Activity Courses (PAC)

(viii) Mandatory non-Credit Courses (MCC)

Each course will have either one or more of three components namely Lecture (L), Tutorial (T) and Practice (P). Each course is assigned credits as detailed below:

(i) Theory courses will carry either 3 or 4 credits - 3 credits for courses with 3 lecture periods per week and 4 credits for courses with 3 lecture periods and 1 tutorial period per week.

(ii) All Elective courses including online courses will carry maximum 3 credits. The student can earn the credits towards the Open Elective Courses (OEC) by completing the online courses offered in NPTEL anytime between third and seventh semester on prior approval of the courses by the Academic Courses Committee of the Institute. Credits earned through the NPTEL courses will be confined to 2 or 3 credits and subject to a maximum of 9 credits during the entire programme of study.

(iii) Practical courses will normally carry either 1 or 1.5 credits – 1.5 credits for courses with 3 practice periods per week and 1 credit for courses with 2 practice periods per week.

(iv) Out of total credits required for successful completion of the degree, 14 to 22 credits can be assigned for Project work and/or Internship.

(v) Mandatory non-credit courses carry zero credit.

8. Examinations:

The theory and practical examinations shall comprise continuous internal assessment throughout the semester in all subjects as well as university examinations conducted by Pondicherry University at the end of the semester (November / December or April / May).

8.1. Evaluation Scheme

All Credit courses are evaluated for 100 marks comprising of Internal assessment and end-semester exam.

For Theory Course, the weightage of internal assessment is 40% and end semester examination is 60%

For Practical course, the weightage of internal assessment is 60% and end semester examination is 40%

For Project, the weightage of internal assessment is 60% and end semester examination is 40%

8.2. Internal Assessment (Theory)

Total Internal Assessment mark for a theory course is 40 marks. The breakup is as follows:

Criteria	Maximum Marks
a) Internal Assessment Tests	30
b) Percentage of Attendance	5
c) Assignment(s)	5
Total	**40**

Marks for Attendance is as follows:

Below 75%	0
75% - 80%	1
81% - 85%	2
86% - 90%	3
91% - 95%	4
96% - 100%	5

The Principal of the College/Institute schedules the Internal Assessment tests for all courses. All faculty members are expected to conduct this Internal Assessment tests for 1.30 hours duration and evaluate and required to upload the marks to the Controller of Examinations of University. Colleges are also requested to preserve the answer sheets of Internal Assessment tests until declaration of results by the University.

8.3. Internal Assessment (Practicals)

Faculty in-charge of Lab courses shall evaluate the practical course for 60 marks. The break up is as follows:

Criteria	Maximum Marks
a) Laboratory exercises and Record	30

b) Mid Semester exam (Average of 2 exams)	15
c) Internal Viva voce	5
d) Percentage of Attendance	10
Total	**60**

Marks for Attendance is as follows:

Below 75%	0
75% - 80%	2
81% - 85%	4
86% - 90%	6
91% - 95%	8
96% - 100%	10

8.4. Internal Assessment (Project)

The Project work carried out in the eighth semester shall be assessed as follows:

Criteria	Marks
a) Continuous assessment (Guide)	25
b) Project Evaluation Committee	35
Total	**60**

8.5 Requirement for appearing for University Examination

The Controller of Examinations (COE) of Pondicherry University schedules the End-Semester exams for all theory and practical courses based on the University academic calendar.

A detailed Exam Time Table shall be circulated to all Colleges at least 15 days before the start of exams. Question Papers shall be set externally based on BOS approved syllabus.

A candidate shall be permitted to appear for university examinations at the end of any semester only if:

i) He / She secures not less than 75% overall attendance arrived at by taking into account the total

number of periods in all subjects put together offered by the institution for the semester under consideration.

(*Candidates who secure overall attendance greater than 60% and less than 75% have to pay a condonation fee as prescribed by University along with a medical certificate obtained from a medical officer not below the rank of Assistant Director*)

ii) He / She earns a progress certificate from the Head of the institution for having satisfactorily completed the course of study in all the subjects pertaining to that semester

iii) His / Her conduct is found to be satisfactory as certified by the Head of the institution.

A candidate who has satisfied the requirement (i) to (iii) shall be deemed to have satisfied the course requirements for the semester.

8.6 End Semester Exam Evaluation Pattern

Course	**Maximum marks**
a) Theory course (Sec A, Sec B and Sec C) Questions from all units of syllabus	60 marks
b) Practical course (Based on Lab exercises/Record/ Practicals /Viva)	40 marks
c) Internship /Project Work (Based on Seminar/Project Work/Project report/Presentation and viva voce)	40 marks

8.7 Consolidation of Marks and Passing Minimum

The Controller of Examinations of the University consolidates the Internal Assessment marks uploaded by the Colleges and marks secured by students in the end-semester examination.

A student shall be declared to have passed the examination in a subject of study only if he/she secures not less than **40% marks individually both in internal assessment and end-semester examination or an aggregate of 40%.**

A candidate who has been declared "Fail" in a particular subject may reappear for that subject during the subsequent semesters and secure pass marks. However, there is a provision for revaluation of failed or passed subjects provided he/she fulfills the following norms for revaluation.

a) Applications for revaluation should be filed within 15 days from the date of declaration of results or 7 days from the date of receipt of grade sheet whichever is earlier.

b) The candidate should have attended all the internal assessments conducted by the college as well as all the end semester examinations conducted by the University.

c) If a candidate has failed in more than two papers in the end semester examinations, his/her representation for revaluation will not be considered.

d) The request for revaluation must be made in the prescribed format duly recommended by the Head of the Institution along with the revaluation fee prescribed by the University.

"A student shall be declared to have passed the examination in a subject of study only if he/she secures not less than **40% marks individually both in internal assessment and end-semester examination, or an aggregate of 40%.**

8.8. Arrear Exams

A student who failed to secure 40% marks in aggregate is declared as "Fail" and he is eligible to take up a supplementary examination by registering to the said course in the following semester. All other candidates who failed due to shortage of attendance and those seeking to improve the grade shall repeat the course.

8.9. Letter Grades and Calculation of CGPA

Total Marks Secured by a student in each course shall be converted into a letter grade. The following Table shows the seven letter grades and corresponding meaning and the grade points for the calculation of Cumulative Grade Point Average (CGPA).

Each course (Theory/Practical) is to be assigned 100 marks, irrespective of the number of credits, and the mapping of marks to grades may be done as per the following table:

Range of Marks	**Assigned Grade**	Grade Points
91-100	A^+	10
81-90	A	9
71-80	B^+	8
61-70	B	7
51-60	C^+	6

46-50	C	5
40-45	D	4
<40	F	0
Not Applicable	F^R (Fail due to shortage of attendance and therefore, to repeat the course)	0

Note: -F- denotes failure in the course; - F^R - denotes absent / detained as per AICTE norms.

After the results are declared, grade sheets will be issued to the students. The grade sheets will contain the following details:

a) The college in which the candidate has studied.

b) The list of courses enrolled during the semester and the grades scored.

c) The Grade Point Average (GPA) for the semester and the Cumulative Grade PointAverage (CGPA) of all enrolled subjects from first semester onwards.

d) GPA is the ratio of sum of the products of the number of credits (C) of courses registeredand the corresponding Grades Points (GP) scored in those courses, taken for all the courses and sum of the number of credits of all the courses.

$$\mathbf{GPA} = \sum(\mathbf{C} \times \mathbf{GP}) / \sum \mathbf{C}$$

CGPA will be calculated in a similar manner, considering all the courses enrolled from first semester. F^R grades are to be excluded for calculating GPA and CGPA.

e) The conversion of CGPA into percentage marks is as follows

$$\% \text{ Mark} = (\text{CGPA} - 0.5) \times 10$$

9. Procedure for completing the B.Tech. course:

A candidate can join/rejoin the course of study of any semester only at the time of its normal commencement and only if he/she has satisfied the course requirements for the previous semester and further has registered for the university examinations of the previous semester in all the subjects as well as all arrear subjects if any.

However, the entire B.Tech. course should be completed within 7 years (14 semesters) and six years (12 semesters) for students admitted under lateral entry.

10. Award of Class and Rank in B.Tech. degree:

i) A candidate who satisfies the course requirements for all semesters and who passes all the examinations prescribed for all the eight semesters (six semesters for lateral entry candidates) within a maximum period of 7 years (6 years for lateral entry candidates) reckoned from the commencement of the first semester to which the candidate was admitted shall be declared to have qualified for the award of B.Tech. degree.

ii) A candidate who qualifies for the award of the B.Tech. degree passing in all subjects pertaining to the semesters 3 to 8 in his/her first appearance within 6 consecutive semesters (3 academic years) and in addition secures a CGPA of 8.50 and above for the semesters 3 to 8 shall be declared to have passed the examination in **FIRST CLASS** with **DISTINCTION**.

iii) A candidate who qualifies for the award of the B.Tech. degree by passing in all subjects relating to semesters 3 to 8 within a maximum period of eight semesters after his/her commencement of study in the third semester and in addition secures CGPA not less than 6.5 shall declared to have passed the examination in **FIRST CLASS**.

iv) All other candidates who qualify for the award of B.Tech. degree shall be declared to have passed the examination in **SECOND CLASS**.

v) For the Award of University ranks and Gold Medal for each branch of study, the CGPA secured from the 1st to 8th semester alone should be considered and it is mandatory that the candidate should have passed all the subjects from the1st to 8th semester in the first attempt. Rank certificates would be issued to the first ten candidates in each branch of study.

11. Provisions for Honors/Minor degree along with B.Tech. degree:

1. <u>B.Tech. with Honors Degree in the same Engineering discipline</u>

a. The student shall be given an option to earn a Honors degree in the same discipline of engineering at the end of first year based on his academic performance in the first year.

b. A student is eligible to exercise this option if he has passed all the subjects offered in the first year in the first attempt itself and has earned a CGPA of not less than 7.5.

c. Honors degree in a particular discipline of engineering shall be offered for a batch of students if and only if a minimum of 5 eligible students opt for it.

d. The student is required to earn an additional 20 credits (over and above the prescribed maximum credits in the curriculum) starting from the third semester onwards to become eligible for the award of Honors degree. 20 credits shall be earned by the student by completing 5 additional

courses of 4 credits each, one in each of the 5 semesters starting from the third to seventh semester. The syllabus of these 5 courses are framed so as to cover advanced topics in that discipline of engineering.

e. The students admitted in the second year through Lateral Entry Scheme will also be given a chance to opt for Honors degree. Eligibility to avail this option is CGPA of 7.5 and above with no arrears in the third Semester. The student will join the existing batch of students in the fourth semester and earn 16 credits by registering the prescribed courses offered up to the seventh semester. The respective BoS will decide on a suitable course in lieu of the course offered in the third semester to facilitate the student to earn the remaining 4 credits.

f. A student is eligible to get the Honors degree only on completing the programme in 'First Class with Distinction' class.

g. A student can exercise the option to withdraw from the Honors degree at any time after entry.

h. Details about the courses completed and credits earned for Honors degree will appear only in the 'Eighth Semester Grade Sheet' and 'Consolidated Grade Sheet'. These details will be listed under the heading 'Credits Earned for Honors degree'. In the case of students who have either withdrawn from Honors degree or become ineligible for Honors degree by not securing 'First Class with Distinction', the credits earned for the courses registered and successfully completed for Honors degree will be listed under the heading 'Additional Credits Earned'.

i. The CGPA will be calculated for all the courses credited by the students inclusive of major and honors courses

j. Nomenclature of Honors Degree is 'B.Tech.(Honors) in XXX ', where XXX is Discipline in which the student has enrolled.

2. B.Tech. with Minor degree in another Engineering discipline

a) The student shall be given an option to earn a minor degree in another discipline of engineering of his choice at the end of first year based on his academic performance in the first year.

b) A student is eligible to exercise this option if he has passed all the subjects offered in the first year in the first attempt itself and has earned a CGPA of not less than 7.5.

c) Minor degree in a particular discipline of engineering shall be offered for a batch of students if and only if a minimum of 5 eligible students opt for it.

d) The student is required to earn an additional 20 credits (over and above the prescribed

maximum credits in the curriculum) starting from the third semester onwards to become eligible for the award of minor degree. 20 credits shall be earned by the student by completing 5 additional courses of 4 credits each, one in each of the 5 semesters starting from the third to seventh semester. The curricular content of these 5 courses are framed in such a way that that these courses will essentially cover the core minimum knowledge required to be fulfilled for award of degree in the discipline of engineering in which the student chooses to earn the minor degree.

e) The students admitted in the second year through Lateral Entry Scheme will also be given a chance to opt for Minor degree. Students with a CGPA of 7.5 and with no arrears in the third semester are eligible to avail this option. The student will join the existing batch of students in the fourth semester and earn 16 credits by registering for prescribed courses offered up to seventh semester. The respective BoS will decide on a suitable course in lieu of the course offered in the third semester to facilitate the student to earn the remaining 4 credits.

f) A student can exercise the option to withdraw from the Minor degree at any time after entry.

g) Details about the courses completed and credits earned for Minor degree will appear only in the 'Eighth Semester Grade Sheet' and 'Consolidated Grade Sheet'. These details will be listed under the heading 'Credits Earned for Minor degree'. In the case of students who have withdrawn from Minor degree, the credits earned for the courses registered and successfully completed for Minor degree will be listed under the heading 'Additional Credits Earned'.

h) Nomenclature of Minor Degree is 'B.Tech. in XXX with Minor in YYY', where XXX is Discipline in which the student is enrolled and YYY is Discipline which the student has opted as Minor.

i)The CGPA will be calculated for all the courses credited by the students inclusive of major and minor courses.

12. Provision for withdrawal:

Based on the recommendation of the Head of the Institution, a candidate with valid reasons may be granted permission by the University to withdraw from writing the entire semester examination as one Unit. The withdrawal application shall be valid only if it is made earlier than the commencement of the last theory examination pertaining to that semester. Withdrawal shall be permitted only once during the entire course. A candidate who has withdrawn is also eligible to be awarded DISTINCTION provided he/she satisfies the other necessary conditions. But, they are not eligible to be awarded a rank.

13. Provisions for exit in B.Tech. course:

(For courses where AICTE specifies exit in the model curriculum)

The curriculum and the syllabus for all B.Tech programmes have been planned in compliance with the NEP guidelines proposed by AICTE. Accordingly, students joining B.Tech programmes shall have all benefits NEP offers in terms of exercising exit option during the course of study. Every B.Tech programme governed under this school board shall adopt the NEP guidelines, as and when proposed/amended by AICTE, and the following scheme will be applied for all such B.Tech programmes specified by AICTE.

NEP 2020 suggests that a student can exercise exits at multiple stages of the course of study. As per AICTE norms, a student can have two possible exits before the completion of the Full Engineering degree and may get a UG Diploma /Certificate or B.Sc. degree in the relevant discipline if he/she fulfils the following conditions: (Subject to change as per AICTE guidelines)

1. UG Diploma/Certificate in the relevant branch of study

A student should be able to get a UG Diploma if he/she completes:

a. 50% of the credits for B.Tech. (80-85 credits)
b. 50% of the program core courses
c. Students exiting the program after earning 50% credit requirements will be awarded a UG Diploma provided they secure an additional 6 credits through summer internships/apprenticeship of 2 months duration.
d. Students admitted through lateral entry cannot exercise the exit option as he will not be able to meet out the 50% Credits for B.Tech. degree.

2 B.Sc. in the relevant branch of study

A student should be able to get a B.Sc. degree if he/she completes:

(i) 75% of the credits for B.Tech. (minimum 120 credits) and at least 3 years in the program.
(ii) 100% of the core program courses.
(iii) Students exiting the program after earning 75% credit requirements will be awarded a B.Sc. provided they secure an additional 6 credits through 2 summer internships/apprenticeship for 2 months each.
(iv) With B.Sc. degree, the student is eligible for entry into programs which take B.Sc. degree as eligibility criteria.

2.1 Award of Class in B.Sc. degree

A candidate who satisfies the course requirements for all semesters and who passes all the examinations within a maximum period of 6 years (5 years for lateral entry candidates) reckoned from the commencement of the first semester to which the candidate was admitted shall be declared to have qualified for the award of B.Sc. degree in the relevant discipline.

i) A candidate who qualifies for the award of the B.Sc. degree passing in all subjects pertaining to semesters the 3 to 6 in his/her first appearance within 4 consecutive semesters (2 academic years) and in addition secures a CGPA of 8.50 and above for the semesters 3 to 6 shall be declared to have passed the examination in **FIRST CLASS** with **DISTINCTION**.

ii) A candidate who qualifies for the award of the B.Sc. degree by passing in all subjects relating to semesters 3 to 6 within a maximum period of six semesters after his/her commencement of study in the third semester and in addition secures CGPA not less than 6.5 shall declared to have passed the examination in **FIRST CLASS.**

iii) All other candidates who qualify for the award of B.Sc. degree shall be declared to have passed the examination in **SECOND CLASS**.

2. Re-entry to complete the program

A student exiting with B.Sc. should be entitled to re-enrol in the programme of the same Engineering discipline. Only students admitted to the B.Tech. programme and exercised an exit option are eligible for readmission to the B.Tech. programme under the same discipline. It is suggested that all credits will be transferred, if the student enrols back within a limited period (3 years) of exiting. In case a student enrols after that, then the decision on the transfer of credits should be based on the changes in the curriculum the student studied. A candidate after exit may rejoin the course only at the commencement of the semester at which he/she discontinued, provided he/she pays the prescribed fees to the University. The total period of completion of the B.Tech. course reckoned from the commencement of the first semester to which the candidate was admitted shall not in any case exceed 7 years, including of the period of discontinuance.

3. Completion Possibility in other Institutions

A student can earn B.Sc. in one institution (Engineering) and complete the degree program in another institution (same Engineering discipline only).

(Note: If these exit options are accepted for multiple B.Tech. programs, it is suggested that AICTE actively communicate these to the industry and other bodies, so they recognize these and accept them as bona-fide credentials for the purposes of recruitment and/or eligibility for admission to programs, appearing in competitive examinations, etc.)

14. Revision of Regulations and Curriculum:

The University may from time-to-time revise, amend or change the regulations of curriculum and syllabus as and when found necessary.

GENERAL COURSE STRUCTURE

&

CREDIT DISTRIBUTION

GENERAL COURSE STRUCTURE & THEME

A. Definition of Credit:

1 Hr. Lecture (L)	1 Credit
1 Hr. Tutorial (T)	1 Credit
2 Hours Practical (P)	1 Credit

B. Range of Credits: In the light of the fact that a typical Model Four-year Under Graduate degree program in Engineering has about 160 credits, the total number of credits proposed for the four-year B. Tech in Electrical and Electronics Engineering is kept as 160.

C. Structure of UG Program in EEE: The structure of UG program in Electrical and Electronics Engineering shall have essentially the following categories of courses with the breakup of credits as given:

S. No	Category	Credit Breakup	Percentage of Credit Breakup
1	Humanities and Social Sciences including Management courses	14	9%
2	Basic Science courses	24	15%
3	Engineering Science courses including workshop, drawing, basics of electronics/ electrical/ mechanical/ computer etc.	14	9%
4	Professional core courses	68	42%
5	Professional Elective courses relevant to chosen specialization/branch	12	7%
6	Open subjects – Electives from other technical and /or emerging subjects	09	6%
7	Project work	19	12%
8	Mandatory Courses [Environmental Sciences, Induction Program, Indian Constitution, Essence of Indian Knowledge Tradition]	(non-credit)	-
	Total	**160***	**100%**

D. Course code and definition:

Course code	Definitions
L	Lecture
T	Tutorial
P	Practical
C	Credits
BSC	Basic Science Courses
ESC	Engineering Science Courses
HSMC	Humanities and Social Sciences including Management courses

PCC	Professional core courses
PEC	Professional Elective courses
OEC	Open Elective courses
MC	Mandatory courses

- **Course level coding scheme:** Three-digit number (odd numbers are for the odd semester courses and even numbers are for even semester courses) used as suffix with the Course Code for identifying the level of the course. Digit at hundred's place signifies the year in which course is offered. e.g.

  101, 102 … etc. for first year.

  201, 202 …. Etc.for second year.

  301, 302 … for third year.

- Category-wise Courses

HUMANITIES & SOCIAL SCIENCES COURSES [HS]

(i) Number of Humanities & Social Science Courses: 5

(ii) Credits: 14

S. No	Code No.	Course Title	Semester	Hours per week			Total Credits
				Lecture	Tutorial	Practical	
1	HSMC-101	English for Technical Writing	I	2	0	2	3
2	HSMC-102	Universal Human Values-II	II	2	1	0	3
3	HSMC-203	Industrial Economics and Management	IV	3	0	0	3
4	HSMC-204	Life Skills / Languages	IV	2	0	0	2
5	HSMC-405	Entrepreneurship Development	VII	3	0	0	3
						Total Credits	**14**

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BASIC SCIENCE COURSE [BSC]

(i) Number of Basic Science Courses:8

(ii) Credits: 24

S. No	Code No.	Course Title	Semester	Hours per week			Total Credits
				Lecture	Tutorial	Practical	
1	BSCT101	Chemistry	I	3	0	0	3
2	BSCP101	Chemistry laboratory	I	0	0	2	1
3	BSCT102	Mathematics-I	I	3	1	0	4
4	BSCT103	Biology for Engineers	I	3	0	0	3
5	BSCT104	Physics	II	3	1	2	5
6	BSCP104	Physics Laboratory	II	0	0	2	1
7	BSCT105	Mathematics-II	II	3	1	0	4
8	BSCT-206	Engineering Mathematics –III (Fourier Transforms And Numerical Techniques)	III	2	1	0	3
						Total Credits	**24**

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ENGINEERING SCIENCE COURSE [ESC]

(i) Number of Engineering Science Courses:7
(ii) Credits: 14

S. No	Code No.	Course Title	Semester	Hours per week			Total Credits
				Lecture	Tutorial	Practical	
1	ESCP101	Engineering Graphics & Design	I	1	0	4	3
2	ESCT102	Programming for Problem Solving	I	3	0	0	3
3	ESCP102	Programming for Problem Solving Laboratory	I	0	0	2	1
4	ESCP103	Design Thinking	I	0	0	2	1
5	ESCT104	Basic Electrical Engineering	II	2	1	0	3
6	ESCP104	Basic Electrical Engineering Laboratory	II	0	0	2	1
7	ESCP105	Digital Fabrication	II	0	0	4	2
						Total Credits	**14**

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PROFESSIONAL CORE COURSES [PCC]

(i) Number of Professional Core Courses: 30

(ii) Credits: 68

SL. No.	CourseCode	Course Title	Preferred Semester	Hrs /Week L: T: P	Credits
1	EEPCCT-201	Circuit Theory	III	3:0:0	3
2	EEPCCT-202	DC Machines & Transformers	III	3:0:0	3
3	EEPCCT-203	Electronic Devices	III	3:0:0	3
4	EEPCCT-204	Electromagnetic Field Theory	III	3:0:0	3
5	EEPCCT-205	Analog Electronic Circuits	III	3:0:0	3
6	EEPCCP-206	Electronic Devices Lab	III	0:0:2	1
7	EEPCCP-207	DC Machines & Transformers Laboratory	III	0:0:2	1
8	EEPCCP-208	Electric and Electronic Circuits Laboratory	III	0:0:2	1
9	EEPCCT-209	AC Machines	IV	3:0:0	3
10	EEPCCT-210	Digital Electronics	IV	3:0:0	3
11	EEPCCT-211	Transmission & Distribution System	IV	3:0:0	3
12	EEPCCT-212	Control Systems	IV	3:0:0	3
13	EEPCCT-213	Electrical Safety and Quality Management	IV	3:0:0	3
14	EEPCCP-214	Synchronous & Induction Machines Laboratory	IV	0:0:2	1
15	EEPCCP-215	Digital Electronics Laboratory	IV	0:0:2	1
16	EEPCCT-316	Measurements & Instrumentation	V	3:0:0	3
17	EEPCCT-317	Power Electronics	V	3:0:0	3
18	EEPCCT-318	Electrical Machine Design	V	3:0:0	3
19	EEPCCT-319	Utilization of Electrical Energy	V	3:0:0	3
20	EEPCCT-320	Linear Integrated Circuits	V	3:0:0	3
21	EEPCCP-321	Measurement and Control Laboratory	V	0:0:2	1
22	EEPCCP-322	Power Electronics Laboratory	V	0:0:2	1
23	EEPCCP-323	Integrated Circuits Laboratory	V	0:0:2	1
24	EEPCCT-424	Power System Analysis	VI	3:0:0	3
25	EEPCCT-425	Microprocessors & Microcontrollers	VI	3:0:0	3
26	EEPCCT-426	Solid State Drives	VI	3:0:0	3
27	EEPCCP-427	Microprocessor and Microcontroller Laboratory	VI	0:0:2	1
28	EEPCCP-428	Power System Simulation Laboratory	VI	0:0:2	1
29	EEPCCP-429	Power System Operation and Control	VII	3:0:0	3
30	SEM EE-430	Seminar	VII	0:0:2	1
				Total Credits	**68**

III. ELECTIVE COURSES

1. PROFESSIONAL ELECTIVES COURSES (PEC)

PROFESSIONAL ELECTIVES COURSES (PEC)				
Sl. No.	**Course Code**	**Course Title**	**Hrs/Week L:T:P**	**Credits**
1	EEPECT-101	Artificial Neural Network	3:0:0	3
2	EEPECT-102	Biomedical Instrumentation	3:0:0	3
3	EEPECT-103	Communication System	3:0:0	3
4	EEPECT-104	Digital Signal Processing	3:0:0	3
5	EEPECT-105	Electric Power Quality	3:0:0	3
6	EEPECT-106	Electric Vehicle Technology	3:0:0	3
7	EEPECT-107	Electrical Energy Audit and Management	3:0:0	3
8	EEPECT-108	Embedded System Design	3:0:0	3
9	EEPECT-109	Fundamentals of FACTS	3:0:0	3
10	EEPECT-110	Fundamentals of Solar PV System	3:0:0	3
11	EEPECT-111	Robotics and Control	3:0:0	3
12	EEPECT-112	High Voltage Engineering	3:0:0	3
13	EEPECT-113	Industrial Automation (PLC and SCADA)	3:0:0	3
14	EEPECT-114	Modern Control System	3:0:0	3
15	EEPECT-115	Nano Electronics	3:0:0	3
16	EEPECT-116	Power System Restructuring and Deregulation	3:0:0	3
17	EEPECT-117	Protection and Switchgear	3:0:0	3
18	EEPECT-118	Smart Grid	3:0:0	3
19	EEPECT-119	Special Electrical Machines	3:0:0	3
20	EEPECT-120	Wind and solar Electrical System	3:0:0	3

OPEN ELECTIVES (OE)

The courses listed below are offered by the Department of Electrical and Electronics Engineering for students of other Departments.

LIST OF OPEN ELECTIVES				
Sl. No.	**Course Code**	**Course Title**	**Hrs/Week L:T:P**	**Credits**
1	EEOET-101	Analog and Digital Electronics	3:0:0	3
2	EEOET-102	Basics of Electrical Circuits	3:0:0	3
3	EEOET-103	Control System Engineering	3:0:0	3
4	EEOET-104	Electric Power Utilization	3:0:0	3
5	EEOET-105	Electrical Machines	3:0:0	3
6	EEOET-106	Power Electronics in Power Systems	3:0:0	3
7	EEOET-107	Introduction to Robotics and Automation	3:0:0	3
8	EEOET-108	Power System Engineering	3:0:0	3
9	EEOET-109	Energy Engineering	3:0:0	3
10	EEOET-110	Sensors and Transducer	3:0:0	3
11	EEOET-111	Power Plant Engineering	3:0:0	3

3. MINOR (MI)

Students who have registered for B.Tech. (Minor) in Electrical and Electronics Engineering can opt to study Minimum 6 out of the courses listed below. Students from non-circuit branches alone can opt for this Minor Programme.

Sl. No.	Course Code	Course Title	Hrs/Week L:T:P	Credits
1	EEMIT-101	Consumer Electronics	3:0:0	3
2	EEMIT-102	Electrical and Electronics Instruments	3:0:0	3
3	EEMIT-103	Electrical Energy Conservation and Auditing	3:0:0	3
4	EEMIT-104	Electrical Traction	3:0:0	3
5	EEMIT-105	Electrical Vehicles	3:0:0	3
6	EEMIT-106	AI Techniques in Electrical Engineering	3:0:0	3
7	EEMIT-107	Industrial Electrical System	3:0:0	3
8	EEMIT-108	Industrial Safety	3:0:0	3
9	EEMIT-109	Introduction to microcontroller	3:0:0	3
10	EEMIT-110	SMPS and UPS	3:0:0	3

4. ADVANCED LEVEL COURSES FOR B.Tech. (HONOURS)

Students who have registered for B.Tech. (Honours) in Electrical and Electronics Engineering can opt to study Minimum 6 out of the courses listed below. Department Students alone can opt for this Honours Programme

Sl. No.	Course Code	Course Title	Hrs/Week L:T:P	Credits
1	EEHT-101	Computer Relaying and Phasor Measurement Unit	3:0:0	3
2	EEHT-102	VLSI Design	3:0:0	3
3	EEHT-103	Distribution System Automation	3:0:0	3
4	EEHT-104	EHV AC and DC Transmission	3:0:0	3
5	EEHT-105	Energy Storage Technology	3:0:0	3
6	EEHT-106	Modern Optimization Techniques for Electric Power Systems	3:0:0	3
7	EEHT-107	Non-linear Control Systems	3:0:0	3
8	EEHT-108	Power Switching Converters	3:0:0	3
9	EEHT-109	Power System Dynamics	3:0:0	3
10	EEHT-110	Vehicular Electric Power Systems	3:0:0	3

PROJECT

Number of Courses: 3

(i) Credits: 16

S.No	Course code	Course Title	Semester	Lecture	Tutorial	Practical	Credits
1	PRJ EE 201	Micro project	IV	0	0	2	1
2	PRJ EE -301	Mini project	VI	0	0	6	3
3	INT EE-431/ PRJ EE-401	Internship/ Project Phase-I	VII	0	0	6	3
4	PRJ EE-402	Project Phase-II	VIII	0	0	24	12
						Total Credits	**19**

PROFESSIONAL ELECTIVE [PEC]

(i) Number of Professional Elective Courses: 4
(ii)Credits: 12

S.No	Code No.	Course Title	Semester	Hours per week			Total Credits
				Lecture	Tutorial	Practical	
1	EEPECT -1	Program Elective-1	VI	3	0	0	3
2	EEPECT -2	Professional Elective-II	VII	3	0	0	3
3	EEPECT -3	Professional Elective-III	VII	3	0	0	3
4	EEPECT -4	Professional Elective- IV	VIII	3	0	0	3
						Total Credits	**12**

OPEN ELECTIVE COURSES [OEC]

(i) Number of Open Elective Courses: 3
(ii)Credits: 9

Sl.No	Code No.	Course Title	Semester	Hours per week			Total Credits
				Lecture	Tutorial	Practical	
1	EEOET-1	Open Elective-I	VI	3	0	0	3
2	EEOET-2	Open Elective-II	VII	3	0	0	3
3	EEOET-3	Open Elective-III	VIII	3	0	0	3
						Total Credits	**09**

SEMESTER WISE STRUCTURE

Semester I

3-Weeks Induction Programme (UHV-I)

S.No	Course Code	Course Title	L	T	P	Credit	Marks		
							IA	UE	TM
1.	BSCT101	Chemistry	3	0	0	3	40	60	100
2.	BSCP101	Chemistry laboratory	0	0	2	1	60	40	100
3.	BSCT102	Mathematics-I	3	1	0	4	40	60	100
4.	ESCP101	Engineering Graphics & Design	1	0	4	3	60	40	100
5.	ESCT102	Programming for Problem Solving	3	0	0	3	40	60	100
6.	ESCP102	Programming for Problem Solving Laboratory	0	0	2	1	60	40	100
7.	BSCT103	Biology for Engineers	3	0	0	3	40	60	100
8.	ESCP103	Design Thinking	0	0	2	1	60	40	100
9.	AU-101^	IDEA Lab Workshop	2	0	4	0	-	-	-
Total						**19**	400	400	800

Note: ^ represents "Audit Course".

Semester II

S.No	Course Code	Course Title	L	T	P	Credit	Marks		
							IA	UE	TM
1.	BSCT104	Physics	3	1	0	4	40	60	100
2.	BSCP104	Physics Laboratory	0	0	2	1	60	40	100
3.	BSCT105	Mathematics-II	3	1	0	4	40	60	100
4.	ESCT104	Basic Electrical Engineering	2	1	0	3	40	60	100
5.	ESCP104	Basic Electrical Engineering Laboratory	0	0	2	1	60	40	100
6.	ESCP105	Digital Fabrication	0	0	4	2	60	40	100
7.	HSMC101	English for Technical Writing	2	0	2	3	60	40	100
8.	HSMC 102	Universal Human Values -II	2	1	0	3	60	40	100
9.	AU-102^	Sports and Yoga	1	0	1	0	-	-	-
Total						**21**	420	380	800

Note: ^ represents "Audit Course".

Semester-III									
S.No.	**Course Code**	**Course Title**	**L**	**T**	**P**	**Credit**	**Marks**		
							IA	**UE**	**TM**
1	BST-206	Engineering Mathematics –III (Fourier Transforms And Numerical Techniques)	3	0	0	3	40	60	100
1	EEPCCT-201	Circuit Theory	3	0	0	3	40	60	100
2	EEPCCT-202	DC Machines & Transformers	3	0	0	3	40	60	100
3	EEPCCT-203	Electronic Devices	3	0	0	3	40	60	100
4	EEPCCT-204	Electromagnetic Field Theory	3	0	0	3	40	60	100
5	EEPCCT-205	Analog Electronic Circuits	3	0	0	3	40	60	100
6	EEPCCP-206	Electronic Devices Lab	0	0	2	1	60	40	100
7	EEPCCP-207	DC Machines & Transformers Laboratory	0	0	2	1	60	40	100
8	EEPCCP-208	Electric and Electronic Circuits Laboratory	0	0	2	1	60	40	100
9	AU-203	Indian constitution & knowledge systems	0	1	0	0	-	-	-
TOTAL						**21**	420	480	900

Note: Department(s) to offer Minor (MI) Course and Honors to those willing students in addition to 21 credits.

Semester-IV									
S. No.	**Course Code**	**Course Title**	**L**	**T**	**P**	**Credit**	**Marks**		
							IA	**UE**	**TM**
1	EEPCCT-209	AC Machines	3	0	0	3	40	60	100
2	EEPCCT-210	Digital Electronics	3	0	0	3	40	60	100
3	EEPCCT-211	Transmission & Distribution System	3	0	0	3	40	60	100
4	EEPCCT-212	Control System	3	0	0	3	40	60	100
5	EEPCCT-213	Electrical Safety and Quality Management	3	0	0	3	40	60	100
6	EEPCCP-214	AC Machines Laboratory	0	0	2	1	60	40	100
7	EEPCCP-215	Digital Electronics Laboratory	0	0	2	1	60	40	100
8	PRJ EE-201	Micro Project	0	0	2	1	100	-	100
9	HSMC-203	Industrial Economics and Management	3	0	0	3	40	60	100
10	HSMC-204	Life Skills	3	0	0	3	40	60	100
11	AU-204	Environmental Science	1	0	1	0	-	-	-
TOTAL						**24**	460	540	1000

Note: Department(s) to offer Minor (MI) Course and Honors to those willing students in addition to 24 credits

Semester-V									
S. No.	**Course Code**	**Course Title**	**L**	**T**	**P**	**Credit**	**Marks**		
							IA	**UE**	**TM**
1	EEPCCT-316	Measurements & Instrumentation	3	0	0	3	40	60	100
2	EEPCCT-317	Power Electronics	3	0	0	3	40	60	100
3	EEPCCT-318	Electrical Machine Design	3	0	0	3	40	60	100
4	EEPCCT-319	Utilization of Electrical Energy	3	0	0	3	40	60	100
5	EEPCCT-320	Linear Integrated Circuits	3	0	0	3	40	60	100
6	EEPCCP-321	Measurement and Control Laboratory	0	0	2	1	60	40	100
7	EEPCCP-322	Power Electronics Laboratory	0	0	2	1	60	40	100
8	EEPCCP-323	Integrated Circuits Laboratory	0	0	2	1	60	40	100
9	AU-305	Professional Ethics	1	0	0	0	-	-	-
TOTAL						**18**	380	420	800

Note: Department(s) to offer MI/PE/OE/OC and Honors course as 2/3 credits to those willing students In addition to 18 credits.

Semester-VI									
S. No.	**Course Code**	**Course Title**	**L**	**T**	**P**	**Credit**	**Marks**		
							IA	**UE**	**TM**
1	EEPCCT-424	Power System Analysis	3	0	0	3	40	60	100
2	EEPCCT-425	Microprocessors & Microcontrollers	3	0	0	3	40	60	100
3	EEPCCT-426	Solid State Drives	3	0	0	3	40	60	100
4	EEPCCP-427	Microprocessor and Microcontroller Laboratory	0	0	2	1	60	40	100
5	EEPCCP-428	Power System Simulation Laboratory	0	0	2	1	60	40	100
6	EEPECT	Professional Elective –I	3	0	0	3	40	60	100
7	EEOET	Open Elective -I	3	0	0	3	40	60	100
8	PRJ EE- 302	Mini Project	0	0	6	3	100	-	100
TOTAL						**20**	380	420	800

Note: Department(s) to offer MI/PE/OE/OC and Honors course as 2/3 credits to those willing students in addition to 20 credits.

Semester-VII									
S. No.	**Course Code**	**Course Title**	**L**	**T**	**P**	**Credit**	**Marks**		
							IA	**UE**	**TM**
1	EEPCCP-427	Power System Operation and Control	3	0	0	3	40	60	100
2	EEPECT	Program Elective-II	3	0	0	3	40	60	100
3	EEPECT	Program Elective-III	3	0	0	3	40	60	100
4	EEOET	Open Elective -II	3	0	0	3	40	60	100
5	HSMC-405	Entrepreneurship Development	3	0	0	3	40	60	100
6	SEM EE-28	Seminar	0	0	2	1	100	-	100
7	INT EE-29/ PRJEE-401	Internship/ Project Phase-I	0	0	6	3	100	-	100
TOTAL						**19**	400	300	700

Note: Department(s) to offer MI/PE/OE/OC and Honors course as 2/3 credits to those willing students in addition to 19 credits.

Semester-VIII									
S. No.	**Course Code**	**Course Title**	**L**	**T**	**P**	**Credit**	**Marks**		
							IA	**UE**	**TM**
1	EEPECT	Program Elective-IV	3	0	0	3	40	60	100
2	EEOET	Open Elective -III	3	0	0	3	40	60	100
3	PRJ EE-402	Project Phase -II	0	0	24	12	60	40	100
TOTAL						**18**	140	160	300

Note: Department(s) to offer MI/PE/OE/OC and Honors course as 2/3 credits to those willing students in addition to 18 credits

SEMESTER – I

SEMESTER I

Induction Program (UHV-I)	**Three-week duration(mandatory)**

Objective:

The induction program for students offered at the start of the first year aims to provide a holistic and enriching experience to new students, fostering their personal growth, academic preparedness, and a strong sense of belonging to the institution.

The program is designed to achieve the following objectives:

1. To help students smoothly transition from school to college life.
2. To facilitate opportunities for students to interact with their peers, faculty, and staff.
3. To enhance Physical Well-being: and encouraging Creative Expression.
4. To instill Universal Human Values.
5. To develop Communication and Literary Skills, Visit Local areas and get inspiration from Eminent Personalities and thus gain Confidence to nurture a Positive Learning Environment.

The Induction program contains.

- Physical activity
- Creative Arts
- Universal Human Values
- Literary
- Proficiency Modules
- Lectures by Eminent People
- Visits to local Areas
- Familiarization to Dept./Branch & Innovations

The Essence and Details of Induction program can also be understood from the "DetailedGuide on Student Induction program", as available on AICTE Portal,

(Link:https://www.aicteindia.org/sites/default/files/Detailed%20Guide%20on%20Student%20I nduction%20program.pdf).

BSCT101	Chemistry	3L:0T:0P	3 Credits

Course Objectives:

- *To acquaint the students with basic concepts of chemistry in understanding the atomic &molecular structure and its nanoscale applications.*
- *To understand the fundamental concepts of various spectroscopic techniques andapplications.*
- *To understand the basic electrochemical properties such as thermodynamic functions,cell potentials, lead storage batteries, corrosion and phase rule.*
- *To describe and explain the observed trends in atomic size, ionization energy, andelectron affinity of the elements.*
- *To identify the various types, preparation and applications of polymer used in theindustrial processes.*

Course Contents:

MODULE I - ATOMIC AND MOLECULAR STRUCTURE: 9 Hours

Atomic and Molecular Structure: Molecular orbital‟s of diatomic molecules. Band theory of solids. Liquid crystal and its applications. Point defects in solids. Structure and applications of Graphite and Fullerenes. Concepts of Nanomaterials and its application

MODULE II - SPECTROSCOPIC TECHNIQUES AND APPLICATIONS: 9 Hours

Principles of spectroscopy and selection rules. Electronic spectroscopy. Fluorescence and its applications in medicine. Elementary idea and simple applications of Rotational, Vibrational, Ultravoilet & Visible and Raman spectroscopy.

MODULE III – ELECTRO CHEMISTRY: 9 Hours

Thermodynamic functions: energy, entropy and free energy. Estimations of entropy and free energies. Free energy and EMF. Cell potentials, Nernst Equation and application, Lead storagebattery. Corrosion; causes, effects and its prevention. Phase Rule and its application to water system.

MODULE IV - PERIODIC PROPERTIES 9 Hours

Effective nuclear charge, penetration of orbital‟s, variations of s, p, d and f orbital energies of atoms in the periodic table, electronic configurations, atomic and ionic sizes, ionization energies, electron affinity and electro-negativity, polarizability, oxidation states, coordination numbers and geometries, hard soft acids and bases, molecular geometries.

MODULE V – POLYMER: 9 Hours

Basic concepts of polymer-Blend and composites, Conducting and biodegradable polymers. Preparation and application of some industrially important polymers (BunaS, Buna-N, Neoprene, Nylon-6, nylon-6, 6 and Terylene). General methods of synthesis of organometallic compounds (Grignard reagent) and their applications.

Total No. of Hours: 45

Text Books:

1. B. H. Mahan, "University chemistry" Pearson Education, 2009.
2. C.N.R. Rao, "University Chemistry" World Scientific Publishing Company, 2009
3. M. J. Sienko and R. A. Plane, "Chemistry: Principles and Applications" McGraw-Hill,3rd edition 1980.

Reference Books:

1. C. N. Banwell, "Fundamentals of Molecular Spectroscopy" McGraw-Hill BookCompany, 1983.
2. B. L. Tembe, Kamaluddin and M. S. Krishnan, "Engineering Chemistry (NPTELWeb-book).
3. P. W. Atkins, Julio de Paula, "Physical Chemistry" Oxford University Press, 2018

Course Outcomes:

On successful completion of this course, the students will be able to,

- Get an understanding of the theoretical principles understanding molecular structure,bonding and properties
- Distinguish the ranges of the electromagnetic spectrum used for exciting differentmolecular energy levels in various spectroscopic techniques
- Understand and explain the thermodynamic functions and cell potentials for differentapplications.
- Rationalize specific models and processes for better understanding of material propertiesand applications.
- Learn the synthesis of various industrially important polymer and its applications.

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BSCP101	Chemistry Laboratory	0L:0T:2P	1 Credit

Course Objectives:

The Chemistry laboratory course will enable students to get a hands-on experience of determining various analysis parameters learnt in the theory course using different methods/techniques prevalent in analytical chemistry.

List of Experiments:

1. Determination of surface tension and viscosity.
2. Determination of chloride content of water.
3. Determination of cell constant and conductance of solutions.
4. Potentiometry - determination of redox potentials and emfs
5. Synthesis of a polymer/drug.
6. Determination of the partition coefficient of a substance between two immiscible liquids.
7. Saponification/acid value of oil.
8. Chemical analysis of a salt.
9. Lattice structures and packing of spheres.
10. Spectrophotometry: Beer-Lambert‟s law verification and determination of strength of unknownsolution.
11. Thin layer chromatography.
12. Ion exchange column for removal of hardness of water.

the pH of minimum viscosity for gelatin sols and/or coagulation of the whitepart of egg.

Course Outcome*:*

The Chemistry laboratory course aims at developing abilities in combining chemical principles alongside handling instruments/techniques and synthesis methodologies to facilitate good understanding of the subject.

*****

BSCT102	Mathematics-I	3L:1T:0P	4 Credits

Course Objectives:

- *To understand the Eigen values and Eigen vectors, Cayley-Hamilton theorem, andquadratic forms.*
- *To acquire knowledge of improper &double integrals and their applications.*
- *To understand the concept of triple integrals and its applications.*
- *To become familiar with vector differential operators, integral theorems (Green's,Stokes's, Gauss divergence), and vector field properties.*
- *To comprehend the concepts of partial differentiation, total derivatives, Jacobianproperties, and Taylor's series for functions of two variables.*

MODULE I – MATRICES **12 Hours**

Rank of a matrix – Consistency of a system of linear equations – Characteristic equation of a matrix – Eigen values and Eigen vectors – Properties of Eigen values – Cayley-Hamilton theorem (without proof) verification – Finding Inverse and Power of a matrix using it – Diagonalization of matrix by orthogonal transformation – Quadratic form – Nature of Quadratic Form – Orthogonal reduction of quadratic form to canonical form.

MODULE II – I**NTEGRAL CALCULUS** **12 Hours**

Improper integrals – Gamma functions and Beta functions – properties – Double integration (Cartesian form and Polar form) – constant limits – variable limits – over the region R – Change of variables in double integrals (Cartesian to polar) – Application of double integral - Area by double integration.

MODULE III – **TRIPLE** I**NTEGRAL CALCULUS** **12 Hours**

Change of Order of Integration – Triple Integration (Cartesian –Spherical and Cylindrical) – constant limits – variable limits – over the region R – Application of triple integral -Volume by triple integration (Cartesian).

MODULE IV – VECTOR CALCULUS **12 Hours**

Vector Differential Operator – Gradient – Properties – Directional derivative – Divergence and curl – Properties – Solenoidal and Irrotational vector fields – Line integral – Integral Theorems (excluding Proof) – Green‟s theorem – Stoke‟s theorem – Gauss divergence.

MODULE V – **FUNCTIONS OF SEVERAL VARIABLES** **12 Hours**

Partial differentiation – Partial derivatives of first order and higher order – Partial differentiation of implicit functions – Euler‟s theorem on homogeneous functions – Total derivative – Jacobian – Properties of Jacobian – Taylor‟s series for functions of two variables – Maxima and minima of functions of two variables;

Total No. of Hours: 60

Text Books:

1. Grewal B.S., "Higher Engineering Mathematics", Khanna Publishers, New Delhi, 43rd Edition, 2014.
2. Veerarajan T., "Engineering Mathematics", Tata McGraw-Hill, New Delhi, 2008.
3. Ramana B.V., "Higher Engineering Mathematics", Tata McGraw-Hill, New Delhi, 2010.

Reference Books:

1.Bali N.P and Manish Goyal., "A Text Book of Engineering Mathematics", Laxmi Publications (P) LTD-2011.

2. Dr. M.K. Venkataraman, "Engineering Mathematics – Volume I and Volume II", The National Publishing Company, Madras 2001.

Course Outcomes:

On successful completion of this course, the students will be able to

- Determine the rank of a matrix, analyze system consistency, find Eigen values and Eigenvectors, verify the Cayley-Hamilton theorem, and perform orthogonal diagonalization.
- Demonstrate proficiency in evaluating improper integrals, understanding Gamma/Betafunctions, performing double integration, and computing areas.
- Perform triple integration and calculate volumes.
- Apply Green"s theorem, Stoke"s theorem and Gauss divergence theorem.
- Compute partial derivatives, determine total derivatives, Jacobians, employ Taylor series,and find extremes of functions of two variables.

*****

ESCP101	Engineering Graphics & Design	1L:0T:4P	3 Credits

Course Objectives:

- *To provide the basic knowledge about Engineering Drawing.*
- *To learn the concepts of projections, technical drawing, dimensioning andspecifications*
- *To understand the engineering graphics standards and solid modeling.*
- *To learn the analysis of Isometric views*
- *To understand the basic concepts of computer aided drafting hardware and itsimportance in the field of engineering and design.*

MODULE I- INTRODUCTION

Introduction, Conics and Special Curves

MODULE II- PROJECTIONS

Projection of points, lines and planes

MODULE III- SOLIDS:

Projection of solids, section of solids, development of surface

MODULE IV- ISOMETRIC PROJECTIONS:

Isometric and Orthographic projections

MODULE V- AUTOCAD:

Introduction to computer Aided Drafting hardware overview of application software – 2Ddrafting commands (Auto CAD) for simple shapes – Dimensioning

Text Books:

1. Bhatt N.D., Panchal V.M. & Ingle P.R., "Engineering Drawing" Charotar PublishingHouse (2014).
2. Shah, M.B. & Rana B.C., "Engineering Drawing and Computer Graphics" PearsonEducation (2008).
3. Agrawal B. & Agrawal C. M., "Engineering Graphics" TMH Publication, 2012.
4. K. Venugopal, "Engineering Drawing and Graphics + Auto CAD" 4th edition, New AgeInternational Publication Ltd., 2004

Reference Books:

1. Narayana, K.L. & P Kannaiah, "Text book on Engineering Drawing" ScitechPublishers, 2008.
2. CAD Software Theory and User Manuals.

Course Outcomes:

On successful completion of this course, the students will be able to

- Describe engineering design and its place in society.
- Discuss the visual aspects of engineering design.
- Use engineering graphics standards.
- Illustrate solid modeling.
- Use computer-aided geometric design.
- Design creating working drawings.

*****

ESCT102	Programming For Problem Solving	3L:0T:0P	3 Credits

Course Objectives:

- *To learn the fundamentals of computers.*
- *To understand the various steps in program development.*
- *To learn the syntax and semantics of any programming language.*
- *To learn the usage of structured programming approach in solving problems.*
- *To understated and formulate algorithm for programming script*
- *To analyze the output based on the given input variables*

MODULE I - INTRODUCTION TO PROGRAMMING: 6 Hours

Introduction to components of a computer system: - disks, memory, processor, where a program is stored and executed, operating system, compilers etc. Idea of Algorithm: steps to solve logical and numerical problems. Representation of Algorithms Flowchart/Pseudocode with examples.

MODULE II- ALGORITHMS TO PROGRAMS: 6 Hours

Source code, variables (with data types) variables and memory locations, Syntax and Logical Errors in compilation, object and executable code. Arithmetic expressions and precedence. Conditional Branching and Loops. Writing and evaluation of conditionals and consequent branching. Iteration and loops.

MODULE III - INTRODUCTION TO ARRAYS AND APPLICATIONS: 6 Hours

Arrays, Arrays (1-D, 2-D), Character arrays and Strings, Basic Algorithms, Searching, Basic Sorting Algorithms (Bubble, Insertion and Selection), Finding roots of equations, notion of order of complexity through example programs (no formal definition required)

MODULE IV – FUNCTIONS: 6 Hours

Functions (including using built in libraries), Parameter passing in functions, call by value, Passing arrays to functions: idea of call by reference. Recursion as a different way of solving problems. Example programs, such as Finding Factorial, Fibonacci series, Ackerman function etc.Quick sort or Merge sort.

MODULE V – STRUCTURES AND POINTERS: 6 Hours

Defining structures and Array of Structures. Pointers, Idea of pointers, Defining pointers, Use ofPointers in self-referential structures, notion of linked list (no implementation), File handling.

Total No. of Hours: 30

Text Books:

1. Byron Gottfried, Schaum's, "Outline of Programming with C", McGraw-Hill. 1996
2. Balaguruswamy, "Programming in ANSI C" Tata McGraw-Hill. 2019.

Reference Books:

1. Brian W. Kernighan and Dennis M. Ritchie, "The C Programming Language" Prentice Hall of India. Second Edition 2015.

Course Outcomes:

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

- Formulate simple algorithms for arithmetic and logical problems and translate the algorithms to programs and execute the programs and correct syntax and logical errors.
- Discuss the use of arrays for to work with arrays, strings, and basic data structures likelinked lists, queues, and stacks.
- Understand the use of functions in the programming language.
- Discuss the arrays and its significance in the programming language with involving array concepts.
- Implement the use of pointers and implementation of memory and handling of files inany programming.

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ESCP102	Programming For Problem Solving Laboratory	0L:0T:2P	1 Credit

Course Objectives:

- *Introduce students to the fundamental concepts of the any programming language, including variables, data types, operators, and control structures.*
- *Introduce problem-solving techniques and algorithms to approach and solveprogramming challenges efficiently.*
- *Develop proficiency in writing any programs to implement algorithms andsolve computational problems.*
- *Introduce students to basic data structures in any, such as arrays, strings, and pointers and guide them in applying these structures to solve problems effectively.*

List of Experiments:

1. Familiarization with programming environment
2. Simple computational problems using arithmetic expressions
3. Problems involving if-then-else structures
4. Iterative problems e.g., sum of series
5. 1D Array manipulation
6. Matrix problems, String operations
7. Simple functions
8. Programming for solving Numerical methods problems
9. Recursive functions
10. Pointers and structures
11. File operations.

Course Outcomes:

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

- Demonstrate the problem solving skills through programming simple logics.
- Demonstrate the array concepts and memory management through programming.
- Illustrate the pointers and file operations through programming.

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BSCT103	Biology For Engineers	3L:0T:0P	3 Credits

Course Objectives:

- *To familiarize the students with the basic biological concepts and their engineering applications.*
- *To develop the interdisciplinary vision of biological engineering.*
- *Familiarize engineering students with the principles of microbiology, including the structure and function of microorganisms, their significance in various engineering applications, and techniques for microbial analysis and identification.*

MODULE I - INTRODUCTION AND CLASSIFICATION OF BIOLOGICAL SCIENCE

9 Hours

Bring out the fundamental differences between science and engineering by drawing a comparison between eye and camera, Bird flying and aircraft. Biological observations of 18th Century that lead to major discoveries. Examples from Brownian motion and the origin of thermodynamics by referring to the original observation of Robert Brown and Julius Mayor. Classification based on (a)energy and carbon utilization-Autotrophs, heterotrophs, lithotropes (b) Ammonia excretion – aminotelic, uricoteliec, ureotelic (c) Habitata- acquatic or terrestrial (d) Molecular taxonomy- three major kingdoms of life.

MODULE II – GENETICS **9 Hours**

Mendel‟s laws, Concept of segregation and independent assortment. Concepts of excessiveness and dominance. Concept of mapping of phenotype to genes. Discuss about the single gene disorders in humans. Discuss the concept of complementation using human genetics.

MODULE III - BIOMOLECULES AND ENZYMES **9 Hours**

Discuss - monomeric units, polymeric structures, sugars, starch and cellulose, amino acids and proteins. Enzyme classification. Mechanism of enzyme action. Enzyme kinetics and kinetic parameters.

MODULE IV - INFORMATION TRANSFER **9 Hours**

DNA as a genetic material. Hierarchy of DNA structure- from single stranded to double helix to nucleosomes. Concept of genetic code. Universality and degeneracy of genetic code. Define gene in terms of complementation and recombination. DICOM Image formats, The DNA Technology (Use and Application) Regulation Bill, 2019

MODULE V - MICROBIOLOGY ANALYSIS **9 Hours**

Proteins- structure and function. Hierarch in protein structure. Primary secondary, tertiary and quaternary structure. Proteins as enzymes, transporters, receptors and structural elements. Exothermic and endothermic versus endergonic and xergonic reactions. Synthesis of glucose from CO_2 and H_2O (Photosynthesis). Energy yielding and energy consuming reactions. Identification and classification of single celled organisms.

Total No. of Hours: 45

Text Books:

1. Conn,E.E; Stumpf,P.K; Bruening,G; Doi,R.H., "Outlines of Biochemistry" John Wiley and Sons, 2009.
2. Prescott, L.M J.P. Harley and C.A. Klein, "Microbiology" Wm C. Brown Publishers , 2nd edition 1995.

Reference Books:

1. Uma Devi Koduru, "General Biology" Khanna Book Publishing Company. 2022
2. Campbell, N. A.; Reece, J. B.; Urry, Lisa; Cain, M, L.; Wasserman, S. A.; Minorsky, P. V.; Jackson, R. B. "Biology: A global approach" Pearson Education Ltd. 12th Edition, 2020.
3. E.E; Stumpf, P.K; Bruening, G; Doi, R.H., "Outlines of Biochemistry" John Wiley and Sons. 2006.

Course Outcomes:

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

- Describe how biological observations of 18th Century that lead to major discoveries.
- Highlight the concepts of recessiveness and dominance during the passage of geneticmaterial from parent to offspring
- Classify enzymes and distinguish between different mechanisms of enzyme action.
- Identify DNA as a genetic material in the molecular basis of information transfer.
- Identify and classify single celled microorganisms

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ESCP103	DESIGN THINKING	0L:0T:2P	1 Credit

Course Objectives:

- *To provide the new ways of creative thinking*
- *To learn the innovation cycle of Design Thinking process*
- *To develop innovative products*

MODULE I - LEARNING, MEMORY AND EMOTIONS **6 Hours**

Understanding the learning process, kolb‟s learning styles, assessing and interpreting, understanding the memory process, problems in retention, memory enhancement techniques, understanding emotions: experience & expression, assessing empathy, application with peers

MODULE II - DESIGN THINKING, BEING INGENIOUS & FIXING PROBLEM

6 Hours

Definition of design thinking, need for design thinking, objectives of design thinking, concepts& brainstorming, stages of design thinking process (explain with examples) – empathize, define, ideate, prototype, test, understanding creative thinking process, understanding problem solving, testing creative problem solving.

MODULE III - PRODUCT DESIGN, PROTOTYPING & TESTING **6 Hours**

Process of engineering product design, design thinking approach, stages of product design, examples of best product designs and functions, assignment – engineering product design, What is Prototype? Why Prototype? Rapid Prototype Development process, Testing, Sample Example, Test Group Marketing

MODULE IV - CELEBRATING THE DIFFERENCE AND CUSTOMER CENTRICITY

6 Hours

Understanding of individual differences & uniqueness, group discussion and activities to encourage the understanding, acceptance and appreciation of individual difference. Practical examples of customer challenges, use of design thinking to enhance customer experience, parameters of product experience, alignment of customer expectations with product design.

MODULE V - FEEDBACK, RE-DESIGN & RE-CREATE **9 Hours**

Feedback loop, Focus on User Experience, Address “ergonomic challenges, User focused design, rapid prototyping & testing, final product, Final Presentation – “Solving Practical Engineering Problem through Innovative Product Design & Creative Solution”.

Total no. of Hours: 45

Course Outcomes:

On successful completion of the module students will be able to:

- Compare and classify the various learning styles and memory techniques and Apply themin their engineering education
- Analyze emotional experience and Inspect emotional expressions to better understandusers while designing innovative products
- Develop new ways of creative thinking and Learn the innovation cycle of DesignThinking process for developing innovative products
- Propose real-time innovative engineering product designs and Choose appropriateframe works, strategies, techniques during prototype development
- Perceive individual differences and its impact on everyday decisions and furtherCreate a better customer experience.

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AU-101	IDEA LAB WORKSHOP	2L:0T:4P	0 Credit

Course Objectives:

- *To learn all the skills associated with the tools and inventory associated withthe IDEA Lab.*
- *Learn useful mechanical and electronic fabrication processes.*
- *Learn necessary skills to build useful and standalone system/ project with enclosures.*
- *Learn necessary skills to create print and electronic documentation for the system /project.*

MODULE	Topics
1.	Electronic component familiarization, Understanding electronic system design flow. Schematic design and PCB layout and Gerber creation using Eagle CAD. Documentation using Doxygen, Google Docs, Overleaf. Version control tools - GIT and Git Hub. Basic 2D and 3D designing using CAD tools such as Free CAD, Sketchup, Prusa Slicer, Flat CAM, Ink space, Open BSP and Veri CUT.
2.	Familiarization and use of basic measurement instruments - DSO including various triggering modes, DSO probes, DMM, LCR bridge, Signal and function generator. Logic analyzer and MSO. Bench power supply (with 4-wire output) Circuit prototyping using (a) breadboard, (b) Zero PCB (c) „Manhattan" style and (d) custom PCB. Single, double and multilayer PCBs. Single and double-sided PCB prototype fabrication in the lab. Soldering using soldering iron/station. Soldering using a temperature controlled reflow oven. Automated circuit assembly and soldering using pick and place machines.
3.	Electronic circuit building blocks including common sensors. Arduino and Raspberry Pi-programming and use. Digital Input and output. Measuring time and events. PWM. Serial communication. Analog input. Interrupts programming. Power Supply design (Linear and Switching types),Wireless power supply, USB PD, Solar panels, Battery types and charging.
4.	Discussion and implementation of a mini project.
5.	Documentation of the mini project (Report and video).

LABORATORY ACTIVITIES:

S. No.	List of Lab activities and experiments
1.	Schematic and PCB layout design of a suitable circuit, fabrication and testing of the circuit.
2.	Machining of 3D geometry on soft material such as soft wood or modeling wax.
3.	3D scanning of computer mouse geometry surface. 3D printing of scanned geometry using FDM or SLA printer.
4.	2D profile cutting of press fit box/casing in acrylic (3 or 6 mm thickness)/cardboard, MDF(2 mm) board using laser cutter & engraver.
5.	2D profile cutting on plywood /MDF (6-12 mm) for press fit designs.
6.	Familiarity and use of welding equipment.
7.	Familiarity and use of normal and wood lathe.
8.	Embedded programming using Arduino and/or Raspberry Pi.
9.	Design and implementation of a capstone project involving embedded hardware, software and machined or 3D printed enclosure.

Reference Books:

1. Chris Hackett. Weldon Owen, "The Big Book of Maker Skills: Tools & Techniques for Building Great Tech Projects". 2018.
2. Sean Michael Ragan, Weldon Owen; "The Total Inventors Manual (Popular Science): TransformYour Idea into a Top-Selling Product", 2017.
3. Paul Horowitz and Winfield Hill, "The Art of Electronics". Cambridge University Press. 3rd edition. 1995.
4. Simon Monk, "Programming Arduino: Getting Started with Sketches" McGraw Hill. 2ndedition.2012.
5. Ian Gibson, David W Rosen, Brent Stucker., "Additive Manufacturing Technologies: RapidPrototyping to Direct Digital Manufacturing", Springer, 2010.
6. Chapman W.A.J, "Workshop Technology", Volume I, II, III, CBS Publishers and distributors,5th Edition,2002.

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SEMESTER – II

BSCT104	Physics	3L:1T:0P	4 Credits

Course Objectives:

- *To understand the physics of simple harmonic motion (SHM) and its applications in various fields.*
- *To understand the characteristics and behavior of non-dispersive transverse and longitudinal waves in one dimension and to introduce the concept of dispersion in waves and its implications.*
- *To understand the behavior and propagation of light and to study the principles of geometric optics and their applications.*
- *To understand the wave nature of light and its interactions with matter and study the principles of wave optics and their applications.*
- *To understand the principles and applications of lasers and study the properties and behavior of laser light.*

MODULE I - SIMPLE HARMONIC MOTION AND OSCILLATOR 12 Hours

Mechanical and electrical simple harmonic oscillators, complex number notation and phasor representation of simple harmonic motion, damped harmonic oscillator – heavy, critical and light damping, energy decay in a damped harmonic oscillator, quality factor, forced mechanical and electrical oscillators, electrical and mechanical impedance, steady state motion of forced damped harmonic oscillator, power absorbed by oscillator.

MODULE II -WAVES AND INTRODUCTION TO DISPERSION 12 Hours

Transverse wave on a string, the wave equation on a string, Harmonic waves, reflection and transmission of waves at a boundary, impedance matching, standing waves and their Eigen frequencies, longitudinal waves and the wave equation for them, acoustics waves and speed of sound, standing sound waves. Waves with dispersion, water waves, superposition of waves and Fourier method, wave groups and group velocity.

MODULE III - PROPAGATION AND GEOMETRIC OPTICS 12 Hours

Fermat‟s principle of stationary time and its applications e.g. in explaining mirage effect, laws of reflection and refraction, Light as an electromagnetic wave and Fresnel equations, reflectance and transmittance, Brewster‟s angle, total internal reflection, and evanescent wave. Mirrors and lenses and optical instruments based on them, transfer formula and the matrix method.

MODULE IV - WAVE OPTICS 12 Hours

Huygens‟ principle, superposition of waves and interference of light by wave front splitting and amplitude splitting; Young‟s double slit experiment, Newton‟s rings, Michelson interferometer, Mach- Zehnder interferometer. Farunhofer diffraction from a single slit and a circular aperture, the Rayleigh criterion for limit of resolution and its application to vision; Diffraction gratings and their resolving power.

MODULE V – LASERS **12 Hours**

Einstein‟s theory of matter radiation interaction and A and B coefficients; amplification of light by population inversion, different types of lasers: gas lasers (He-Ne, CO2), solid-state lasers (ruby, Neodymium), dye lasers; Properties of laser beams: mono-chromaticity, coherence, directionality and brightness, laser speckles, applications of lasers in science, engineering and medicine.

Total No. of Hours: 60

Course Outcomes:

On successful completion of the module students will be able to:

- Solve engineering problems dealing with simple, damped, or forced harmonic oscillationand perform Fourier analysis of wave phenomena.
- Differentiate between transverse and longitudinal waves and explain their properties.
- Understand the generation and propagation of light and explain the principles ofgeometric optics, including reflection and refraction.
- Understand the wave nature of light and its properties, such as interference anddiffraction.
- Understand the basic principles of laser operation, including population inversion andstimulated emission

Text Books:

1. Ian G. Main, “Vibrations and Waves” Physics Cambridge University Press; 3rd Edition(1993).
2. H.J. Pain, “The physics of vibrations and waves” John Wiley & Sons, Ltd. 6th Edition2005.

Reference Books:

1. E. Hecht, “Optics” addison wesley (2001)
2. O. Svelto, “Principles of Lasers” Springer books, 2010.
3. R.N.Chaudhuri, “Waves and Oscillations” New Age International (P) Limited, 2010.

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BSCP104	Physics Laboratory	0L:0T:2P	1 Credit

Course Objectives:

- *To observe and study the diffraction pattern produced by a single slit.*
- *To observe and study the interference pattern produced by double slits.*
- *To verify the wave nature of light and measure the wavelength of light.*
- *To measure the speed of light using a Michelson interferometer setup.*
- *To measure the speed of light on a tabletop using the modulation technique.*

List of Experiments

1. Single-Slit Diffraction Experiment
2. Double-Slit Interference Experiment
3. Young's Double-Slit Experiment
4. Michelson Interferometer (Measurement of Speed of Light
5. Measurement of Speed of Light using Modulation
6. Minimum Deviation from a Prism
7. Lloyd's Mirror Interferometer.
8. Experiments to study Lasers.

Course Outcomes:

- Comprehend the concept of interference and how waves combine constructively and destructively to produce varying amplitudes.
- Understand the single-slit diffraction pattern and calculate the angles ofdiffraction for different wavelengths and slit sizes.
- Understand the double-slit interference pattern and calculate fringe spacing and angles of interference for various setups.
- Develop skills to analyze and interpret interference patterns resulting from different light sources and experimental configurations.
- Develop a comprehensive understanding of the fundamental principles of laser operation, including stimulated emission, population inversion, and optical gain.

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BSCT105	Mathematics- II (Complex Analysis And Transform)	3L:1T:0P	4 Credits

Course Objectives:

- *To understand the necessary and sufficient conditions for analyticity in Cartesian and polar coordinates, comprehend the properties of analytic functions, construct analytic functions, and apply standard conformal mapping and bilinear transformation.*
- *To apply line integrals, Cauchy's integral theorem, and Cauchy's integral formula, expand functions using Taylor's and Laurent's series, analyze singularities, calculate residues, and utilize the residue theorem for evaluating real integrals.*
- *To determine the existence conditions for Laplace transform, transform elementary functions, apply properties of Laplace transform including derivatives, unit step and impulse functions, shifting theorems, and transforms of derivatives and integrals, and utilize initial and final value theorems and transforms of periodic functions.*
- *To compute inverse Laplace transforms, utilize properties of Laplace transform, apply the convolution theorem, and solve ordinary differential equations with constant coefficients, simultaneous ordinary differential equations, and integral equations using Laplace transform.*
- *To understand the Fourier Integral theorem, Fourier transform, and its inverse, analyze properties of Fourier transform, apply Fourier sine and cosine transforms and their properties, utilize convolution and Parseval's identity in the context of Fourier transforms.*

MODULE I – ANALYTIC FUNCTIONS **12 Hours**

Analytic Functions – Necessary and sufficient conditions for analyticity in Cartesian and polar coordinates – Properties of Analytic Functions– Harmonic conjugates – Construction of analytic function – Standard Conformal mapping –Bilinear transformation.

MODULE II – COMPLEX INTEGRATION **12 Hours**

Line integral – Cauchy‟s integral theorem – Cauchy‟s integral formula – Taylor‟s and Laurent‟s series – Singularities – Residues – Residue theorem – Application of residue theorem for evaluation of real integrals – Use of circular contour and semicircular contour.

MODULE III – LAPLACE TRANSFORM **12 Hours**

Existence conditions – Transforms of elementary functions – Properties – Laplace Transform of Derivatives – Transform of unit step function and unit impulse function – Basic properties – Shifting theorems – Transforms of derivatives and integrals – Initial and final value theorems – Transform of periodic functions.

MODULE IV – APPLICATIONS OF LAPLACE TRANSFORM **12 Hours**

Inverse Laplace Transforms – Properties – Convolution theorem — Application to solution of ordinary differential equations with constant coefficients – Solution of simultaneousordinary Differential equations – Solution of integral equations.

MODULE V – FOURIER TRANSFORM **12 Hours**

Fourier Integral theorem (statement only) – Fourier transform and its inverse – properties – Fourier sine and cosine transforms – their properties, convolution and Parseval‟s identity.

Total No. of Hours: 60

Text Books:

1. Grewal B.S., "Higher Engineering Mathematics", Khanna Publishers, New Delhi, 43rd Edition, 2014.
2. Veerarajan T., "Engineering Mathematics", Tata McGraw-Hill, New Delhi, 2008.

Reference Books:

1. Ramana B.V., "Higher Engineering Mathematics", Tata McGraw-Hill, New Delhi, 2010.
2. Bali N.P and Manish Goyal, "A Text Book of Engineering Mathematics", Laxmi Publications (P) LTD-2011.
3. Dr. M.K. Venkataraman, "Engineering Mathematics – Volume I and Volume II", The National Publishing Company, Madras 2001.

Course Outcomes:

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

- Analyze and construct analytic functions, understand conformal mapping, and apply bilinear transformations.
- Apply complex integration techniques, including Cauchy's integral theorem and formula, Taylor's and Laurent's series, and residue theorem for real integral evaluation.
- Understand Laplace transform, its properties, and applications in solving ordinary andintegral differential equations.
- Apply the Laplace Transforms to convolution Integral and differential equations
- Apply Fourier transform, Fourier sine and cosine transforms, and understands theirproperties, convolution, and Parseval‟s identity.

*****

ESCT104	Basic Electrical Engineering	2L: 1T:0 P	3 Credits

Course Objectives:

- *To understand and gain basic knowledge about DC and AC circuits.*
- *To learn the concept of single phase and three phase circuit with power measurement.*
- *To study the operating principles of Transformers.*
- *To explore the working of the DC Machines and motors.*
- *To study the three phase induction motors.*

MODULE I - D. C. CIRCUITS **9 Hours**

Ohm's Law and Kirchhoff's Laws; Analysis of series, parallel and series-parallel circuits excited by independent voltage sources; Power and energy; Electromagnetism covering, Faradays Laws, Lenz's Law, Fleming's Rules, Statically and dynamically induced EMF; Concepts of self-inductance, mutual inductance and coefficient of coupling; Energy stored in magnetic fields;

MODULE II - A.C. CIRCUITS **9 Hours**

Generation of sinusoidal voltage- definition of average value, root mean square value, form factor and peak factor of sinusoidal voltage and current and phasor representation of alternating quantities; Analysis with phasor diagrams of R, L, C, RL, RC and RLC circuits; Real power, reactive power, apparent power and power factor, series, parallel and series- parallel circuits; Three Phase A.C. Circuits - Necessity and Advantages of three phase systems, Generation of three phase power, definition of Phase sequence, balanced supply and balanced load; Relationship between line and phase values of balanced star and delta connections; Power in balanced three phase circuits, measurement of power by two wattmeter method;

MODULE III – TRANSFORMERS **9 Hours**

Principle of operation and construction of single-phase transformers (core and shell types). EMF equation, losses, efficiency and voltage regulation

MODULE IV - DC MACHINES **9 Hours**

Working principle of DC machine as a generator and a motor; Types and constructional features; EMF equation of generator, relation between EMF induced and terminal voltage enumerating the brush drop and drop due to armature reaction; DC motor working principle; Back EMF and its significance, torque equation; Types of D.C. motors, characteristics and applications; Necessity of a starter for DC motor;

MODULEV- THREE PHASE INDUCTION MOTORS **9 Hours**

Concept of rotating magnetic field; Principle of operation, types and constructional features; Slip and its significance; Applications of squirrel cage and slip ring motors; Necessity of a starter, star-delta starter.

Total No. of Hours: 45

Text Books:

1. Nagrath I.J. and D. P. Kothari, "Basic Electrical Engineering" Tata McGraw Hill (2001).
2. Hayt and Kimberly, "Engineering Circuit Analysis" Tata McGraw Hill, 8th Edition, 2013.

References Books:

1. Kulshreshtha D.C., "Basic Electrical Engineering" Tata McGraw Hill (2009).
2. Rajendra Prasad, "Fundamentals of Electrical Engineering" Prentice Hall, IndiaHughes, 2009.

Course Outcomes:

On successful completion of the module students will be able to

- Understand the concept of DC circuits and Electromagnetic principles over inductors,
- Explain the concepts of AC circuits over RLC circuits and with knowledge of power and load performance and Obtain the power measurement using single phase and three phase circuit
- Discuss the principles of operation and construction of single-phase transformers
- Explain the operation and characterizes of DC machines and motors.
- Illustrate the principle of the three phase induction motors.

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ESCP104	Basic Electrical Engineering Laboratory	0L:0T:2 P	1 Credit

Course Objectives:

- *Understand the importance of electrical safety in handling electrical equipment andwiring.*
- *Understand the techniques for making secure and reliable electrical joints.*
- *Understand the principles of series and parallel circuits and their applications in lampcircuits.*
- *Learn the concept and purpose of staircase, wiring in residential and commercial settings.*
- *Learn the concept of load tests in motors and transformers.*

List of Experiments

1. Electrical Safety, Precautions, study of tools and accessories.
2. Practices of different joints. Wiring and testing of series and parallel lamp circuits.
3. Staircase wiring, Doctor‟s room wiring.
4. Bed room and godown wiring
5. Wiring and testing a ceiling fan and fluorescent lamp circuit.
6. Study of different types of fuses, circuit breakers and A.C and D.C meters.
7. OC and SC test on single phase transformer.
8. Load test on single phase transformer.
9. Load test on DC shunt motor.
10. Two wattmeter method of power measurement.
11. Load test on single phase induction. and 3 phase induction motor.
12. Speed control methods of DC motor

Course Outcomes:

On successful completion of the experiment students will be able to

- Demonstrate a thorough understanding of electrical safety practices, including theuse of personal protective equipment (PPE) and safety guidelines.
- Design and execute wiring layouts for series and parallel lamp circuits, understanding their applications and advantages.
- Plan and execute a staircase/ n wiring system, incorporating appropriate switchingmechanisms for efficient and convenient lighting control.
- Evaluate the performance of Transformers and motors for different loads.
- Discuss the power measurements in DC machines.

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ESCP105	Digital Fabrication	0L:0T:4P	2 Credits

Course Objectives:

The course is designed to impart knowledge and skills related to 3D printing technologies, selection of material and equipment and develop a product using this technique in Industry environment.

Course Contents:

1. **3D Printing (Additive Manufacturing)**
   Introduction, Process, Classification, Advantages, Additive V/s Conventional Manufacturing processes, Applications.

2. **CAD for Additive Manufacturing**
   CAD Data formats, Data translation, Data loss, STL format.

3. **Additive Manufacturing Techniques**

   Stereo- Lithography, LOM, FDM, SLS, SLM, Binder Jet technology. Process, Process parameter, Process Selection for various applications. Additive Manufacturing Application Domains: Aerospace, Electronics, Health Care, Defence, Automotive, Construction, Food Processing, Machine Tools

4. **Materials**
   Polymers, Metals, Non-Metals, Ceramics.
   Various forms of raw material- Liquid, Solid, Wire, Powder; Powder Preparation and their desired properties, Polymers and their properties.
   Support Materials.

5. **Additive Manufacturing Equipment**
   Process Equipment- Design and process parameters Governing Bonding Mechanism
   Common faults and troubleshooting Process Design

6. **Post Processing: Requirement and Techniques**

7. **Product Quality**
   Inspection and testing Defects and their causes

List of Experiments

1. 3D Modelling of a single component.
2. Assembly of CAD modelled Components.
3. Exercise on CAD Data Exchange.
4. Generation of .stl files.
5. Identification of a product for Additive Manufacturing and its AM process plan.
6. Printing of identified product on an available AM machine.

7. Post processing of additively manufactured product.
8. Inspection and defect analysis of the additively manufactured product.
9. Comparison of Additively manufactured product with conventional manufactured counterpart.

Course Outcomes:

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

- Develop CAD models for 3D printing.
- Import and Export CAD data and generate. stl file.
- Select a specific material for the given application.
- Select a 3D printing process for an application.
- Produce a product using 3D Printing or Additive Manufacturing (AM).

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HSMC101	English For Technical Writing	2L:0T:2P	3 Credit

Course Objectives:

- *To provide learning environment to practice listening, speaking, reading and writing skills and assist the students to carry on the tasks and activities through guided instructions and materials.*
- *To effectively integrate English language learning with employability skills and training, by providing hands-on experience through case-studies, mini-projects, group and individual presentations.*

MODULE I - VOCABULARY BUILDING 9 Hours

The concept of Word Formation, Root words from foreign languages and their use in English. Acquaintance with prefixes and suffixes from foreign languages in English to form derivatives. Synonyms, antonyms, and standard abbreviations.

MODULEII - BASIC WRITING SKILLS 9 Hours

Sentence Structures, Use of phrases and clauses in sentences, Importance of proper punctuation, Creating coherence, Organizing principles of paragraphs in documents,Techniques for writing precisely.

MODULE III - IDENTIFYING COMMON ERRORS IN WRITING 9 Hours

Subject-verb agreement, Noun-pronoun agreement, Misplaced modifiers, Articles, Prepositions, Redundancies and Clichés.

MODULE IV - NATURE, STYLE OF SENSIBLE WRITING 9 Hours

Describing, Defining, Classifying, Providing examples or evidence, Writing introduction and conclusion

MODULE V - WRITING PRACTICES AND ORAL COMMUNICATION 9 Hours

Comprehension, Précis Writing, Essay Writing, Listening Comprehension, Pronunciation, Intonation, Stress and Rhythm, Common Everyday Situations: Conversations and Dialogues, Communication at Workplace, Interviews, Formal Presentations.

Total No. of Hours: 45

Text Books:

1. Effective Communication Skills. Kul Bhushan Kumar, Khanna Book Publishing,2022.
2. Practical English Usage. Michael Swan. OUP. 1995.
3. Remedial English Grammar. F.T. Wood. Macmillan, 2007.

Reference Books:

1. On Writing Well. William Zinsser. Harper Resource Book. 2001.
2. StudyWriting. Liz Hamp-Lyons and Ben Heasly. Cambridge University Press. 2006.

Course Outcomes:

Upon successful completion of the course, students should be able to

- Aware of correct usage of English grammar in writing and speaking
- Increase their reading speed and comprehension of academic articles
- Improve their reading fluency skills through extensive reading
- Speaking ability in English both in terms of fluency and comprehensibility
- Oral presentations and receive feedback on their performance.

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HSMC-102	Universal Human Values - II	2L:1T:0P	3 Credits

PRE-REQUISITES: None. Universal Human Values 1 (Desirable)

Course Objectives:

During the Induction Program, students would get an initial exposure to human values through Universal Human Values-I. This exposure is to be augmented by this compulsory full semester foundation course. This introductory course input is intended:

- *To help the students appreciate the essential complementarily between 'VALUES' and 'SKILLS' to ensure sustained happiness and prosperity which are the core aspirations of all human beings.*
- *To facilitate the development of a Holistic perspective among students towards life and profession as well as towards happiness and prosperity based on a correct understanding of the Human reality and the rest of existence. Such a holistic perspective forms the basis of Universal Human Values and movement towards value- based living in a natural way.*
- *To highlight plausible implications of such a Holistic understanding in terms of ethical human conduct, trustful and mutually fulfilling human behavior and mutually enriching interaction with Nature.*
- *Thus, this course is intended to provide a much-needed orientational input in value education to the young enquiring minds.*

MODULE I – INTRODUCTION TO VALUE EDUCATION 9 Hours

Right Understanding, Relationship and Physical Facility (Holistic Development and the Role of Education); Understanding Value Education; Self-exploration as the Process for Value Education; Continuous Happiness and Prosperity – the Basic Human Aspirations; Happiness and Prosperity – Current Scenario; Method to Fulfill the Basic Human Aspirations: Exploring Natural Acceptance.

MODULE II – HARMONY IN THE HUMAN BEING 9 Hours

Understanding Human being as the Co-existence of the Self and the Body; Distinguishing between the Needs of the Self and the Body; Exploring the difference of Needs of Self and Body; The Body as an Instrument of the Self; Understanding Harmony in the Self ; Harmony of the Self with the Body ; Programme to ensure self-regulation and Health; Exploring Harmony of Self with the Body.

MODULE III – HARMONY IN THE FAMILY AND SOCIETY 9 Hours

Harmony in the Family – the Basic Unit of Human Interaction; „Trust' – the Foundational Value in Relationship; 'Respect' – as the Right Evaluation; Other Feelings, Justice in Human- to-Human Relationship; Understanding Harmony in the Society; Vision for the Universal Human Order.

MODULE4 – HARMONY IN THE NATURE/EXISTENCE 9 Hours

Understanding Harmony in the Nature; Interconnectedness, self-regulation and Mutual Fulfillment among the Four Orders of Nature: - Exploring the Four Orders of Nature; Realizing Existence as Co-existence at All Levels; The Holistic Perception of Harmony in Existence: - Exploring Co-existence in Existence.

MODULE5 – IMPLICATIONS OF THE HOLISTIC UNDERSTANDING – A LOOK AT PROFESSIONAL ETHICS 9 Hours

Natural Acceptance of Human Values; Definitiveness of (Ethical) Human Conduct: - Exploring Ethical Human Conduct; A Basis for Humanistic Education, Humanistic Constitution and Universal Human Order; Competence in Professional Ethics:- Exploring Humanistic Models in Education; Holistic Technologies, Production Systems and Management Models-Typical Case Studies; Strategies for Transition towards Value-based Life and Profession.

Total No. of Hours: 45

Text Book and Teachers Manual

1. R R Gaur, R Asthana, G P Bagaria, "A Foundation Course in Human Values and Professional Ethic",Excel Books, 2nd Revised Edition, New Delhi, 2019.
2. A.N. Tripathi, "Human Values" New Age Intl. Publishers, New Delhi, 2004.

Reference Books:

1. Ek Parichaya, A Nagaraj, Jeevan Vidya Prakashan, Amarkantak," Jeevan Vidya"1999.
2. The Story of Stuff (Book).
3. Mohandas Karamchand Gandhi "The Story of My Experiments with Truth".

Course Outcomes:

On successful completion of the course the students will be able to

- Discuss the Right understanding about the human aspirations.
- Explore the harmony in the human being with the right understanding about the bodyand self.
- Develop effective communication skills for promoting understanding and resolvingconflicts within the family and society with Trust and Respect.
- Develop a comprehensive understanding of the concept of harmony and itssignificance in nature and human life.
- Recognize the Natural Acceptance of Human Values and Strategies for Transitiontowards Value-based Life and Profession.

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AU-102	Sports and Yoga	1L:0T:1P	0 Credit

Course Objectives:

- *To make the students understand the importance of sound health and fitness principles as they relate to better health.*
- *To expose the students to a variety of physical and yogic activities aimed at stimulating their continued inquiry about Yoga, physical education, health and fitness.*
- *To create a safe, progressive, methodical and efficient activity based plan to enhance improvement and minimize risk of injury.*
- *To develop among students an appreciation of physical activity as a lifetime pursuit and a means to better health.*

MODULE I - INTRODUCTION TO PHYSICAL EDUCATION 9 Hours

Meaning & definition of Physical Education; Aims & OBJECTIVESs of Physical Education; Changing trends in Physical Education; Ancient & Modern Olympics (Summer & Winter); Olympic Symbols, Ideals, OBJECTIVESs & Values; Awards and Honours in the field of Sports in India (Dronacharya Award, Arjuna Award, Dhayanch and Award, Rajiv Gandhi Khel Ratna Award etc.)

MODULE II - PHYSICAL FITNESS, WELLNESS AND LIFE STYLE 9 Hours

Meaning & Importance of Physical Fitness & Wellness. Components of Physical fitness Components of Health related fitness. -Components of wellness. - Preventing Health Threats through Lifestyle Change; Concept of Positive Lifestyle; Nutritional practices for good Health.

MODULE III - FUNDAMENTALS OF ANATOMY AND PHYSIOLOGY IN PHYSICALEDUCATION, SPORTS AND YOGA 9 Hours

Define Anatomy, Physiology & Its Importance; Effect of exercise on the functioning of Various Body Systems. (Circulatory System, Respiratory System, Neuro-Muscular System etc.)

MODULE IV - YOGA AND LIFESTYLE 9 Hours

Meaning & Importance of Yoga, Elements of Yoga; Introduction - Asanas, Pranayama, Meditation & Yogic Kriyas; Yoga for concentration & related Asanas (Sukhasana; Tadasana; Padmasana &Shashakasana); Relaxation Techniques for improving concentration

- Yog-nidra

Asanas as preventive measures.

Hypertension: Tadasana, Vajrasana, Pavan Muktasana, Ardha Chakrasana Bhujangasana,Sharasana.

Obesity: Procedure, Benefits & contraindications for Vajrasana, Hastasana, Trikonasana, Ardh Matsyendrasana.

Back Pain: Tadasana, Ardh Matsyendrasana, Vakrasana, Shalabhasana, Bhujangasana. *Diabetes:* Bhujangasana, Paschimottasana,Pavan Muktasana, Ardh Matsyendrasana. *Asthema:* Sukhasana, Chakrasana, Gomukhasana, Parvatasana, Bhujangasana,Paschimottasana, Matsyasana.

MODULE V - PSYCHOLOGY & SPORTS **9 Hours**

Definition & Importance of Psychology in Physical Edu. & Sports; Define & Differentiate Between Growth & Development; Adolescent Problems & Their Management; Emotion: Concept, Type & Controlling of emotions; Meaning, Concept & Types of Aggressions in Sports. Psychological benefits of exercise. Anxiety & Fear and its effects on Sports Performance. Motivation, its type & techniques. Understanding Stress & Coping Strategies. Meaning and Concept of Doping ; Prohibited Substances & Methods :- Side Effects of Prohibited Substances.

Total No. of Lectures: 45

Text Books:

1. Ajmer Singh, Jagdish Bains , Jagtar Singh Gill and Rachpar Singh Brar, "Essentialsof Physical Education" by Kalyani publications, 2022.
2. B.K.S. Iyengar, "Light On Yoga: The Classic Guide to Yoga by the World's Foremost Authority"2006.
3. Health and Physical Education – NCERT (11th and 12th Classes).

Course Outcomes:

On successful completion of the course the students will be able to:

1. Discuss the physical education needs and history with reference to awards given in promotion of the sports in India.
2. Practice Physical activities and Hatha Yoga and Breathing techniques focusing on yoga for strength, flexibility, and relaxation, including strength and flexibility, balance and coordination.
3. Learn techniques for increasing concentration and decreasing anxiety which leads to stronger academic performance.
4. Develop understanding of health-related fitness components: cardio respiratory endurance, flexibility and body composition etc.
5. Develop understanding of psychological problems associated with the age and lifestyle.
6. Demonstrate an understanding of sound nutritional practices as related to health and physical performance.

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SEMESTER – III

BST-206	Engineering Mathematics –III (Fourier Transforms And Numerical Techniques)	2L:1T:0P	3 Credits

Course Objectives:

- *Understand the importance of transform techniques to solve engineering problems.*
- *Apply Laplace and Fourier transform to solve the mathematical equations arising in mechanical engineering.*
- *Understand Fourier series analysis and its use in solving boundary value problems.*
- *Numerical Methods for Solving Linear Systems*
- *Methods to solve equations of One Variable as well as system of equations with two variables.*
- *Curve fitting for the given data.*
- *Numerical solution of linear difference equation.*

MODULE I - FOURIER SERIES **9 Hours**

Dirichlet's conditions - Half range Fourier cosine and sine series - Parseval's relation - Fourier series in complex form – Harmonic analysis.

MODULE II - FOURIER TRANSFORMS **9 Hours**

Fourier cosine and sine transforms – inverse transforms - convolution theorem and Parseval's identity for Fourier transforms - Finite cosine and sine transforms.

MODULE III - SOLUTION OF LINEAR SYSTEM **9 Hours**

Gaussian elimination and Gauss-Jordan methods - LU - decomposition methods - Crout's method - Jacobi and Gauss-Seidel iterative methods - sufficient conditions for convergence.

MODULE IV - SOLUTION OF NONLINEAR SYSTEM **9 Hours**

- Bisection method - Secant method - Regula falsi method - Newton- Raphson method for $f(x) = 0$ and for $f(x,y) = 0$, $g(x,y) = 0$ - Order of convergence. Newton’s forward, backward and divided difference interpolation – Lagrange’s interpolation

MODULE V - CURVE FITTING **9 Hours**

Method of least squares and group averages - Least square approximation of functions - solution of linear difference equations with constant coefficients

Total No. of Hours: 45

Text Books:

1. Grewal.B.S., Higher Engineering Mathematics, Khanna Publisher, Delhi, 43rd Edition, 2012

2. Debnath L., and Dambaru Bhatta, Integral Transforms and Their Applications, 2nd Edition, (Special Indian Ed).Chapman & Hall/CRC, Indian Edition, 2010

3. Erwin Kreyszig, Advanced Engineering Mathematics, John Wiley & Sons, 2010.

Reference Books:

1. David Kincaid and Ward Cheney, Numerical Analysis, 3rd edition, American Mathematics Society, (Indian edition) – 2010.

2. Gerald C.F., and Wheatley P.O., Applied Numerical Analysis, Addison-Wesley Publishing Company, 1994 6. Jain, M.K., Iyengar, S.R. and Jain, R.K., Numerical Methods for Scientific and Engineering Computation, New Age international,2003

Course Outcomes:

On completion of the course, students should be able to:

- Apply the importance of transform techniques to solve engineering problems.
- Apply Laplace and Fourier transform to solve the mathematical equations arising in mechanical engineering.
- Discuss the Fourier series analysis and its use in solving boundary value problems.
- Apply Numerical Methods for Solving Linear Systems
- Understanding the Methods to solve equations of One Variable as well as system of equations with two variables.

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EEPCCT-201	Circuit Theory	3L:0T:0P	3 Credits

Course Objectives:

- *To analyze the given electrical network using Kirchhoff's laws.*
- *To introduce the basic knowledge of Laplace transform and Fourier Transform and to analyze the network using suitable technique.*
- *To analyze the two-port network.*
- *To understand the use of network topology in circuit solving.*

MODULE I - LOOP AND NODAL ANALYSIS **9 Hours**

Kirchhoff's laws, Node and Loop equations, Matrix approach of complicated network containing voltage and current sources, and source transformation.

MODULE II -NETWORK THEOREM **9 Hours**

Superposition, Thevenin's, Norton's, Maximum power Transfer, Reciprocity theorem as applied to DC and AC. circuits.

MODULE III - TWO PORT NETWORK AND NETWORK FUNCTIONS **9 Hours**

Two Port Networks, terminal pairs, relationship of two port variables, impedance parameters, admittance parameters, and hybrid parameters, interconnections of two port networks.

MODULE IV - RLC CIRCUITS **9 Hours**

Transient analysis of RC, RL, and RLC networks with and without initial conditions- Laplace transforms evaluation of initial conditions for sinusoidal response, Analysis of series - parallel resonance circuits and inductively coupled circuits - single tuned and double tuned circuits.

MODULE V - NETWORK TOPOLOGY **9 Hours**

Network terminology- Graph of a network- Incidence and reduced incidence matrices-Trees- Cut set-Fundamental cut set- Cut set matrix Tie set- Link currents and Tie set schedules- Twig voltages and Cut set schedules, Duality and dual networks.

Total No. of Hours: 45

Text Books:

1. Van, Valkenburg.; "Network analysis"; Prentice hall of India, 2000.
2. A William Hayt, "Engineering Circuit Analysis" McGraw Hill Science Engineering, 8th Edition, 2013.
3. A. Sudhakar, Shyammohan S. Palli , "Circuits and Networks: Analysis and Synthesis", McGraw Hill Publications, 5th Edition, 2015.

Reference Books:

1. 1. Ashfaq Husain, Networks and Systems, Khanna Book Publishing, 2021.
2. Mahmood Nahvi, Joseph Edminister, "Electric Circuits (Schaum's Outline series)", McGraw-Hill Publications, 5th Edition, 2017.

Course Outcomes:

At the end of this course students will demonstrate the able to

- Analyze the circuit using Kirchhoff's law and Network simplification theorems.
- Infer and evaluate Transient response and Steady state response of a network.
- Analyze electrical networks in the Laplace domain and understand concept of network functions and stability.
- Compute the parameters of a two-port network.
- Analyze the network terminology.

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EEPCCT-202	DC Machines & Transformers	3L: 0T:0 P	3 Credits

Course Objectives:

- *To familiarize the basic knowledge about magnetic circuits and working of DC generator.*
- *To explore the working and speed control of DC motors.*
- *To learn the operations and characteristics of single phase transformer with load and no load.*
- *To explore the working and various types of three phase transformer connections in three phase transformer.*
- *To test and analyze the characteristics of transformer and DC machines.*

MODULE I - ELECTROMECHANICAL ENERGY CONVERSION AND DC GENERATOR

9 Hours

Electromechanical energy conversion concept–Review of magnetic circuits-Single and multiple excited systems. DC Generators: Construction of DC Machine – Principle of operation – Types of Windings, types-Characteristics – EMF equation -Losses and efficiency-Armature Reaction – Commutation - methods of improving commutation – Applications.

MODULE II - DC MOTORS **9 Hours**

Principle of operation - Back emf - Torque equation -Condition for maximum efficiency - Power flow diagram – types - Performance characteristics. Starters: Need for starter – types - Speed control: Armature and field Speed control – Electric braking – Applications

Module III - SINGLE PHASE TRANSFORMERS **9 Hours**

Single Phase Transformers: Construction - Types – Principle of operation - emf equation - Operation of transformer under no load and on load- Phasor diagrams - Equivalent circuit; Losses and efficiency; Regulation and all-day efficiency- Parallel operation-Auto transformer: copper savings – Applications.

Module IV - THREE PHASE TRANSFORMERS **9 Hours**

Three Phase Transformers: Construction – Principle of operation – Types of connections – Open delta – Scott connection – three-phase to single phase conversion – three phase to two phase conversion – Tap changing transformers - off load and on load tap changers-Applications.

MODULE V - TESTING OF DC MAC HINES AND TRANSFORMERS 9 Hours

Testing Of Dc Machines: Load test – Swinburne‘s test - Hopkinson‘s test - Retardation test-speed control. Testing of Transformers: Load test – OC and SC test – Polarity test - Sumpner‘s test – Separation of no load losses, parallel operation.

Total No. Of Hours: 45

Text Books

1. A.E.Fitzgerald, Charles Kingsley, Jr, Stephen D Umans, “Electric Machinery”, Tata McGraw Hill Education, India , 5th Edition,2017.
2. B. L. Theraja and A. K. Theraja, ―A Textbook of Electrical Technology-Vol. II, S. Chand & Co. Ltd., New Delhi, 23rd Multicolor Edition, 2016.
3. DP Kothari, IJ Nagrath, ‘’ Electric Machines”, Tata McGraw Hill Education, India, 5th Edition, 2017.

Reference Books

1. J. B. Gupta, ―Theory and Performance of Electrical Machines, S. K. Kataria and Sons, New Delhi, 14th Edition, 2010.
2. Vincent Del Toro, ‘Basic Electric Machines’ Pearson India Education, 2016

Course Outcomes:

On successful completion of the module students will be able to:

- Describe the basic concepts of electromechanical energy conservation, operation and characteristics of dc generator.
- Discuss about the concept, operation and characteristics of DC Motor.
- Explain the operation and characteristics of single phase transformers.
- Illustrate the operation and outline the different types of connections in three phase transformers.
- Interpret the efficiency, characteristics of Transformers and DC machines by conducting Suitable tests.

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EEPCCT-203	Electronic Devices	3L:0T:0P	3 Credits

Course Objectives:

- *To provide a comprehensive understanding of semiconductor materials and construction and working of PN junction diodes with its characteristics.*
- *To provide a comprehensive understanding of construction, operating principle and characteristics of bipolar junction transistors (BJTs)*
- *To explore the construction and fabrication of field-effect transistors (FETs).*
- *To examine the construction, operating principle of various electronics switching devices – SCS, SCR, TRIAC, DIAC, GTO, and schokkely diode with its characteristics.*
- *To discuss the construction and operating principle of special semiconductor devices*

MODULE I - SEMICONDUCTOR THEORY AND DIODES 9 Hours

Introduction to Semiconductor materials – Energy band structure of insulators, conductors and semiconductors – intrinsic and extrinsic semiconductors – Construction of PN Diode – forward and reverse bias operation – mathematical model of a PN diode – Effects of temperature on diode operation – Static and dynamic resistances –-Transition and diffusion capacitances – Zener diode and its characteristics- Applications of diodes.

MODULE II - BIPOLAR JUNCTION TRANSISTORS 9 Hours

Construction and operation – NPN and PNP transistors – CB, CE and CC configurations – Transistor characteristics and regions of operation – Biasing of BJTs– DC load line characteristics – Operating point – stabilization – Biasing circuits – Bias compensation techniques

MODULE III - FIELD EFFECT TRANSISTORS 9 Hours

Comparison between JFET and BJT, JFET – Construction – drain and transfer characteristics – Shockley's equation — MOSFET –characteristics of Enhancement and Depletion modes. – Biasing of FETs -Comparison of MOSFET with JFET

MODULE IV - POWER DEVICES 9 Hours

Construction, principle of operation and characteristics of Power Diode – Shockley diode – SCR – SCS – GTO– DIAC – TRIAC – UJT

MODULE V - SPECIAL SEMICONDUCTOR DEVICES 9 Hours

Metal-Semiconductor Junction -Schottky barrier diode - MESFET, FINFET, PINFET, CNTFET, DUAL GATE MOSFET.

Text Books:

1. J. Millman, C. Halkias and S. Jit, Electronic Devices and Circuits, Tata McGrawHill, 4th edition, 2015

2. Robert L. Boylestad and Louis Nashelsky, "Electronic Devices and Circuit Theory", Prentice-Hall India, 2015.

3. Donald Neamen , Dhrubes Biswas "Semiconductor Physics and Devices" McGraw-Hill Education,

4th edition, 2021.

Reference books:

1. Allen Mottershed, "Electronic Devices and Circuits: An Introduction", PHI Learning 2011.
2. Ben G Streetman, "Solid-state electronic devices", Prentice Hall of India, 6th edition, 2008.
3. Theodre. F. Boghert, 'Electronic Devices & Circuits', Pearson Education, 6th Edition, 2003.
   Ben G. Streetman and Sanjay Banerjee, 'Solid State Electronic Devices', Pearson Education, 2002 / PHI.

Course outcomes:

At the end of this course students will demonstrate the ability to

- Classify the semiconductor materials and describe the construction and working of PN junction diodes with its characteristics.
- Discuss the construction, operating principle and characteristics of transistors.
- Discuss the construction, operating principle of Field effect transistor devices with its V-I Characteristics curves.
- Discuss the construction, operating principle of various electronics switching devices – SCS, SCR, TRIAC, DIAC, GTO, and schokkely diode with its characteristics.
- Discuss the construction and operating principle of special semiconductor devices

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EEPCCT-204	Electromagnetic Field Theory	3L:0T:0P	3 Credits

Course objectives:

- *To impart knowledge on the basics of static electric and magnetic field and the associated laws.*
- *To demonstrates the unification of electrostatic and magneto-static fields as a time varying electromagnetic fields.*
- *To make the students deep understanding of EM waves and the propagation of EM waves.*
- *To make the students understand and work out problems of steady magnetic fields and Electromagnetic wave equation*

MODULE I - ELECTROSTATIC FIELDS 9 Hours

Introduction- Coulomb's law – Electric field intensity – electric fields due to point line, surface and volume charge distributions – Electric flux density – Gauss law – Applications of Gauss'Law – Divergence – Maxwell's first equation Divergence theorem- Electric potential –Potential field - Potential gradient –Field due to dipoles– dipole moment– Energy density.

MODULE II - ELECTRIC FIELDS 9 Hours

Current and current density– Continuity of current – Conductor properties and Nature of Dielectrics– Boundary conditions–Capacitance–Capacitance of system of conductors– Polarization in dielectrics – Dielectric constant and Dielectric strength - Energy stored in capacitor - Poisson's and Laplace equations–Electrostatic applications in Van de Graff generator and Xerography.

MODULE III - MAGNETIC FIELDS 9 Hours

Introduction– Biot- Savart Law–Ampere's Circuital Law–Applications–Curl and Stoke's theorem – Magnetic flux and Magnetic flux density – The Scalar and Vector magnetic potentials– Force on a moving charge and current elements– Force and Torque on closed circuit.

MODULE IV - MAGNETIC MATERIALS, CONCEPTS AND APPLICATIONS 9 Hours

Introduction to magnetic materials – Magnetization and Permeability – Magnetic boundary conditions – Magnetic circuit–Potential energy and forces on Magnetic materials–Inductance and mutual inductance–Inductance of solenoids, toroids, and transmission lines–Faraday's Law – Time varying magnetic field. Application of Magnetic field in Induction heating and Magnet plane.

MODULE V - ELECTROMAGNETIC WAVE PROPAGATION 9 Hours

Conduction current and Displacement current – Maxwell's equation in point and integral forms, Power and the Poynting Vector – Wave propagation in free space– Wave propagation in Dielectrics– – Propagation in good conductors.

Total No. of Hours: 45

Text Books:

1. David K. Cheng, ―Field and Wave Electromagnetics, Second Edition, Pearson Education, Asia, 2008.

2. Edward C. Jordan and Keith G. Balaman, ―Electromagnetic waves and radiating systems, PHI Learning, 2nd Edition, 2007.

3. William H Hayt, ―Engineering Electromagnetics, McGraw Hill, 5th Edition, 2008.

Reference Books:

1. N. Narayana Rao, "Elements of Engg. Electro Magnetics", Prentice Hall of India, 6th Edition,2008

2. Sadiku MH, ―Principles of Electromagnetics, Oxford University Press Inc, New Delhi, 2009

Course Outcomes:

On successful completion of the module students will be able to:

- Apply fundamental knowledge of mathematics, science and engineering to understand and analyze electrostatic field and its theorems.
- Identify, formulate, and solve engineering problems like Electric Flux Density, Dipole Moment and Magnetic Fields.
- Design and analyze Electromagnetic Induction and Electromagnetic Waves.

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EEPCCT-205	Analog Electronic Circuits	3L: 0T:0 P	3 Credits

Course Objectives:

- *To impart knowledge on frequency response of small signal and large signal amplifiers.*
- *To explore the working of amplifiers with positive and negative feedback systems.*
- *To familiarize in time base and sweep circuits.*
- *To impart the importance of multi stage amplifier.*
- *To introduce stable operating point for BJT on various classes of power amplifiers.*

MODULE I - SMALL SIGNAL AMPLIFIERS 9 Hours

Introduction - Transistor hybrid model and h-parameters – Determination of h-parameters from transistor characteristics – Analysis of CB, CE and CC circuits using h-parameter model – Comparison of CB, CE and CC circuits – CE amplifier with unbiased emitter resistance – Transistor Re model – Small signal equivalent model – High frequency transistor model – Low frequency FET model.

MODULE II - LARGE SIGNAL AMPLIFIERS 9 Hours

Classification of Power amplifiers – Class A power amplifier – Direct coupled and transformer coupled – Class B amplifier – push-pull arrangement and complementary symmetry amplifiers – Conversion efficiency calculations – cross-over distortion – Class AB amplifier – Amplifier distortion – Power transistor heat sinking – Class C, Class D, Class E and Class S amplifiers.

MODULE III - MULTISTAGE AMPLIFIERS AND TIME BASE CIRCUIT 9 Hours

Cascading amplifier – Direct and RC coupled two stage CE amplifiers – Darlington pair –Cascode amplifier – Tuned amplifier: Single tuned – Double tuned – Stagger tuned amplifiers; Schmitt trigger and Multivibrators circuits: using BJT – UJT sweep circuits – Voltage and current sawtooth sweeps – Fixed amplitude sweep – Miller and bootstrap time base.

MODULE IV - FEEDBACK AMPLIFIERS 9 Hours

Feedback concept – Gain with feedback – General characteristics of negative feedback amplifiers – Four basic types of feedback and the effect on gain, input and output resistances – Multistage feedback amplifiers.

MODULE V - OSCILLATORS 9 Hours

Conditions for sustained oscillations – Barkhausen criterion – RC Phase shift, Wein-bridge oscillators –LC oscillators – Analysis of Hartley, Colpitts, Tuned oscillators-Crystal oscillators and frequency stability – UJT relaxation oscillators.

Total No of Hrs :45

Text Books:

1. David A. Bell, "Electronic devices and circuits", Oxford University higher education, 5th Edition, 2008.

2. Muhammad H. Rashid, "Microelectronic Circuits: Analysis & Design", Cengage learning Inc, 2nd Edition, 2011.

3. G.S. Tomar, Ashish Bagwari, "Fundamentals of Electronic Devices and Circuits", Springer Nature, 2019.

Reference Books:

1. Robert L. Boylestad and Louis Nashelsky, "Electronic Devices & Circuit theory" Pearson Education, 9th Edition, 2007.

2. R. S. Sedha, "A textbook of Applied Electronics", S. Chand Publications, Multicolor Edition, 2019

Course Outcomes:

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

- Design the transistor Amplifiers using its small signal model.
- Design cascade amplifiers and sweep circuits.
- Evaluate the performance analysis of large signal amplifier.
- Design the feedback amplifiers and analyze frequency response.
- Design oscillators for different types of signal generation.

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EEPCCP-206	Electronic Devices Lab	0L:0T:2P	1 Credit

(A minimum of TEN experiments to be conducted in the following Topics)

Course Objectives:

- *Develop practical skills in electronics through hands-on laboratory work and experiments*
- *To plot the V-I characteristics of PN junction diodes, Transistors, FET ,SCR , TRIAC & UJT*
- *To construct the biasing circuits of Transistors and rectifier circuits and analyzing its performance*

List of Experiments:

1. Obtain the V-I characteristics of PN junction diode and determine its static, dynamic resistance and Impedance.
2. Determine the VI characteristics of zener diode.
3. Determine the input and output characteristics of BJT and identify cut-off, active and saturation region for CB configurations.
4. Determine the input and output characteristics of BJT and identify cut-off, active and saturation region for CE configurations.
5. Obtain the transfer and drain characteristics of JFET and determine their drain resistance, mutual conductance.
6. Obtain the transfer and drain characteristics of MOSFET and determine their drain resistance, mutual conductance.
7. Determine the characteristics of SCR
8. Determine the characteristics of TRIAC
9. Determination of intrinsic stand-off ratio of UJT.
10. Design of half wave, full wave rectifier circuits with and without filters and determine the ripple factor.
11. Design of self-bias and fixed bias circuits using transistor and compare their performance.

Course Outcomes:

- Proficient in using basic electronic measurement instruments such as multimeters, oscilloscopes, and function generators. They should be able to measure voltage, current, frequency, and other relevant parameters accurately
- Analyze the V-I characteristics of diodes, transistors,
- Analyze the V-I characteristics of SCR,TRIAC and UJT
- Implement the application of diode by constructing the rectifiers with and without filters
- Design self-bias and fixed bias circuits using transistor

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EEPCCP-207	DC Machines & Transformers Laboratory	0L: 0T:2 P	1 Credit

(A minimum of TEN experiments to be conducted in the following Topics)

Course Objectives:

- *To determine the internal and external characteristics of the given DC generators from the test data*
- *To determine or predetermine the performance characteristics of the given DC motors from the test data.*
- *To determine or predetermine the regulation and efficiency of the single phase transformers from the test data*
- *To determine the regulation and efficiency of the three phase transformers from the test data*
- *To understand the parallel operation and load sharing of single phase transformers*.

DC MACHINES

1. Load test on DC shunt Motor
2. Load test on DC series Motor
3. Load test on DC Compound Motor
4. Open Circuit Characteristics of self-excited DC shunt Generator
5. Load test on self-excited DC shunt Generator
6. Open Circuit Characteristics of separately excited DC shunt Generator
7. Load test on separately excited DC shunt Generator
8. Load test on DC series Generator
9. Swinburne's Test
10. Hopkinson's test on DC Machines
11. Study on Retardation test and Speed control of DC Motors.

TRANSFORMERS

12. Load test on single phase transformer
13. O.C and S.C test on single phase transformer
14. Load test on three phase transformer
15. Parallel operation of single phase transformers
16. Sumpner's test on single phase transformers
17. Study of three phase transformer connections

Course Outcomes

On successful completion of the module students will be able to:

- Analyze the performance of any DC machine (shunt, series or compound) and transformer by conducting suitable experiments and report the results.
- Predetermine the different performance characteristics of DC machines and transformers.
- Analyze the various speed control techniques for DC motors.
- Experiment the parallel operation and analyze the load sharing of single phase transformers.

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EEPCCP-208	Electrical and Electronics Circuits Laboratory	0L: 0T:2 P	1 Credit

Course objectives:

- To gain practical experience on electric circuits to measure various electrical parameters like current, voltage and power using various network theorems for DC and AC circuits
- To gain practical experience to evaluate the solution of three phases AC balanced and unbalanced circuits for star and delta connection.
- Analyzing and comparing the operations of different Oscillators
- Implementation of circuits experimentally based on the knowledge gained in Digital-to- analog converters

List of Experiments:

1 Simulation and experimental verification of electrical circuit problems using Kirchhoff's voltage and current laws.

2 Simulation and experimental verification of electrical circuit problems using Super position theorem Thevenin's theorem and Norton's theorem

3 Simulation and experimental verification of electrical circuit problems using Maximum Power Transfer theorem

4 Simulation and experimental verification of electrical circuit problems using Reciprocity theorem

5 Simulation and verification in between voltage and current in three phase balanced star and delta connected loads

6 Frequency response characteristics of RC coupled amplifier single stage.

7 Design and verification of RC phase shift oscillator.

8 Design and verification of UJT relaxation oscillator.

9 Design and verification of Astable /Monostable /Bistable Multivibrator.

10 Design and verification of Schmitt Trigger.

11 Design and characterization of Class A amplifier.

Course outcomes:

At the end of the course the student should be able to

- Verify the basic laws and simplify more complicated circuits into simple equivalent circuits using network theorems to compute various parameters of typical DC and AC electrical circuits.
- Evaluate the solution of three phase AC balanced and unbalanced circuits with different types of loads.
- Understanding the frequency response characteristics of small signal amplifiers.
- Analyzing the operation of power amplifiers with their characteristics.
- Knowledge to design and test the different types of oscillators for the generation of required frequency.

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AU-203	Indian Constitution & Knowledge Systems	0L:1T:0P	No Credits

Course Objectives:

- *To recognize ones fundamental duties and rights*
- *To understand the structure and functions of legislature, executive and judiciary*
- *To understand the functioning of state governments and union territories*
- *To understand the centre-state relations and functioning of constitutional bodies*

MODULE I - INTRODUCTION OF INDIAN CONSTITUTION AND DEMOCRACY 9 Hours

Overview of Democracy - The Making of Indian Constitution - The Constituent Assembly - Sources of Indian Constitution - Preamble and theSupreme Court's Judgments on Preamble.

State, Rights and Duties: State and Union Territories – Citizenship - Fundamental Rights - Directive Principles ofState Policy - Fundamental Duties.

MODULE II- UNION GOVERNMENT 9 Hours

Union Government - The Powers and Functions of the President, Vice–President, Council of Ministers, Prime Minister, Judiciary, Supreme Court - Judicial Review - Judicial Activism- Public Interest Litigation - Power and Functions of the Parliament - Budget Power and Functions of Parliament, Speaker of Lok Sabha.

MODULE III - STATE GOVERNMENTS 9 Hours

State Governments – Governor - State Council of Ministers - Chief Minister- Legislative Assembly- High Courts; Union Territories - Panchayati Raj Institutions - 73th and 74th Constitutional Amendment - Gram Panchayats ;Block Panchayats - Municipalities.

MODULE IV - UNION- STATE RELATIONS, CONSTITUTIONAL BODIES 9 Hours

Centre – State Relations - Public Service - Election Commission - NITI Ayog, Emergency Powers of the President- Constitution Amendment Procedure- Right to Information Act - Right to Education. Major Constitutional Amendments and their impact on Indian Political System

MODULE V - INDIAN TRADITIONAL VALUES 9 Hours

Basic structure of Indian knowledge system, Modern science and Indian knowledge system, Yoga and holistic Health care. Philosophical tradition, Indian linguistic tradition, Indian artistic tradition.

Total No. of Hours: 45

Text Books:

1. N. Sivaramakrishnan (Ed.) Culteral Heritage of India – Course Materal, BharatiyaVidyaBhavan, Mumbai,5th edition, 2014.

2. Swami Jitatmanand," Modern Physics and Vedanta", BharatiyaVidyaBhavan,2012

Reference Books:

1. Fritzof Capra, "Tao of Physics",2019

2. Yoga Sutra of Patanjali, Ramakrishna Mission, Kolkatta.

3. R.N. Jha, "Science of Conciousness Psychotherapy and yoga Practices", VidyanidhiPrakashan, Delhi 2016.

Course Outcomes:

The course will enable the student to:

- Understand the structure, duties and functions of legislature, executive and judiciary
- Understand the functioning of state governments and union territories
- Understand the centre-state relations and functioning of constitutional bodies
- Understand connect up and explain basics of Indian traditional knowledge in modern scientificperspective.
- Under the Basic structure of Indian knowledge system.

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SEMESTER – IV

HSMC-203	Industrial Economics and Management	3L:0T:0P	3 Credits

C**ourse objectives:**

- *To inculcate the students with the Knowledge and Understanding of the Concept of Economics*
- *To enable the students to gain valuable insight in to the working of business.*
- *The course will review the evolution of management thoughts, functions and practicesthrough the focus on Indian experiences, approaches and cases.*
- *After undergoing this course student will get clear idea about Financial Management.*
- *Also they can be a member of Directing and Controlling in anorganization.*

MODULE I - INTRODUCTION TO ECONOMICS 9 Hours

Overview of Economy – GDP - Flow in an Economy, Law of Demand and Supply, Concept of Engineering Economics–Engineering Efficiency, Economic Efficiency, Scope of Engineering Economics, Elements of Costs, Marginal Cost, Marginal Revenue, Sunk Cost ,Opportunity cost, Break-Even Analysis, P/V ratio, Elementary Economics Analysis–Structure of Market, Pricing and its related factors.

MODULE II - FUNCTIONS OF MANAGEMENT 9 Hours

Overview of Management: Definition –Nature and scope of management- Importance - skills of managers–Levels of Management- Principles of Hendry Foyal.

Planning: Definition -Nature and purpose – Planning process – Importance of planning – types of plan- Decision making - Definition –steps and process and various types of decisions

MODULE III – ORGANIZATION 9 Hours

Definition -Types of organization – Organizational structure –Span of control – use of staff MODULE s and committees. Delegation: Delegation and Centralization. Centralization and Decentralization.

MODULE IV - FINANCIAL MANAGEMENT 9 Hours

Sources of finance (Internal and External)-Types of capital-Working capital-Types of investment-Preparation of Trading, Profit and Loss Account and Balance Sheet- Types of Accounting and significance of each types.

MODULE V – DIRECTING AND CONTROLLING **9 Hours**

Definition -Nature and purpose of Directing - Principles – Motivation - Definition - Theories of Motivation, Leadership: Definition- Styles – Communication: Definition - Importance of Communication – Methods of Communication – Types – Barriers

Meaning and importance of controlling–control process–Requisites of an effective control system– Relationship between planning and controlling

Text books:

1. Panner Selvam.R. "Engineering Economics", Prentice-Hall of India Pvt. Ltd, New Delhi, Feb-2013.
2. P.C.Tripathi & P.NReddy, "Principles of Managements",Tata Mc.GrawHill-NewDelhi,2012
3. Harold Koontz and Heinz Weihrich," Essentials of Management: An International, Innovation and Leadership Perspective", Tata McGraw-Hill Education, 10th Edition, 2015.

Reference books:

1. Degaramo E.P., Sullivan W.G and Canada J.R., "Engineering Economy" Macmillan,Newyork.
2. Peter Eichhorn & Ian Towers," Principles of Management: Efficiency and Effectiveness in the Private and Public Sector", Springer International Publishing. 2018

Course Outcomes:

On the successful completion of the course, student will be able to:

- Examine and explain the management evolution and how it will affect future managers.
- Estimate the conceptual framework of planning and decision-making in day to day life.
- Explain the various managerial functions to achieve the goals and objectives of the organization.
- Analyze the theories of motivation, leadership and communication in a variety of circumstances and management practices in organizations.
- An ability to understanding of professional and ethical responsibility.

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EEPCCT-209	AC Machines	3L: 0T:0 P	3 Credits

Course Objectives

- *To equip the students to understand and analyze the characteristics of three phase induction motor.*
- *To learn different types of starters and speed control of three phase induction motor.*
- *To equip the students to understand and analyze the characteristics of alternator.*
- *To learn characteristics of synchronous motor and effect of varying load and excitation.*
- *To get familiar with performance characteristics of single phase induction motors and special machines.*

MODULE I - INDUCTION MOTOR **9 Hours**

Single phase Induction Motors: Construction – Principle of operation - Double revolving field theory - Torque-speed characteristics – starting methods – Applications.

Three phase Induction Motors: Construction – principle of operation – Types - Effect of slip on rotor parameters – Torque equation - phasor diagram - torque slip characteristics - Power Stages - equivalent circuit – no load and blocked rotor test - circle diagram - Losses and efficiency – Applications.

MODULE II - STARTING AND SPEED CONTROL OF THREE PHASE INDUCTION MOTOR **9 Hours**

Starters: Need for starters – Starting methods. Speed control: Stator side – Rotor side – Solid state control. Cogging and Crawling - Electric Braking - deep bar and double cage rotor – Synchronous induction motor – Induction generator – Applications.

MODULE III – ALTERNATORS **9 Hours**

Construction – operation – Types of rotors – EMF equation – Synchronous reactance – Armature reaction - Alternator on load – phasor diagram. Voltage regulation: EMF, MMF, ZPF. Synchronizing and parallel operation – effect of change of excitation and prime mover inputs – automatic voltage regulators – Two reaction theory of Salient pole machines – slip test - power angle diagram – Applications.

MODULE IV - SYNCHRONOUS MOTOR **9 Hours**

Construction - principle of operation - starting methods - Torque and power equations - speed control– phasor diagram – effect of varying load and excitation - 'V' and inverted 'V' curves - hunting – synchronous condenser – Applications.

MODULE V - SPECIAL MACHINES **9 Hours**

Stepper motors - Reluctance motor - Hysteresis motor– Servo motor– Linear induction motor– AC series motor - switched reluctance motor – overview of Brushless DC motors and its applications – PMSM – Applications.

Total No. Of Hours: 45

Text Books:

1. E. Fitzgerald, Charles Kingsley, Stephen. D. Umans, "Electric Machinery", Tata McGraw Hill, New Delhi, 7th Edition, 2017.
2. B. L. Theraja and A. K. Theraja, ―A Textbook of Electrical Technology-Vol. II, S. Chand & Co. Ltd., New Delhi, 23rd Multicolor Edition, 2016.
3. J. Nagrath and D.P. Kothari, "Electric machines" T.M.H. publishing Co.Ltd., New Delhi, 5th Edition, 2017

Reference Books:

1. Battacharya S K, "Electrical Machines", Technical Teachers Training institute", 2nd Edition.2003.
2. P.C.Sen,"Principles of Electric Machines and Power Electronics, Wiley Student Edition, 2nd Edition, 2008.

Course Outcomes:

On successful completion of the module students will be able to:

- Evaluate and analyze the performance of three phase induction motor using equivalent circuits and circle diagram.
- Apply suitable starting and speed control methods to enhance the performance of three phase induction motors.
- Analyze the performance characteristics of alternator and compute voltage regulation with different methods.
- Analyze the characteristics of synchronous motor and its performance with effect of varying load and excitation.
- Recognize the characteristics of single phase induction motors and special machines as well as choose an appropriate motor for any industrial application.

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EEPCCT-210	Digital Electronics	3L:0T:0P	3 Credits

Course Objectives:

- *To understand the student to digital fundamentals.*
- *To understand the fundamental concepts to build any combinational circuit with logic gates and exclusively using universal gates.*
- *To understand the concepts of Sequential logic circuits.*
- *To understand the sequential circuits, emphasize is given to the variety of counter circuits both under synchronous.*
- *To understand the* Asynchronous sequential logic circuits.

MODULE I - NUMBER SYSTEM AND LOGIC FAMILIES 9 Hours

Review of number systems, binary codes, error detection and correction codes. Digital Logic Families – Introduction to RTL, DTL, TTL, ECL and MOSL families – wired and operation, characteristics of digital logic family – comparison of different logic families.

MODULE II - COMBINATIONAL LOGIC 9 Hours

Representation of logic functions – SOP and POS forms, K-map representations – minimization using K-maps- simplification and implementation of combinational logic – multiplexers and demultiplexers – code converters, adders, subtractors.

MODULE III - SEQUENTIAL LOGIC 9 Hours

SR, JK, D and T flip-flops – level triggering and edge triggering – counters – Pulse forming circuits - asynchronous and synchronous type – Modulo counters – Shift registers – Ring counters.

MODULE IV - SYNCHRONOUS SEQUENTIAL LOGIC CIRCUITS 9 Hours

State table and excitation tables - state diagrams - Moore and Mealy models - design of counters - analysis of synchronous sequential logic circuits - state reduction and state assignment.

MODULE V - ASYNCHRONOUS SEQUENTIAL LOGIC CIRCUITS 9 Hours

Transition table, flow table – race conditions – circuits with latches, analysis of asynchronous sequential logic circuits – implication table – hazards.

Text Books:

1. Morris Mano.M, 'Digital Logic and Computer Design', Prentice Hall of India, 3rd Edition, 2005.
2. Donald D. Givone, 'Digital Principles and Design', Tata McGraw Hill, 1st Edition, 2003.
3. Thomas L Floyd, 'Digital fundamentals', Pearson Education Limited, 11th Edition, 2015.

Reference Books:

1. Tocci R.J., Neal S. Widmer, 'Digital Systems: Principles and Applications', Pearson Education Asia, 2014.
2. Donald P Leach, Albert Paul Malvino, Goutam Sha, 'Digital Principles and Applications', Tata McGraw Hill, 7th Edition, 2010.

Course Outcomes:

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

- Interpret, convert and represent different number systems.
- Manipulate and examine Boolean algebra, logic operations, Boolean functions and their simplification.
- Design and analyze combinational and sequential logic circuits.

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EEPCCT-211	Transmission & Distribution Systems	3L: 0T:0 P	3 Credits

Course Objectives:

- *To provide the structure of the electrical power system with various types of A.C/D.C Transmission and distribution systems*
- *To explain about the classification of transmission lines and their technical parameters.*
- *To understand the concept of transmission line models and its performance.*
- *To understand the necessity and importance of various insulators and cables used in power system.*
- *To have an overview of the modern electrification schemes and recent technologies in Transmission and Distribution systems*.

MODULE I - DISTRIBUTION SYSTEMS 9 Hours

Structure of electric power systems - Single Line Diagram of Generation, Transmission and Distribution Systems – capacity and types of distribution system -Comparison of distribution systems – Radial and Ring main – DC two wire, AC single phase and three phase systems – Selection of Feeders and Distributors – secondary distribution system - Kelvin's law and its limitations.

MODULE II - LINE PARAMETERS AND EFFECTS ON TRANSMISSION SYSTEMS 9 Hours

Resistance, inductance and capacitance of single and three phase transmission lines - symmetrical and unsymmetrical spacing – transposition - single and double circuits - stranded and bundled conductors - application of self and mutual GMD–Skin, Proximity and Corona effect - inductive and radio interference - Computation of line parameters.

MODULE III - PERFORMANCE ANALYSIS ON TRANSMISSION SYSTEMS 9 Hours

Development of equivalent circuits for short, medium and long lines – Calculation of efficiency and voltage regulation – Tuned power lines - Power circle diagrams for sending and receiving ends - transmission capacity, steady state stability limit –voltage control of lines.

MODULE IV - INSULATORS AND CABLES FOR DISTRIBUTION SYSTEMS 9 Hours

Insulators: types and comparison – voltage distribution in string insulator – string efficiency – Methods of improving string efficiency – Stress and sag calculations – effect of wind and ice – supports at different levels. Cables: types – capacitance of cables – insulation resistance - dielectric stress and grading - dielectric loss -thermal characteristics - capacitance of three core cables.

MODULE V - RECENT TRENDS IN TRANSMISSION AND DISTRIBUTION 9 Hours

Design of Rural distribution, planning and design of town electrification schemes – Need for power system interconnections systems – Components of a HVDC system - Types of DC links - Modern trends in DC Transmission systems – Comparison of HVDC and HVAC Transmission systems – Introduction to FACTS - FACTS controllers – Shunt and Series – Grounding methods in power stations.

Total no of Hours: 45

Text Books:

1. S .N .Singh, 'Electric Power Generation, Transmission and Distribution', Prentice Hall of India Pvt. Ltd, New Delhi, 2nd Edition, 2011.
2. V. K. Metha and Rohit Metha, "Principles of Power System", S. Chand, 3rd Edition, 2005.
3. C. L. Wadhwa, Electrical Power Systems, 5th Edition, New Age International (P) Limited, New Delhi, 2006.

Reference Books:

1. R .Padiyar, "HVDC Power Transmission Systems – Technology and System Interactions", New Age International Publishers, 2012
2. B. L. Theraja and A. K. Theraja, ―A Textbook of Electrical Technology-Vol. III, S. Chand & Co. Ltd., New Delhi, 23rd Multicolor Edition, 2016.

Course Outcomes:

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

- Summarize the structure of Generation, Transmission and Distribution with real time connection schemes.
- Calculate the line parameters in the transmission system and their effects in the overhead lines.
- Analyze on different types of transmission lines (short, medium, long) and its performance.
- Choose the adaptable types of insulators and cables for transmission and distribution systems.
- Compare various schemes of electrification and gain knowledge on High Voltage AC / DC systems

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EEPCCT-212	Control Systems	2L:1T:0P	3 Credits

C**ourse Objectives:**

- *To explain the use of transfer function models for analysis of physical systems*
- *To explain various control system components*
- *To provide basic knowledge about time response of systems and steady state error analysis*
- *To introduce the concepts and applications of P, PI and PID controllers*
- *To teach how to obtain open-loop and closed-loop frequency responses*
- *To introduce stability analysis and design of compensators*
- *To introduce state variable representation of physical systems and state feedback*

MODULE I - CONTROL SYSTEMS AND THEIR REPRESENTATION 9 Hours

Basic elements in control systems – Open and closed loop systems – Electrical analogy of mechanical and thermal systems – Transfer function – Synchros – AC and DC servomotors – Block diagram reduction techniques – Signal flow graphs.

MODULE II - TIME RESPONSE ANALYSIS 9 Hours

Time response – Time domain specifications – Types of test input – I and II order system response – Error coefficients – Generalized error series – Steady state error – Root locus construction- Effects of P, PI, PID modes of feedback control –Time response analysis.

MODULE III - FREQUENCY RESPONSE ANALYSIS 9 Hours

Frequency response – Bode plot – Polar plot – Determination of closed loop response from open loop response - Correlation between frequency domain and time domain specifications- Effect of Lag, lead and lag-lead compensation on frequency response- Lag/Lead compensator design using bode plots.

MODULE IV - STABILITY ANALYSIS 9 Hours

Concept of stability of LTI systems–Routh and Hurwitz stability criteria–relative stability analysis using Routh's stability criterion– Root locus concepts – Construction of root loci Stability analysis in frequency domain – Nyquist stability criterion– Relative stability analysis using phase margin and gain margin specifications

MODULE V - STATE SPACE ANALYSIS OF LTI SYSTEMS 9 Hours

Concept of state variables – State models for linear and time invariant Systems – Solution of state and output equation in controllable canonical form – Concepts of controllability and observability – Effect of state feedback.

Total No. of Hours: 45

Text Books:

1. Katsuhiko Ogata, "Modern Control Engineering", Pearson, 2015.
2. Benjamin C. Kuo, "Automatic Control Systems", Wiley, 2014.
3. Nagarath, I.J. and Gopal, M., "Control Systems Engineering", New Age International Publishers, 2017.

Reference Books:

1. Norman S. Nise,"Control System Engineering", 4th edition, Wiley Student Edition, 2008
2. Richard C.Dorf and Bishop, R.H., "Modern Control Systems", Pearson Education, 2009.

Course Outcomes:

At the end of this course students will able to

- Understand the basic concepts of modeling of dynamical control systems in transfer function approach.
- Able to deduce the analogy between mechanical and electrical systems and to infer how first order and second order dynamical systems respond to standard test signals during transient and steady state conditions.
- Gain knowledge on how the locus of all possible closed-loop poles travel in s plane as a system parameter varies from 0 to ∞.
- Understands the frequency response of LTI systems using polar and Bode plots.
- Understand the stability of dynamical systems using Routh-Hurwitz and Nyquist stability criteria and to study the performance indices of a system in frequency domain.
- Understand the concept of modeling a dynamic system directly in time domain using state-space approach and to solve the state equation to study the evolution of state variables with respect to time when subject to standard test signals.

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EEPCCT-213	Electrical Safety and Quality Management	3L:0T:0P	3 Credits

Course Objectives:

This course will enable students to:

- *To familiarize the Indian Electricity Rules and Act related with electrical safety.*
- *To provide a knowledge about electrical shocks and safety precautions.*
- *To create awareness of the electrical safety associated with installation of electrical equipment.*
- *To analyze different Hazardous areas for electrical safety.*
- *To expose knowledge about necessity of safety policy and safety management.*

MODULE I - CONCEPTS AND STATUTORY REQUIREMENT 9 Hours

Objective and scope of electrical safety - National electrical Safety code - Statutory requirements – Indian Electricity (IE) acts related to electrical safety - Safety electrical one line diagram - International standards on electrical safety - safe limits of current and voltage - Grounding of electrical equipment of low voltage and high voltage systems - Safety policy - Electrical safety certificate requirement.

MODULE II - ELECTRICAL SHOCKS AND THEIR PREVENTION 9 Hours

Primary and secondary electrical shocks - Possibilities of getting electrical shock and its severity - Effects of electrical shock on human beings - Shocks due to flash/ Spark over's - Firing shock - Multi storied building - Prevention of shocks - Safety precautions - Safe guards for operators - Do's and Don'ts for safety in the use of domestic electrical appliances - Case studies on electrical causes of fire and explosion

MODULE III - SAFETY DURING INSTALLATION, TESTING AND COMMISSIONING, OPERATION AND MAINTENANCE 9 Hours

:Need for inspection and maintenance - Preliminary preparations - Field quality and safety - Personal protective equipment - Safe guards for operators - Safety equipment - Risks during installation of electrical plant and equipment - Effect of lightning current on installation and buildings - Safety aspects during installation -Safety during installation of electrical rotating machines - Importance of earthing in installation– Agricultural pump installation

MODULE IV - HAZARDOUS ZONES **9 Hours**

Primary and secondary hazards - Hazardous area classification and of electrical equipments (IS, NFPA, API and OSHA standards) - Explosive gas area classifications: Class I (Division 1) - Zone 0, Zone 1, zone 2 classified locations, Design Philosophy for Equipment and installations-Classification of equipment enclosure for various hazardous gases and vapors - flash hazard calculation and approach distances- calculating the required level of arc protection.

MODULE V - SAFETY MANAGEMENT OF ELECTRICAL SYSTEMS **9 Hours**

Principles of Safety Management - Occupational safety and health administration standards - Safety organization - Safety auditing - Employee electrical safety teams - Electrical safety training to improve Quality management - Total quality control and management – Importance of high load factor - Causes of low power factor - Disadvantages of low power factor - Power factor improvement - Importance of P.F. improvement - Case studies of electrical workplace safety practices.

Total No. of Hours: 45

Text books:

1. John Cadick, Mary Capelli Schellpfeffer, Dennis Neitzel, Al Winfield, "Electrical Safety Handbook", McGraw-Hill Education, 4th Edition, 2012.
2. S. Rao, Prof. H.L. Saluja, "Electrical safety, fire safety Engg and safety management", Khanna Publishers. NewDelhi, 1988.
3. Mohamed A. El-Sharkawi, "Electric Safety: Practice and Standards", CRC Press; 1st Edition, 2013.

Reference Books:

1. Rob Zachariason, "Electrical Safety", Delmar Cengage Learning, 1st Edition, 2011.
2. Peter E. Sutherland, "Principles of Electrical Safety", Wiley-IEEE Press; 1st Edition, 2014

Course Outcomes:

On successful completion of this course, the students will be able to,

- Describe the Indian Electricity (IE) acts and various rules for electrical safety.
- Expose safety measures to prevent electrical shock in handling of domestic electrical appliances.
- Evaluate the safety aspects during installation of plant and equipment.
- Describe the various hazardous area and application of electrical safety in various places.
- Acquire knowledge about importance of electrical safety training to improve quality management in electrical systems.

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EEPCCP-214	AC Machines Laboratory	0L: 0T:2 P	1 Credit

(A minimum of TEN experiments to be conducted in the following Topics)

Course Objectives:

- *To equip the students to test and evaluate the performance of induction and synchronous machines by conducting appropriate experiments.*
- *To learn different methods to predetermine the characteristics of single phase and three phase induction motors*
- *To get familiar with different types of speed control of three phase induction motor.*
- *To understand the synchronization of three phase alternator with infinite bus bar.*
- *To learn the assembling of different types of AC machines.*

List of Experiments

1. Load test on single phase induction motor
2. Load test on three phase squirrel cage
3. Load test on three phase slip ring induction motors
4. No load and blocked rotor tests on three phase induction motor
5. Speed control of induction motor
   (i). Stator voltage control
   (ii). Rotor resistance control
6. Electrical Braking of Induction motor
   (i). Dynamic Braking
   (ii). Plugging
   (iii). Regenerative Braking
7. Load test on induction generator
8. Load test on Single phase alternator
9. Load test on three-phase alternator
10. Voltage regulation of alternator (EMF, MMF, ZPF)
11. Slip test on three phase salient pole alternator.
12. Synchronization of three phase alternator with infinite bus bar.
13. V and inverted V curve of synchronous Motor.
14. Performance Characteristics of Universal Motor.

Course Outcomes:

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

- Test the performance of induction and synchronous machines by conducting suitable experiments and report the results.
- Predetermine the different performance characteristics of single phase and three phase induction motors.
- Analyze the speed control techniques and electrical braking of induction motor.
- Experiment the synchronization of alternators and analyze the power exchange with the grid.
- Develop any prototype modules implementing different control techniques in Induction and Synchronous machines for various applications.

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EEPCCP-215	Digital Electronics Laboratory	0L: 0T:2 P	1 Credit

Course Objectives:

- *To represent logical functions in canonical and standard forms.*
- *To design and analyse the combinational logic circuits.*
- *To design and analyse the sequential logic circuits.*
- *To implement combinational and sequential logic circuits using Verilog HDL.*

List of Experiments:

1. Design and implementation of the following Code convertors
   a. BCD to excess-3 code and vice versa b. Binary to gray code and vice-versa
2. Design and implementation of 4 bit binary Adder/ Subtractor and BCD adder using IC7483
3. Magnitude comparator
   a. Study of 4-bit magnitude comparator IC
   b. Realization of 8-bit magnitude comparator using 4-bit magnitude comparator ICs.
4. Multiplexers and Encoders
   a. Realization of 16×1 multiplexer using 8×1 multiplexer ICs
   b. Realization of a combinational circuit using multiplexer
   c. Construction and study of a simple Priority Encoder
5. Decoders and Demultiplexers
   a. Realization of 4 to 16 line decoder using 3 to 8 line decoder ICs
   b. Realization of a combinational circuit using a decoder IC
6. Shift register
   a. Construction of ring counter and Johnson counter using a shift register IC and study of their timing diagrams
   b. Designing a PN Sequence Generator using a shift register IC
7. Ripple Counters and their timing diagrams
   a. 3-bit binary up/down counter
   b. BCD counter using mod-10 counter ICs
8. Design and implementation of Synchronous Counters and study of their timing diagrams
   a. Binary counter
   b. Non-sequential binary counter
   c. 3-bit binary up/down counter

d. A modulo-N-counter

9. Study of a Memory IC
   a. READ and WRITE operations involving memory chips
   b. Expansion of memory size
10. Simulate the following circuits:
    a. Half Adder and Full Adder
    b. Multiplexer and DeMultiplexer
    c. Binary Up-down Counter
    d. Shift Register

Course Outcomes:

At the end of the course the student should be able to

- Understand the number systems and IC characteristics
- Understand the Boolean algebra and its properties
- Design and analyze the combinational and Sequential logic circuits.

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PRJ EE-201	Micro Project	0L:0T:2P	1 Credit

Micro Project

Guidelines: The micro-project is a team activity having 3-4 students in a team. This is electronic circuit building and testing for developing real life small electronic applications. The micro-project may be a complete hardware or hardware with small programming aspect. It should encompass electronics components, devices, analog or digital ICs, micro controller etc. Micro-Project should cater to a small system required in laboratory or real-life application. Based on comprehensive literature survey/ need analysis, the student shall identify the title and define the aim and objectives of Micro-project.

Course Outcomes:

At the end of the micro project, students will able to

- Identify and define a problem statement from the requirements raised from literature survey /need analysis
- Build and Test electronic circuits/prototype for developing real life small electronic applications.
- Work in teams; write comprehensive report and effective presentation of the project work.
- Understand the rapid prototyping which will lead them towards entrepreneurship.

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HSMC-203	Life Skills	3L:0T:0P	3 Credits

Course Objectives:

- *To Identify different life skills required in personal and professional life*
- *To apply well-defined techniques to cope with emotions and stress.*
- *To understand the basic mechanics of effective communication and demonstrate these throughpresentations.*
- *To use appropriate thinking and problem solving techniques to solve new problems*
- *To understand the basics of teamwork and leadership*

MODULE I - OVERVIEW OF LIFE SKILLS **9 Hours**

Meaning and significance of life skills, Life skills identified by WHO: Self awareness, Empathy, Critical thinking, Creative thinking, Decision making, problem solving, Effective communication, interpersonal relationship, coping with stress, coping with emotion.

LIFE SKILLS FOR PROFESSIONALS: positive thinking, right attitude, attention to detail, having the big picture, learning skills, research skills, perseverance, setting goals and achieving them, helping others, leadership, motivation, self-motivation, and motivating others, personality development, IQ,EQ, and SQ.

MODULE II - SELF-AWARENESS **9 Hours**

Definition, need for self-awareness; Coping with Stress and Emotions, Human Values, toolsand techniques of SA: questionnaires, journaling, reflective questions, meditation, mindfulness, psychometrictests, feedback.

Stress Management: Stress, reasons and effects, identifying stress, stress diaries, the four A's of stress management, techniques, **Approaches:** action-oriented, emotion-oriented, acceptance oriented, resilience, Gratitude Training, **Coping with emotions:** Identifying and managing emotions, harmful ways of dealing with emotions, PATH method and relaxation techniques. **Morals, Values and Ethics:** Integrity, Civic Virtue, Respect for Others, Living Peacefully. Caring, Sharing, Honesty, Courage, Valuing Time, Time management, Cooperation, Commitment, Empathy, Self-Confidence, Character, Spirituality, Avoiding Procrastination, Sense of Engineering Ethics.

MODULE III - 21ST CENTURY SKILLS **9 Hours**

Creativity, Critical Thinking, Collaboration, Problem Solving, Decision Making, Need for Creativity in the 21st century, Imagination, Intuition, Experience, Sources of Creativity, Lateral Thinking,Myths of creativity, Critical thinking Vs Creative thinking, Functions of Left Brain & Right brain, Convergent &Divergent Thinking, Critical reading & Multiple Intelligence.

Steps in problem solving: Problem Solving Techniques, Six Thinking Hats, Mind Mapping, Forced Connections. Analytical Thinking, Numeric, symbolic, and graphic reasoning. Scientific temperament and Logical thinking.

MODULE IV - GROUP AND TEAM DYNAMICS **9 Hours**

Introduction to Groups: Composition, formation, Cycle, thinking, Clarifying expectations, Problem Solving, Consensus, Dynamics techniques, Group vs Team, Team Dynamics, Virtual Teams. Managing team performance and managing conflicts, Entrepreneurship.

MODULE V - LEADERSHIP **9 Hours**

Leadership framework, entrepreneurial and moral leadership, vision, cultural dimensions. Growing as a leader, turnaround leadership, managing diverse stakeholders, crisis management. Types of Leadership, Traits, Styles, VUCA Leadership, Levels of Leadership, Transactional vs Transformational Leaders, Leadership Grid, Effective Leaders.

Total No. of Hours: 45

Text Books:

1. Kalyana, "Soft Skill for Managers"; Wiley Publishing Ltd, 1st Edition, 2015.
2. Larry James, "The First Book of Life Skills"; Embassy Books, 1st Edition, 2016

References books:

1. Remesh S., Vishnu R.G., "Life Skills for Engineers", Ridhima Publications, 1st Edition,, 2016.
2. Training in Interpersonal Skills: Tips for Managing People at Work, Pearson Education, India; 6th Edition, 2015.

Course Outcomes:

On the successful completion of the course, student will be able to:

- Define and Identify different life skills required in personal and professional life
- Develop an awareness of the self and apply well-defined techniques to cope with emotions and stress.
- Explain the basic mechanics of effective communication and demonstrate these through presentations and take part in group discussions.
- Use appropriate thinking and problem solving techniques to solve new problems.
- Understand the basics of teamwork and leadership

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AU-204	Environmental Science	1L:0T:1P	No Credits

Course Objectives:

- *It is concerned with the exploration, investigation and development of an understanding of the natural, human and social dimensions of local and wider environments.*
- *It provides opportunities to engage in active learning, to use a wide range of skills, and to acquire open, critical and responsible attitudes.*
- *The objective of this activity is to raise awareness about sustainable living practices and encourage students to adopt eco-friendly habits in their daily lives.*

Course Contents:

MODULE I - ECO SYSTEM **6 Hours**

Introduction- Abiotic and Biotic components, Structure and functions of Ecosystem – Food Chain, Food web, Ecological pyramids, Energy flow and biogeochemical cycles.

MODULE II - BIODIVERSITY **6 Hours**

Values, Type and levels of Biodiversity. Causes of depletion. Conservation of biodiversity

MODULE III - POLLUTIONS **6 Hours**

Water Pollution-Sources of water, water quality standards, type of pollutants – its sources and effects. **Air Pollution** – composition of atmosphere, Air quality standards, Sources and adverse effects of air pollution, Greenhouse effect, global warming, acid rain, ozone depletion.

Noise Pollution – Introduction, Level of noise, Sources and adverse effects of noise, Control of noise pollution.

MODULE IV - SOLID WASTE MANAGEMENT **6 Hours**

Municipal waste – Introduction, classification of solid waste, composition and characteristics of solid waste

MODULE V **6 Hours**

Activities for Environmental Studies in Engineering Colleges (any 2 activities)

1. **Green Campus Initiative:** Organize a campus-wide green initiative to promote sustainable practices, such as recycling, reducing energy consumption, and minimizing water wastage. Conduct workshops and awareness campaigns on campus to involve students and staff actively.
2. **Waste Audit and Management:** Conduct a waste audit on campus to analyze the types and quantities of waste generated. Based on the findings, implement effective waste management practices, including recycling programs and proper waste disposal.

3. **Environmental Impact Assessment:** Assign students real-life projects to conduct environmental impact assessments of construction projects or industrial facilities to identify potential environmental impacts and propose mitigation measures.
4. **Energy Efficiency Workshop:** Organize workshops and seminars on energy efficiency, renewable energy technologies, and energy conservation to educate students about sustainable energy practices.
5. **Green Design Competition:** Host a green design competition where students come up with sustainable engineering solutions for environmental challenges. Encourage innovative designs that promote sustainability and eco-friendliness.
6. **Nature Walk and Biodiversity Study:** Organize nature walks and biodiversity study trips to nearby natural areas. Students can learn about local ecosystems, wildlife, and the importance of conserving biodiversity.
7. **Sustainable Transportation Campaign:** Raise awareness about sustainable transportation options such as cycling, carpooling, and public transit. Encourage students to use these eco-friendly modes of transportation on campus.
8. **Water Conservation Challenges:** Run a water conservation challenge where students compete to reduce water usage in their hostels or departments. Monitor water consumption and reward the most water-conscious groups.
9. **Community Outreach Program:** Engage with the local community on environmental issues through outreach programs. Students can conduct workshops on waste management, renewable energy, or other eco-friendly practices.
10. **Green Tech Exhibition:** Organize a green technology exhibition to showcase sustainable engineering solutions and environmentally friendly projects developed by students. Invite industry experts and environmentalists to judge and provide feedback.

Total No. of Hours: 30

Text Books:

1. P.Yugananth, R.Kumaravelan, Environmental Science and Engineering, Scitech Publications(Inida) P.Ltd., Delhi, 2017.
2. John Pichtel, Waste Management Practices: Municipal, Hazardous and Industrial, CRC Press,2014.
3. S.S.Dara, A text book of Environmental Chemistry and Pollution Control, S.Chand andCompany Ltd., New Delhi, 2014

Reference Books:

1. V.S.K.V.Harish, Arunkumar, Green Building Energy Simulation and Modeling, ElsevierScience & Technology,2018.

2. Anubha Kaushik and C.P.Kaushik, Environmental Science and Engineering, New AgeInternational (P) Ltd., New Delhi, 2010.

Course Outcomes:

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

- Recognize the impact of environmental depletion especially on ecosystem and biodiversity
- Identify factors causing land, water, air and noise pollution
- Determine the effects of pollution
- Develop keen understanding of non conventional energy source, solid waste management andtechnologies for sustainable development
- Understand the environment legislations in India.

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SEMESTER V

EEPCCT-316	Measurements and Instrumentation	3L:1T:0P	3 Credits

Course Objectives:

- *To give the students an insight into the constructional details and working principles of various measuring instruments.*
- *To provide the use of different types of analog and digital meters for measuring electrical and physical quantities.*
- *To demonstrate various Bridges for the measurement of resistance, inductance and capacitance.*
- *To provide the procedure to calibrate an energy meter*.

MODULE I - INTRODUCTION TO MEASUREMENTS 9 Hours

Functional elements of Generalized measurement system - Types of measurement - Classification of instruments - Static and Dynamic characteristics of instruments - Mean, Standard deviation - error - Accuracy, Precision, Sensitivity, Linearity, Resolution, Hysteresis, Threshold, Input impedance - loading effects - Probability of errors- Errors in Measurements - Systematic and random errors, propagation of errors, Limiting errors of instruments.

MODULE II - ELECTRICAL INSTRUMENTS 9 Hours

Essential requirements of an instrument - Ammeter and voltmeter - Moving coil - Moving Iron - Extension of voltmeter and ammeter range - Electro dynamo meter type Wattmeter - Induction type Energy meter - Principle of operation, construction, Torque equation, types, testing and Calibration using direct and phantom loading - Measurement of active and reactive powers in balanced and unbalanced systems - Instrument Transformers - Construction, phasor diagrams, testing, application of measuring CT and VT - Magnetic measurements – Determination of B-H curve and measurements of iron loss.

MODULE III - DIGITAL INSTRUMENTS 9 Hours

Digital Volt Meter and its design - Voltage ratio measurement techniques - Digital ohmmeter, capacitance meter - impedance meters (Polar and Cartesian types) - Decibel meters - Q meter - tan-delta meter - Modulation index meter - Sampling theory and its applications in current, voltage, power, energy measurements - Signal analyzers: wave, network, harmonic distortion, spectrum and logic analyzers - Digital Frequency Meter - Measurement of Frequency - Study of Phasor Measurement Units (PMU).

MODULE IV - BRIDGES AND DISPLAY DEVICES **9 Hours**

Bridges: Measurement of low and high resistances – D.C potentiometer - Wheat stone, Kelvin and Kelvin Double bridge - A.C bridges for measurement of L and C - General principles, sensitivity analysis, Maxwell, Anderson bridge, Hay, Owens and Heavy side Campbell bridges for inductance; Maxwell, De Sauty and Wein bridges for capacitance - Measurement of earth resistance - localization of cable faults by Murray and Varley loop test - Methods of reducing bridge errors - Wagner Earthing Device. Display Devices: CRT display, analog and digital CRO, LED, and LCD.

MODULE V - TRANSDUCERS **9 Hours**

Transducers - Definition and classification - Linear Displacement: Resistive Potentiometers, stain gauge, LVDT, Capacitive Piezoelectric - Rotational Displacement: magnetic, stroboscope, gyroscope – Force: Strain gauge – Torque: Magneto stricitive, strain gauge – Position: synchro Transmitter and receiver – speed: Magnetic and photo electric pickup transducer - Pressure: Manometers, Bourdon – Temperature: Thermistors, thermocouple – Flow: Electromagnetic, Ultrasonic – Level: DP cell, Ultrasonic – Density: Hydrometer - Voltage, current and power: Hall Effect transducer

Total No of Hours: 45

Text Books:

1. A.K. Sawhney, "A Course in Electrical & Electronic Measurements and Instrumentation", Dhanpat Rai and Co., New Delhi, 19th Edition, 2015.

2. J. B. Gupta, "A Course in Electronic and Electrical Measurements", S. K. Kataria & Sons, Delhi, 12th Edition, 2009.

3. E. O. Doebelin and D. N. Manik, "Measurement Systems – Applications and Design", Tata McGraw Hill Education Pvt. Ltd., Special Indian Edition, 2007.

Reference Books:

1. David Bell, "Electronic Instrumentation and Measurements", Oxford University Press, 1st Edition, 2013.

2. H.S. Kalsi, "Electronic Instrumentation", Tata McGraw Hill Education, 4th Edition, 2019.

Course Outcomes:

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

- Acquire knowledge on the characteristics of measuring instruments and their classification.
- Conversant in construction, working of A.C / D.C meters and their proficient use.
- Acquire knowledge in various methods of digital meters and its measurement.
- Acquire knowledge on construction and working principle of various types of display devices and bridge comparison methods for R, L and C measurement.
- Demonstrate the various types of transducers used for physical measurements

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EEPCCT-317	Power Electronics	3L:0T:0P	3 Credits

Course Objectives:

This course will enable students to

- *To explain about the operations, switching characteristics of power semiconductor devices*
- *To study the operations and performance parameters of controlled Rectifiers.*
- *To analyze the operation and performance of dc to dc converters.*
- *To impart knowledge on different control techniques for inverters.*
- *To familiarize the principle of operation of AC voltage controllers and cyclo converters*

MODULE I - POWER SEMICONDUCTOR DEVICES 9 Hours

Study of switching characteristics of MOSFET, IGBT and SCR. Turn on and Turn off methods of SCR – Protection circuits – Triggering circuits.

MODULE II - PHASE CONTROLLED CONVERTERS 9 Hours

Operation and analysis of single and three phase controlled rectifiers – half and fully controlled Converters with R, RL and RLE loads – Effect of source inductance on controlled rectifiers – Power factor and harmonic improvement methods - series converter, twelve pulse converter, Dual converter-circulating and non-circulating current mode.

MODULEIII - DC TO DC CONVERTERS 9 Hours

Principles of step down and step up chopper – Class A, B, C, D and E chopper, Multi-phase chopper, principle of operation of buck, boost and buck boost regulators – switching schemes.

MODULE IV - INVERTERS 9 Hours

Single phase and three phase voltage source inverters – Voltage and harmonic control techniques – Capacitor commutated current source inverter and auto sequential current source inverter.

MODULE V - AC CHOPPER AND CYCLO CONVERETERS 9 Hours

Single phase and Three-phase AC voltage controllers – Control strategy – Single phase step-up/step-down midpoint type and bridge type cyclo-converters – Three phase cyclo-converters Applications – regulated power supply, UPS, solid-state motor starter.

Total No. of Hours: 45

Textbooks:

1. Ned Mohan, M. Underland, William P. Robbins, "Power Electronics Converters, applications and design", JohnWiley & sons, Singapore, 2001.
2. M.H. Rashid, "Power Electronics: Circuits, Devices and Applications", Pearson Education, New Delhi, 4th Edition, 2017.
3. M. D. Singh, K. B. Khanchandani, "Power Electronics", Tata McGraw Hill, New Delhi, 2007.

Reference Books:

1. P. S. Bimbhra, "Power Electronics", Khanna Publishers, New Delhi, 6th Edition, 2018.
2. Cyril W. Lander, "Power Electronics", McGraw Hill Book Company, Singapore, 1993

Course Outcomes:

On successful completion of this course, the students will be able to,

- Discriminate the switching characteristics of power devices and to use for power conversion.
- Inspect the performance of control rectifiers in continuous and discontinuous modes.
- Acquire knowledge on operation and analysis of DC to DC converters.
- Outline the operating principles of various types of inverters.
- Gain knowledge on the operation of AC to AC converters and its applications

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EEPECT -318	Electrical Machine Design	3L:0T:0P	3 Credits

Course Objectives:

To impart knowledge about the following topics

- *Magnetic circuit parameters and thermal rating of various types of electrical machines.*
- *Armature and field systems for DC machines.*
- *Core, yoke, windings and cooling systems of transformers.*
- *Design of stator and rotor of induction machines and synchronous machines.*
- *The importance of computer aided design method*.

MODULE I - DESIGN OF FIELD SYSTEM AND ARMATURE 9 Hours

Major considerations in Electrical Machine Design – Materials for Electrical apparatus – Design of Magnetic circuits – Magnetising current – Flux leakage – Leakage in Armature. Design of lap winding and wave winding.

MODULE II - DESIGN OF DC MACHINES 9 Hours

Construction - Output Equations – Main Dimensions – Choice of specific loadings – Selection of number of poles – Design of Armature – Design of commutator and brushes – design of field Computer program: Design of Armature main dimensions

MODULE III - DESIGN OF TRANSFORMERS 9 Hours

Construction - KVA output for single and three phase transformers – Overall dimensions – design of yoke, core and winding for core and shell type transformers – Estimation of No load current – Temperature rise in Transformers – Design of Tank and cooling tubes of Transformers. Computer program: Complete Design of single phase core transformer

MODULE IV - DESIGN OF INDUCTION MOTORS 9 Hours

Construction - Output equation of Induction motor – Main dimensions – choice of specific loadings – Design of squirrel cage rotor and wound rotor –Magnetic leakage calculations – Operating characteristics : Magnetizing current - Short circuit current – Circle diagram - Computer program: Design of slip-ring rotor

MODULE V - DESIGN OF SYNCHRONOUS MACHINES 9 Hours

Output equations – choice of specific loadings – Design of salient pole machines – Short circuit ratio – Armature design – Estimation of air gap length – Design of rotor –Design of damper winding – Determination of full load field MMF – Design of field winding – Design of turbo alternators –Computer program: Design of Stator main dimensions-Brushless DC Machines

Total No of Hours: 45

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TEXT BOOKS:

1. Sawhney, A.K., 'A Course in Electrical Machine Design', Dhanpat Rai& Sons, New Delhi, 5th Edition, 1984.

2. M V Deshpande 'Design and Testing of Electrical Machines' PHI learning Pvt Lt, 2011.

3. Sen, S.K., 'Principles of Electrical Machine Designs with Computer Programmes', Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi, 2nd Edition, 2009.

REFERENCES

1. A.Shanmugasundaram,G.Gangadharan, R.Palani 'Electrical Machine Design Data Book', New Age International Pvt. Ltd., Reprint 2007.

2. V Rajini, V.S Nagarajan, 'Electrical Machine Design', Pearson, 2017.

Course outcomes:

- Design the machines with proper thermal rating and insulation requirements.
- Analyze and evaluate the various design parameters of a DC machine for variable speed motor applications in industry.
- Analyze the various parameters of transformer and to design distribution and power transformers for real time applications.
- Analyze and formulate the suitable design for three phase induction motor
- Apply the design concepts of Synchronous machines and BLDC motors

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EEPECT -319	Utilization of Electrical Energy	3L:0T:0P	3Credits

Course Objectives

- *To design optimized illumination system for domestic and industrial applications.*
- *To acquire knowledge about the different types of heating and welding.*
- *To make awareness in the usage of refrigeration and air conditioning system.*
- *To familiarize with the construction and working of traction systems.*
- *To impart the knowledge on electroplating techniques and operations of batteries.*

MODULE I- ILLUMINATION 9 Hours

Introduction – basic terminologies – laws of illumination – polar curves – Rousseau's construction – electrical lamps – Basic principles of light control – Types – Design of lighting – illumination calculation (for residential, industrial, commercial, health care, street lightings, sports, administrative complexes) – bureau of energy efficiency star rating for lamps.

MODULE II - ELECTRIC HEATING AND WELDING 9 Hours

Role of electric heating for industrial applications – Types of Heating – Resistance – Induction - Arc furnace – Dielectric - solar – heating of building, domestic water heater, Electric oven. Welding methods – Resistance – Arc - Laser – Ultrasonic - Power supply equipment's for welding.

MODULE III - REFRIGERATION AND AIR CONDITIONING 9 Hours

Electrical Circuit of Refrigerator – Trouble shooting of Refrigerator – Air conditioning types and their applications – smart air conditioning systems – Trouble shooting of air conditioning.

MODULE IV- ELECTRIC TRACTION 9 Hours

Traction system – Power supply – Traction drives – braking – Tractive effort calculations – speed-time characteristics. Locomotives and train – Tram ways and Trolley bus – Recent trends – Metro and Mono rail systems.

MODULE V - ELECTROLYSIS AND DOMESTIC APPLIANCES 9 Hours

Electrolysis- Laws of Electrolysis, power supply, Efficiency – Electro Plating. Batteries-Types – Components, rating of batteries – Methods of charging and maintenance. Domestic appliances: Electric iron, Electric toaster – Introduction to Green Building Concept and energy auditing.

Total no. of Hours: 45

Text Books:

1. J. B. Gupta, "Utilization of Electrical Power and Traction", Kataria Publications, Reprint Edition, 2020
2. R. K. Rajput, "Utilization of Electrical Power", Lakshmi publications, 2nd Edition, 2016.
3. E. Openhshaw Taylor and V. V. L. Rao, "Utilization of Electric Energy", Orient Longman, New Delhi, 2nd Edition, 2007.

Reference Books:

1. S. K. Sahdev, "Utilization of electrical energy and electric traction", New Age International Publisher, 1st Edition, 2016.
2. H. Partap, "Art and Science of Utilization of Electrical Energy", Dhanpat Rai and Sons, Delhi, 2nd Edition, 2015.

Course Outcomes:

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

- Develop a clear idea on lighting requirement for domestic and industrial needs in an efficient way
- Analyze the different types of heating and welding schemes used in the industries
- Repair the minor faults that occurs in refrigerator and in air conditioning system
- Analyze the speed-time characteristics and performance of the electric traction.
- Calculate the power requirement and efficiency of domestic appliances

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EEPCCT-320	LINEAR INTEGRATED CIRCUITS	3L:0T:0P	3 Credits

Course Objectives

- *To introduce IC fabrication process and basic building blocks of linear integrated circuits.*
- *To familiarize the AC and DC characteristics of OP AMP 741 and its basic application circuits.*
- *To outline the design procedure of active filters and waveform generation using operational amplifiers.*
- *To illustrate the design procedure of various Regulator ICs for power supply circuits.*
- *To impart knowledge on the fundamental blocks and applications of special ICs like 555 and 565 ICs.*

MODULE I - IC FABRICATION **9 Hours**

IC classification – Fundamental of monolithic IC technology – Epitaxial growth, masking and etching, diffusion of impurities – Realization of monolithic ICs and packaging: Fabrication of resistance, diode, capacitance and PV cells –BJT – FET – CMOS technology.

MODULE II - OPERATIONAL AMPLIFIERS AND APPLICATIONS 9 Hours

OP-AMP equivalent circuit – AC and DC characteristics – Open and closed loop configuration – Properties of practical op-amps (LM741, LM124, OP07, TL082) – Applications –Inverting and Non Inverting amplifier-Summer and Subtractor –Differentiator and Integrator - Instrumentation amplifier – Clipper and Clamper – D/A converters– A/D converter – TLC0820 and TLC7524 ICs– S/H circuit.

MODULE III - ACTIVE FILTERS AND WAVEFORM GENERATOR USING OP AMP

9 Hours

I and II order Active filter – Low pass, high pass, wide band pass and band stop Butterworth filters –Narrow band pass and notch filters – State variable filter – Switched capacitor filter – Waveform generator : Triangular and saw tooth wave generator – Effect of Slew Rate on waveform generation – Schmitt trigger and Multivibrators - RC Phase shift and Wien bridge oscillators – Applications

MODULE IV - ANALOG IC APPLICATIONS **9 Hours**

Series op-amp regulator – IC voltage regulators: LM78XX, LM79XX Dual tracking regulators – Adjustable voltage regulators: LM117, LM317 – Switching regulator – SMPS – LM2524 – V/F converter – F/V converter – MPY634 Analog Multiplier– AGC and AVC– INA121 Instrumentation Amplifier – LM 380 Power amplifier – IC LM311 Comparator

MODULE V - PHASE LOCKED LOOP AND TIMER **9 Hours**

PLL: 74HCT7046 – phase comparator – PLL Applications: Frequency synthesis, Motor speed control.

IC555 timer – Functional diagram – Multivibrators – Schmitt trigger – Missing pulse detector, Frequency counter – Dual timer SN74AH – CD4093 ICs.

Total no. of Hours: 45

Text Books

1. Ramakant A. Gayakward, "Op-amps and Linear Integrated Circuits", Pearson Education, 5th Edition, 2015.
2. J. Michael Jacob, "Applications and Design with Analog Integrated Circuits", Prentice Hall of India, New Delhi, 2nd Edition, 2010.
3. Sergio Franco, "Design with Operational Amplifiers and Analog Integrated Circuits", McGraw Hill, 1st Edition, 2018.

Reference books

1. Muhammad H. Rashid, "Microelectronic Circuits: Analysis and Design", Cengage learning Inc, 2nd Edition, 2011.
2. Roy Choudhary, Sheil. B. Jani, "Linear Integrated Circuits", New Age Publication, 5th Edition, 2018.

Course Outcomes:

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

- Describe the IC fabrication process for any circuits.
- Design and analyze OP AMP based circuits for different applications like A/D and D/A conversion.
- Design filters and waveform generators using OP AMP.
- Design regulators for power supply circuits.
- Design multi-vibrators using 555 timer and demodulators using 565 PLL

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EEPCCT-321	Measurements and Control Lab	0L:0T:2P	1 Credit

(A minimum of TEN experiments to be conducted in the following Topics)

Course Objectives:

- *To give the students an insight into the constructional details of various measuring instruments for better understanding of their working principles.*
- *To demonstrate various Bridges for the measurement of resistance, inductance and capacitance using simulation and hardware set ups.*
- *To understand the concept of magnetism and to determine the B-H curve for magnetic material specimen.*
- *To provide the procedure to calibrate an energy meter.*
- *To analyze modelling parameters of electrical machines*

List of Experiments:

1. Measurement of electrical parameters using bridges (resistance/ inductance/ capacitance/ high/ medium/ low).
2. Verification of network theorems (Simulation/Practical method).
3. Extension range of voltmeter and ammeter
4. Calibration of energy meter.
5. Measurements on supply systems (frequency/phase/phase sequence).
6. Measurement Magnetic (Flux density (B)/Field intensity (H)/B-H loop/Magnetic Losses).
7. Operation amplifier application to M&I (Instrumentation amplifier/ Signal converter with grounded and floating loads).
8. Measurement parameters to model the electrical machines using the transfer-function method.
9. Measurement of open loop response of the electrical machine using its transfer-function using simulation.
10. Verification of various exercises and plots in control system using simulation.
11. Stability analysis of a system using simulation

Course Outcomes

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

- Realize the advantages and the necessity of measurement systems in all Engineering and Scientific works.
- Measure Resistance, Inductance and capacitance using AC and DC bridges.
- Determine the magnetization characteristics and hysteresis loss of Iron specimen using BH curve.
- Calibrate single phase and three phase energy meters used in domestic and commercial applications.
- Simulate modelling parameters of electrical machines

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EEPCCT-322	Power Electronics Laboratory	0L:0T:2P	1 Credit

(A minimum of TEN experiments to be conducted in the following Topics)

Course Objectives:

This course will enable students to:

- *To introduce the concepts involved in power semiconductor devices and its characteristics and to understand the basics of triggering circuits.*
- *To analyze the basic Power electronic circuit topologies including AC-DC, DC-DC, DC-AC and AC-AC converters.*
- *To enable the students to do simulation of Converter circuits and experimentally verify the results.*
- *To study and analyze the operation of the DC and AC drives.*
- *To introduce the industrial control of power electronic circuits as well as safe electrical connection and measurement practices.*

List of Experiments:

1. Characteristics of SCR, TRIAC and IGBT.
2. Single phase half and fully controlled converter
3. Three phase half and fully controlled converter.
4. Step Down Chopper, Step up Chopper and Multi-quadrant Chopper
5. Single phase AC voltage controller
6. Single phase step up and step down cyclo-converter
7. Single phase and three phase IGBT based PWM inverter
8. Converter/ Chopper fed DC motor.
9. Speed control of Inverter fed Induction motor.
10. Microcontroller based control schemes for Stepper Motor.
11. Study of microcontroller based BLDC Motor Drive.
12. Study of voltage regulation of DC buck converter.

Course Outcomes:

After completion of this course, students will be able to

- Understand the operation of power electronic devices and its applications.
- Analyze the I-V characteristics of SCR, DIAC and TRIAC.
- Analyze the characteristics of IGBT and UJT.
- Illustrate the functioning of rectifiers and firing circuits.
- Distinguish the speed control of DC motor using converters.

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EEPCCT-323	Integrated Circuits Laboratory	0L:0T:2P	1 Credit

(A minimum of TEN experiments to be conducted in the following Topics)

Course Objectives:

- *To learn design, testing and characterizing of circuit behavior with analog ICs.*
- *To familiarize the AC and DC characteristics of OPAMP 741.*
- *To outline the design procedure of the different applications of OPAMP 741.*
- *To introduce the design of filters and waveform generators using OPAMP 741.*
- *To impart knowledge on the design and realization of multivibrator circuits using 555 Timer.*

List of Experiments

1. Obtain various characteristic parameters of IC 741
2. Design and analysis of Inverting, non-inverting amplifiers, Voltage follower, Adder and subtractor using OPAMP 741
3. Design and analysis of Integrator, Differentiator, Log and Antilog amplifier using OPAMP 741.
4. Design and analysis of comparator circuits (PWM and SPWM) and instrumentation amplifier using OPAMP 741.
5. a. Design and analysis of D/A and A/D converters using OPAMP 741.

b. Verification of A/D converters and D/A converters using TLC0820 and TLC7524

6. Design and analysis of Schmitt trigger

Design and analysis of filter circuit (I order and II order) using OPAMP 741.

7. Design and analysis of Wein-bridge and RC phase shift oscillator.
8. Design and verification of waveform generator using OPAMP 741
9. a. Design and analysis of voltage regulators using IC 78XX/79XX and variable voltage regulator using IC LM317.

   b. Design and verification of power source using LM2524 IC.
10. a. Design and analysis of Monostable and Astable multivibrator using IC555.

    b. Design and verification of Monostable and Astable, multivibrator using IC
11. Implementation of Frequency system using IC 565

Course Outcomes

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

- Design and use the OPAMP for various applications.
- Design the application circuits like A/D, D/A filters using OPAMP and special ICs.
- Design and test various waveform generation circuits using OPAMPS and special ICs.
- Design and test regulator circuits for power supplies using voltage regulator ICs.
- Verify and demonstrate V/F, frequency multiplier and SMPS.

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AU - 305	Professional Ethics	1L:0T:0P	0 Credit

Course Objectives*:*

- *To enable the students to create an awareness on Engineering Ethics and Human Values,*
- *To in still Moral and Social Values and Loyalty and to appreciate the rights of others.*

MODULE I - HUMAN VALUES **3 Hours**

Morals, values and Ethics – Integrity – Work ethic – Service learning – Civic virtue – Respect for others – Living peacefully – Caring – Sharing – Honesty – Courage – Valuing time – Cooperation – Commitment – Empathy – Self-confidence – Character – Spirituality – Introduction to Yoga and meditation for professional excellence and stress management.

MODULE II - ENGINEERING ETHICS **3 Hours**

Senses of 'Engineering Ethics' – Variety of moral issues – Types of inquiry – Moral dilemmas – Moral Autonomy – Kohlberg's theory – Gilligan's theory – Consensus and Controversy – Models of professional roles - Theories about right action – Self-interest – Customs and Religion – Uses of Ethical Theories.

MODULE III - ENGINEERING AS SOCIAL EXPERIMENTATION **3 Hours**

Engineering as Experimentation – Engineers as responsible Experimenters – Codes of Ethics –A Balanced Outlook on Law.

MODULE IV - SAFETY, RESPONSIBILITIES AND RIGHTS **3 Hours**

Safety and Risk – Assessment of Safety and Risk – Risk Benefit Analysis and Reducing Risk - Respect for Authority – Collective Bargaining – Confidentiality – Conflicts of Interest – Occupational Crime – Professional Rights – Employee Rights – Intellectual Property Rights (IPR) – Discrimination.

MODULE V - GLOBAL ISSUES **3Hours**

Multinational Corporations – Environmental Ethics – Computer Ethics – Weapons Development – Engineers as Managers – Consulting Engineers – Engineers as Expert Witnesses and Advisors – Moral Leadership –Code of Conduct – Corporate Social Responsibility.

Total no of Hours: 15

Text books:

1. Mike W. Martin and Roland Schinzinger, “Ethics in Engineering”, Tata McGraw Hill, New Delhi, 2003.
2. Govindarajan M, Natarajan S, Senthil Kumar V. S, “Engineering Ethics”, Prentice Hall of India, New Delhi, 2004.
3. Charles B. Fleddermann, “Engineering Ethics”, Pearson Prentice Hall, New Jersey, 2004.

References Books:

1. Charles E. Harris, Michael S. Pritchard and Michael J. Rabins, “Engineering Ethics – Concepts and Cases”, Cengage Learning, 2009.
2. John R Boatright, “Ethics and the Conduct of Business”, Pearson Education, New Delhi, 2003

Course Outcomes:

- Upon completion of the course, the student should be ability to apply ethics in society,
- Discuss the ethical issues related to engineering and realize the responsibilities and rights in the society.

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SEMESTER – VI

EEPCCT-424	Power System Analysis	2L:1T:0P	3 Credits

Course objectives:

- *To create computational models for power system using per unit analysis.*
- *To perform load flow analysis using Gauss Seidal and Newton-Raphson methods.*
- *To analyze the sequence network using symmetrical components.*
- *To import the knowledge about symmetrical and unsymmetrical faults in power system.*
- *To model and analyze stability problems in power system.*

MODULE I - POWER SYSTEM 9 Hours

Need for system planning and operational studies - Power scenario in India - Power system components – Representation - Single line diagram - per unit quantities - p.u. impedance diagram - p.u. reactance diagram - Network graph, Bus incidence matrix, Primitive parameters, Bus admittance matrix from primitive parameters - Representation of off nominal transformer - Formation of bus admittance matrix of large power network– Reduction techniques on network matrices for network changes - Z bus Building algorithm.

MODULE II - POWER FLOW STUDIES 9 Hours

Classification of buses - formulation of load flow problem - Load flow solution by Gauss - Seidal, Newton -Raphson and Fast Decoupled Load Flow (FDLF) Analysis - Comparison - Computation of slack bus power, transmission loss and line flow - Voltage Control Methods - Tap-changing and phase - shifting transformers

MODULE III - SYMMETRICAL COMPONENTS AND SEQUENCE NETWORKS 9 Hours

Symmetrical components – Simple problems to calculate symmetrical voltages and currents – Sequence networks- positive, negative and zero sequence networks - Sequence networks of Series impedance, loads and Rotating machines – Advantages and Limitations.

MODULE IV - UNSYMMETRICAL FAULT ANALYSIS 9 Hours

Symmetrical components - Sequence impedances - Sequence networks - Analysis of Unsymmetrical faults at generator terminals: LG, LL and LLG - unsymmetrical fault occurring at any point in a power system - computation of post fault currents in symmetrical component and phasor domains.

MODULE V - STABILITY ANALYSIS **9 Hours**

Definition - Importance of stability analysis- classifications - Steady state and transient stability - Angle and voltage stability - Single Machine Infinite Bus (SMIB) system - swing equation – Swing Curve – Numerical integration methods - Equal area criterion - Critical clearing angle and time - Factors affecting stability -Methods of improving transient stability - Contingency selection and ranking for the power system**.**

Total No of Hours- 45

Text Books:

1. John J. Grainger, William D. Stevenson, Jr, 'Power System Analysis', Mc Graw Hill Education (India) Private Limited, New Delhi, 2015.

2. Kothari D.P. and Nagrath I.J., 'Power System Engineering', Tata McGraw-Hill Education, 2nd Edition, 2008.

3. Hadi Saadat, 'Power System Analysis', Tata McGraw Hill Education Pvt. Ltd., New Delhi, 21st reprint, 2010.

Reference Books:

1. Pai M A, 'Computer Techniques in Power System Analysis', Tata Mc Graw-Hill Publishing Company Ltd., New Delhi, 2nd , 2007.

2. J. Duncan Glover, MulukutlaS.Sarma, Thomas J. Overbye, 'Power System Analysis & Design', Cengage Learning, 5th , 2012.

Course Outcomes:

- Ability to model the power system under steady state operating condition
- Ability to understand and apply iterative techniques for power flow analysis
- Ability to model and carry out short circuit studies on power system
- Ability to acquire knowledge on Fault analysis.
- Ability to model and analyze stability problems in power system

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EEPCCP- 425	Microprocessors and Microcontrollers	3L:0T:0P	3Credits

Course Objectives*:*

This course will enable students to

- *To get familiar with basic architecture and programming techniques of microprocessor 8085.*
- *To learn interfacing of memory and data transfer techniques using microcontroller.*
- *To understand the interfacing of input/output devices required for real time applications.*
- *To introduce the basic concepts of embedded system design using microcontroller.*
- *To equip the student with ability to design PWM control for various applications such as AC-DC, DC-DC converter, etc.*

MODULE I - ARCHITECTURE AND PROGRAMMING OF 8085 MICROPROCESSOR

9 Hours

8085 Microprocessor: Architecture, Addressing modes, Instruction set, Need for Assembly language – Development of Assembly language programs – Machine cycles and Timing diagrams, Programming and Interfacing. Application: Interfacing of stepper motor control with 8085 microprocessor.

MODULE II- INTRODUCTION TO MICROCONTROLLERS 9 Hours

Microprocessor and Microcontroller difference, RISC and CISC programmer's model, Criteria for selecting microcontroller. Overview of PIC family, PIC Microcontroller architecture, status register, Special function registers, Memory units, On-Chip peripherals, PIC16F877A and PIC24F pin configuration, Fuse bits of PIC – Case study on traffic light control using PIC Microcontroller.

MODULE III- PROGRAMMING FOR MICROCONTROLLERS 9 Hours

Data types and assembler directives, Addressing modes, Data transfer, Arithmetic, Logic and Compare, Rotate and Shift, Branch and Call instructions, MPLABX setup for assembly language programming, PIC24F I/O Port Programming, Time delay loop, Look-up table, Bit

addressability, MACROs, Intel HEX file. Timer programming, Input capture and Wave Generator, PWM programming External Interrupt programming, ADC programming, EEPROM programming – Program using PIC24F Timer to generate waveforms.

MODULE IV - SERIAL COMMUNICATION PROTOCOLS AND PERIPHERAL INTERFACING **9 Hours**

Serial communication protocols: Introduction to UART protocol, I2C protocol and its Programming, SPI protocol and its Programming, Serial Port programming using polling and interrupt. Peripheral interfacing and its programming : LCD and Keyboard Interfacing, Relay interfacing, Stepper and DC Motor control, RTC Interfacing, LM35 Temperature sensor interfacing, MAX7219 display controller interfacing – Program using PIC24F microcontroller for interfacing ultrasonic sensors.

MODULE V - ADVANCED MICROCONTROLLER **9 Hours**

dsPIC33EV: Block diagram, Clock Distribution System, interrupt, Timer, PWMX control registers, high-speed PWMX module register- interconnection diagram, ADC-signal processing and conditioning.

Total No. of Hours: 45

Text Books:

1. Muhammad Ali Mazidi, Sarmad Naimi and Sepehr Naimi, "PIC Microcontroller and Embedded Systems: Using Assembly and C for PIC18", Micro Digital Education, Illustrated Edition, 2017.
2. Ramesh S Gaonkar, "Microprocessor Architecture: Programming and Applications with the 8085", Prentice Hall of India, New Delhi, 5th Edition, 2011.
3. Sunil Mathur, Jeebananda Panda, "Microprocessor and microcontroller", PHI Learning Private Limited, New Delhi, 1st Edition, 2016.

Reference Books:

1. Sunil Mathur, Jeebananda Panda, "Microprocessor and Microcontroller", PHI Learning Private Limited, New Delhi, 1st Edition, 2016.

Course Outcomes:

On successful completion of this course, the students will be able to,

- Illustrate the architecture of microprocessor and to develop skills in writing assembly language program.
- Have a clear understanding of microcontroller architecture with functional details of each pin.
- Write and debug Assembly and C programs for 8 bit Microcontroller.
- Interface input/output peripheral devices and to implement the advanced communication protocol like I2C and SPI using PIC Microcontroller.
- Design and develop microcontroller based real-time applications.

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EEPECT -426	Solid State Drives	3L:0T:0P	3Credits

Course Objectives:

To impart knowledge on the following Topics

• Steady state operation and transient dynamics of a motor load system.

• Analyze the operation of the converter/chopper fed dc drive, both qualitatively and quantitatively.

• Operation and performance of AC motor drives.

• Analyze and design the current and speed controllers for a closed loop solid state DC motor drive.

MODULE I - DRIVE CHARACTERISTICS 9 Hours

Electric drive – Equations governing motor load dynamics – steady state stability – multi quadrant Dynamics: acceleration, deceleration, starting & stopping – typical load torque characteristics – Selection of motor.

MODULE II - CONVERTER / CHOPPER FED DC MOTOR DRIVE 9 Hours

Steady state analysis of the single and three phase converter fed separately excited DC motor drive– continuous conduction – Time ratio and current limit control – 4 quadrant operation of converter / chopper fed drive-Applications.

MODULE III -INDUCTION MOTOR DRIVES 9 Hours

Stator voltage control–V/f control– Rotor Resistance control-qualitative treatment of slip power recovery drives-closed loop control— vector control- Applications.

MODULE IV -SYNCHRONOUS MOTOR DRIVES 9 Hours

V/f control and self-control of synchronous motor: Margin angle control and power factor control-Three phase voltage/current source fed synchronous motor- Applications.

MODULE V - DESIGN OF CONTROLLERS FOR DRIVES 9 Hours

Transfer function for DC motor / load and converter – closed loop control with Current and speed feedback–armature voltage control and field weakening mode – Design of controllers; current controller and speed controller- converter selection and characteristics.

Text Books:

1. Gopal K.Dubey, Fundamentals of Electrical Drives, Narosa Publishing House, 2nd Edition, 2001.
2. Bimal K.Bose. Modern Power Electronics and AC Drives, Pearson Education, 2002.
3. Vedam Subramanyam, “Electric Drives Concepts and Applications”, 2nd Edition, McGraw Hill, 2016

Reference Books:

1. M.H.Rashid, "Power Electronic Circuits, Devices and Applications", Prentice Hall International, 2007.
2. R.Krishnan, Electric Motor & Drives: Modeling, Analysis and Control, Pearson, 2001.

Course Outcomes:

Upon completion of this course, the student able will able to

- Learns the fundamental concepts of power electronic converter fed DC and AC machines
- Can analyze the converter fed motor under different torque/speed conditions.
- Will be able to design converter fed drives with existing/new control techniques.

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EEPCCP- 427	Microprocessors and Microcontrollers Laboratory	0L:0T:2P	1Credit

(A minimum of TEN experiments to be conducted in the following Topics)

Course Objectives:

- *To become familiar with architecture and instruction set for 8085.*
- *To provide hands-on training of interfacing external sensors and actuators with microcontroller*
- *To impart knowledge for on-chip peripheral programs*
- *To impart knowledge to generate pulses for electrical applications.*
- *To impart knowledge to do minor projects using microcontroller for solving real world engineering problems*

List of Experiments

Microprocessor Experiments using 8085:

1. 8 bit - Addition, Subtraction, Multiplication and Division
2. Assembly Language Programming: Subroutines, parameter passing to subroutines

Microcontroller Experiments using PIC:

3. PIC Assembly language- Programming using the PIC Instruction Set.
4. a) PIC Timer to generate accurate delay using polling and interrupt
   b) PIC Timer to generate waveforms
   c) Seven Segment Display interfacing with PIC
5. a) 16x2 LCD interfacing with PIC
   b) 4x4 matrix keyboard interfacing with PIC
6. PIC USART programming
7. PIC on-chip ADC for interfacing analog sensors

Application of Microcontroller using PIC:

8. Experimentation of DC Motor Interfacing and Speed/Direction Control
9. Stepper motor interfacing
10. DS1307 RTC Interfacing
11. MAX7219 LED matrix driver interfacing
12. Interface to peripherals and use of the I^2C bus
13. Design of zero crossing detector
14. Design Frequency Counter which displays frequency of unknown pulse on 16x2 LCD
15. Design Bluetooth controlled 2-ch variable frequency square wave generator

Course Outcomes:

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

- Develop assembly language program for microprocessor 8085.
- Analyze various platforms for programming by knowing the complete hardware configurations.
- Analyze abstract problems and apply a combination of hardware and software to address the problem.
- Design a control algorithm for various applications using microcontrollers.
- Design and generate pulses for real time electrical applications.

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EEPCCP- 428	Power Systems Simulation Laboratory	0L:0T:2P	1Credit

(A minimum of TEN experiments to be conducted in the following Topics)

Course Objectives:

- *To analyze the electrical power system using per unit analysis.*
- *To apply iterative techniques for power flow analysis of power system.*
- *To carry out short circuit studies and Economic load dispatch on power system.*
- *To analyze Load curve and Load duration curve.*
- *To model and analyze the voltage and frequency control loops in power system*.

List of Experiments

1. Computation of power system components in per units.
2. Modeling and Computation of Transmission Line Parameters
3. Formulation of a bus impedance matrix and admittance Matrix
4. Symmetrical components for different case studies
5. Short circuit studies of Power System.
6. Analysis of power-flow problem using Gauss-Seidel method.
7. Analysis of power-flow problem using Newton Raphson method.
8. Analysis of Economic load dispatch in power system.
9. Load curve and load duration curve
10. Numerical Integration of Swing equation
11. Modeling and Analysis of Load frequency control
12. Modeling and Analysis of Automatic Voltage Regulator system

Course Outcomes:

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

- Calculate the reactance values of power system components
- Formulate Bus Admittance and Impedance matrices, used in power flow analysis.
- Analyze the voltage and power flow condition of power system using Gauss Seidal and Newton Raphson methods.
- Analyze Symmetrical and Unsymmetrical faults in power system used to design relays and circuit breakers.
- Develop the load and load duration curves for calculating average load, unit generated load factor, etc.

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PRJ EE- 302	MINI PROJECT	0L:0T:6P	3 Credits

Course Objectives:

- *To develop their own innovative prototype of ideas.*
- *To train the students in preparing mini project reports and examination.*

The students in a group of 5 to 6 works on a topic approved by the head of the department and prepares a comprehensive mini project report after completing the work to the satisfaction. The progress of the project is evaluated based on a minimum of two reviews. The review committee may be constituted by the Head of the Department. A mini project report is required at the end of the semester. The mini project work is evaluated based on oral presentation and the mini project report jointly by external and internal examiners constituted by the Head of the Department.

Total no of Hours: 45

Course Outcomes:

• On Completion of the mini project work students will be in a position to take up their final year project work and find solution by formulating proper methodology.

VII SEMESTER

EET-426	POWER SYSTEM OPERATION AND CONTROL	3L:0T:0P	3 Credits

Course Objectives:

- *To understand the economics of power system operation and planning.*
- *To realize the requirements and methods of real and reactive power control in power system*
- *To recognize the recent advancements in power system operation.*

MODULE I - INTRODUCTION **9 Hours**

Introduction - Causes and effect of variable load on power stations, load curves and basic concepts of load dispatch - load forecasting. Necessity of voltage and frequency regulation– Factors affecting system security – Operating states of power system, P-f and Q-V loops – Need for voltage and frequency regulation in power system - Energy control center Functions.

MODULE II - REAL POWER CONTROL **9 Hours**

Load Frequency Control (LFC) of single area system- Automatic Generation Control (AGC) - AGC in single and multi-area system- Tie-line bias control system. Generation and absorption of reactive power - basics of reactive power control – Automatic Voltage Regulator.

MODULE III - REACTIVE POWER CONTROL **9 Hours**

Reactive power control – Generation and absorption of reactive power – Typical excitation system – Modeling – Static and dynamic analysis – Stability compensation – Generation and absorption of reactive power, Methods of voltage control: shunt reactors – Shunt capacitors – Series Capacitors – Synchronous condensers – Static VAR systems – Tap-changing transformer.

MODULE IV - LOAD FORECASTING AND UNIT COMMITMENT **9 Hours**

Load forecasting – Components of system load – Forecasting of the base load by method of least square fit - Unit Commitment – Constraints: spinning reserve – Thermal unit constraints – Hydro constraints – Fuel constraints and other constraints – methods.

MODULE V - ROLE OF COMPUTERS IN POWER SYSTEM **9 Hours**

Need of computer control of power systems-concept of energy control centres and functions– PMU, SCADA, EMS, WAMS- various operating states - state transition diagram- state estimation; Reliability: Indices - methods - unavailability.

Total No of Hours: 45

Course Outcomes:

At the end of the course the student will be able to

- Explain the effect of variable load on power system and load forecasting.
- Determine power system operation schedule.
- Design and analyze LFC and AGC loops.
- Recognize the role of computers in power system

Text Books:

1. Allen J. Wood, Bruce F. Wollen berg, "Power Generation, operation and control", John Wiley and sons, 2nd Edition, 2008.

2. Abhijit Chakrabarti and Sunita Halder, "Power System Analysis Operation and Control", PHI learning Pvt. Ltd., 3rd Edition, 2010

3. Hadi Saadat, 'Power System Analysis', McGraw Hill Education Pvt. Ltd., New Delhi

Reference Books:

1. Kothari D.P. and Nagrath I.J., 'Power System Engineering', Tata McGraw-Hill Education,

2. A. K. Mahalanbias, D. P. Kothari and S. I. Ahson, "Computer Aided Power System Analysis and Control", Tata McGraw Hill, 1990

3. P.S.R. Murty, "Operation and Control in Power Systems", BS Publications, 2nd Edition, 2011.

4. Carson. W. Taylor, "Power System Voltage Stability", Taylor-McGraw Hill, 2000.

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HSMC-405	ENTREPRENEURSHIP DEVELOPMENT	3L:0T:0P	3 Credits

Course Learning Objectives:

- To enable the students to understand the concept of Entrepreneur and Entrepreneurship and relevant roles
- To enable the students to learn creativity and entrepreneurial plan including Project Feasibility and Project Appraisal
- To enable the students to understand Corporate entrepreneurship and issues related to Corporate entrepreneurship
- To enable the students to understand Family and Non-Family Entrepreneur & Women entrepreneurs and women entrepreneurs in India
- To enable the students to understand International Entrepreneurship Opportunities and Case studies on Indian Start ups

MODULE I - ENTREPRENEURSHIP 9 Hours

Definition of Entrepreneur, Internal and External Factors, Functions of an Entrepreneur, Entrepreneurial motivation and Barriers, Classification of Entrepreneurship, Theory of Entrepreneurship, Concept of Entrepreneurship, Development of entrepreneurship; Concept of entrepreneur ,Manager and Entrepreneur(differences in their roles, responsibilities and Career Opportunities)

MODULE II - CREATIVITY AND ENTREPRENEURIAL PLAN 9 Hours

The business plan as an entrepreneurial tool, Contents of a business plan, Idea Generation, Screening and Project Identification, Creative Performance, Feasibility Analysis: Economic, Marketing, Financial and Technical; Project Planning: Evaluation, Monitoring and Control segmentation. Creative Problem Solving: Heuristics, Brainstorming, Synectics, Value Analysis, Innovation. Project Feasibility and Project Appraisal.

MODULE III - CORPORATE ENTREPRENEURSHIP 9 Hours

Introduction, Flavors of corporate entrepreneurship, Corporate venturing, Intrapreneurship, organizational transformation, Industry rule bending, Need for corporate entrepreneurship, domain of corporate entrepreneurship, conditions favorable for Corporate entrepreneurship, benefits of Corporate entrepreneurship, issues related to Corporate entrepreneurship.

MODULE IV - FAMILY AND NON FAMILY ENTREPRENEUR & WOMEN ENTREPRENEURS 9 Hours

Role of Professionals, Professionalism vs family entrepreneurs, Role of Woman entrepreneur, Factors influencing women entrepreneur, Challenges for women entrepreneurs, Growth and development of women entrepreneurs in India

MODULE V -INTERNATIONAL ENTREPRENEURSHIP OPPORTUNITIES 9 Hours

The nature of international entrepreneurship, Importance of international business to the firm, International versus domestics' entrepreneurship, Stages of economic development. Institutional support for new ventures: Supporting Organizations; Incentives and facilities; Financial Institutions and Small scale Industries, Govt. Policies for SSIs. Case studies on Indian Startups.

Total No of Hours: 45

Course outcomes:

At the end of the course the student will be able to

- Understand the concept of Entrepreneur and Entrepreneurship and relevant roles
- Learn creativity and entrepreneurial plan including Project Feasibility and Project Appraisal
- Understand corporate entrepreneurship and issues related to corporate entrepreneurship
- Understand Family and Non-Family Entrepreneur & Women entrepreneurs and women entrepreneurs in India
- Understand International Entrepreneurship Opportunities and Case studies on Indian Start ups

Text Books:

1. Dynamics of Entrepreneurship Development Vasant Desai Himalaya Publication house 2011
2. Entrepreneurship, New Venture Creation David Holt Prentice Hall India 1991
3. Entrepreneurial Development S.S. Khanka Chand& Company Ltd. New Delhi 2013

Reference Books:

1. Entrepreneurship – Theory, Process and Practice Donald F Kuratko Cengage Learning 9th Edition, 2014
2. "Entrepreneurship Rajeev Roy Oxford University Press 2nd Edition, 2011

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SEM EE-28	SEMINAR	0L:0T:2P	1 Credit

Course Objectives:

- To encourage the students to study advanced engineering developments
- To prepare and present technical reports.
- To encourage the students to use various teaching aids such as over -head projectors, power point presentation and demonstrative models.

Method of Evaluation:

- During the seminar session each student is expected to prepare and present a topic on engineering/ technology, for duration of about 15 minutes.
- In a session of three periods per week, 6 to 8 students are expected to present the seminar.
- Each student is expected to present atleast twice during the semester and the student is evaluated based on that.
- At the end of the semester, he / she can submit a report on his / her topic of seminar and marks are given based on the report.
- A Faculty guide is to be allotted and he / she will guide and monitor the progress of the student and maintain attendance also.
- Evaluation is 100% internal.

Course Outcomes:

After completion of the course, the students will be able to Review, prepare and present technological developments and face the placement interviews with confidence.

INT EE-29/PRJEE-401	INTERNSHIP/ PROJECT PHASE -I	0L:0T:6P	3 Credits

- The objective of the projects is to enable the students to work in convenient group of not more than four members in a group on a project involving analytical, experimental, design combination of these related to one or more areas of Electrical & Electronics Engineering.

- Each project shall have a guide who is member of faculty of Electrical &Electronics Engineering. Six periods per week is allotted for the phase-I of the project work.

- Each group of students should complete the project literature survey, problem statement methodology with few results. The guide and departmental committee shall evaluate the student's work for 100 marks based on one project presentation and internal viva-voice.

- Industrial training or Project work is and effective way to transfer the theoretical knowledge gained within the classroom to the real field application.

- It will provide a platform for the students to get a close glimpse about the functioning of the industry and how real-life challenges are solved in the domain of Electrical Engineering giving them practical exposure.

- Thus, the Industrial training or Project work will equip them with skill-sets which is essential from the perspective of employability as well.

PRJ EE-402	PROJECT PHASE -II	0L:0T:24P	12 Credits

Course Objectives:

- To develop the skills to solve a specific problem right from its identification and literature review till the successful solution of the same.
- To develop students' innovative ideas for the prototype design.
- To encourage the students to work as a team to solve the engineering problem
- To train the students for the preparation of project reports.
- To train the students to defend reviews and viva voce examination.

Course Description:

- A Project topic must be selected either from published lists or the students themselves may propose suitable topics in consultation with their guides.

- The aim of the project work is to deepen comprehension of principles by applying them to a new problem which may be the design and manufacture of a device, a research investigation, a computer or management project or a design problem.

- The progress of the project is evaluated based on a minimum of three reviews. The review committee may be constituted by the Head of the Department.

- The End Semester Examination for the project work shall consist of an evaluation of the final project report by an external examiner, followed by a viva-voce examination conducted by a committee consisting of the external examiner and an internal examiner.
- Each team is expected to present their work at National/International conferences. Team that has come out with novel contribution will be encouraged to publish their work in any referred journals

.

Course Outcomes:

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

- Identify the problem statement for the project work through the literature survey.
- Choose the proper components as per the requirements of the design/system.
- Apply the acquainted skills to develop final model/system.
- Estimate, plan and execute the project as a team.
- Defend the finding and conclude with oral/written reports.

PROFESSIONAL ELECTIVE COURSES (PEC)

EEPECT - 101	Artificial Neural Networks	3L:0T:0P	3Credits

Course Objectives:

- *To understand the biological neural network and to model equivalent neuron models.*
- *To understand the architecture, learning algorithms*
- *To know the issues of various feed forward and feedback neural networks.*
- *To explore the Neuro dynamic models for various problems.*

MODULE I - INTRODUCTION TO NEURAL NETWORKS 9 Hours

Introduction: A Neural Network, Human Brain, Models of a Neuron, Neural Networks viewed as Directed Graphs, Network Architectures, Knowledge Representation, Artificial Intelligence and Neural Networks Learning Process: Error Correction Learning, Memory Based Learning, Hebbian Learning, Competitive, Boltzmann Learning, Credit Assignment Problem, Memory, Adaption, Statistical Nature of the Learning Process

MODULE II - ARCHITECTURE OF NEURAL NETWORKS 9 Hours

Single Layer Perceptrons: Adaptive Filtering Problem, Unconstrained Organization Techniques, Linear Least Square Filters, Least Mean Square Algorithm, Learning Curves, Learning Rate Annealing Techniques, Perceptron –Convergence Theorem, Relation Between Perceptron and Bayes Classifier for a Gaussian Environment Multilayer Perceptron: Back Propagation Algorithm XOR Problem, Heuristics, Output Representation and Decision Rule, Computer Experiment, Feature Detection

MODULE III - BASIC NEURAL NETWORK TECHNIQUES 9 Hours

Back Propagation: Back Propagation and Differentiation, Hessian Matrix, Generalization, Cross Validation, Network Pruning Techniques, Virtues and Limitations of Back Propagation Learning, Accelerated Convergence, Supervised Learning

MODULE IV - COMPETITIVE NEURAL NETWORKS 9 Hours

Neural network based on competition: fixed weight competitive nets- Kohonen self organizing maps and applications-learning vector quantization-counter propagation nets and applications adaptive resonance theory: basic architecture and operation-architecture, algorithm, application and analysis of ART1 & ART2

MODULE V - SPECIAL NEURAL NETWORKS **9 Hours**

Cognitron and Neocognitron - Architecture, training algorithm and application-fuzzy associate memories, fuzzy system architecture- comparison of fuzzy and neural systems.

Total No of Hours: 45

Text books:

1. Hagan, Demuth, Beale, 'Neural Network Design', PWS Publishing Company, 1st Edition, 2002.

2. Freeman, J.A and Skapura, D.M., 'Neural Networks - Algorithms, Applications and Programming Techniques', Addison Wesley Publications, Digitized Reprint (2007), 1991.

3. Andrew Glassner, "Deep Learning: From Basics to Practice" Vol-2, The Imaginary Institute, Seattle, WA, February 20, 2018

Reference Books:

1. Satish Kumar, 'Neural Networks–A Classroom Approach', Tata McGraw-Hill Publishing Company Limited, 2013.

2. N.P. Padhy, S.P. Simon, 'Soft Computing with MATLAB Programming', Oxford University Press, 2015.

Course Outcomes:

Upon completing this course, the student will be able to

- Understand the similarity of Biological networks and Neural networks
- Perform the training of neural networks using various learning rules.
- Understanding the concepts of forward and backward propagations.
- Understand and Construct the Hopfield models.

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EEPECT-102	BIO MEDICAL INSTRUMENTATION	3L:0T:0P	3 Credits

Course Objectives:

- *To gain knowledge about the various physiological parameters measurements.*
- *To understand the various biochemical and nonelectrical sensors.*
- *To study about the assist devices.*
- *To gain knowledge on surgical equipments and telemetry in healthcare.*
- *To understand the concepts of recent advancements in healthcare.*

MODULE I- BIO - CHEMICAL AND NON ELECTRICAL PARAMETER MEASUREMENT **9 Hours**

pH, PO2, PCO2, Colorimeter, Blood flow meter, Cardiac output, respiratory, blood pressure, temperature and pulse measurement, Blood Cell Counters.

MODULE II- ELECTRO-PHYSIOLOGY AND BIO-POTENTIAL RECORDING **9 Hours**

Sources of bio medical signals, Bio-potentials, Bio potential electrodes, biological amplifiers, ECG, EEG, EMG, PCG, typical waveforms and signal characteristics

MODULE III- ASSIST DEVICES **9 Hours**

Artificial kidney, Dialysis action, hemodialysis unit, membrane dialysis, portable dialyser monitoring and functional parameters, Heart-Lung Machine.

MODULE IV- PHYSICAL MEDICINE AND BIOTELEMETRY **9 Hours**

Diathermies - Shortwave, ultrasonic and microwave type and their applications, Surgical Diathermy, Biotelemetry - Single Channel and Multiple Channel.

MODULE V- RECENT TRENDS IN MEDICAL INSTRUMENTATION **9 Hours**

Telemedicine, Insulin Pumps, Radio pill, Endo-microscopy, Brain machine interface, Lab on a chip, Cryogenic Technique.

Total No. of Hours: 45

Textbooks:

1. Leslie Cromwell, "Biomedical Instrumentation and Measurement", Prentice Hall of India, New Delhi, 2011.
2. R. S. Khandpur, "Handbook of Biomedical Instrumentation", TATA Mc Graw-Hill, New Delhi, 2017.
3. John G. Webster, "Medical Instrumentation Application and Design", Third Edition, Wiley India, 2012

Reference Books:

1. Joseph J. Carr and John M. Brown, "Introduction to Biomedical Equipment Technology", John Wiley and Sons, New York, 2011.
2. R. Anandanatarajan, "Biomedical Instrumentation and Measurements", Second Edition, PHI Learning, 2016.

Course Outcomes:

On successful completion of this course, the students will be able to,

- Explain the electro- physiological parameters and bio-potentials recording.
- Measure the biochemical and non-electrical physiological parameters.
- Interpret the various assist devices used in the hospitals.
- Identify physical medicine methods and biotelemetry.
- Analyse recent trends in medical instrumentation.

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EEPECT-103	COMMUNICATION SYSTEMS	3L:0T:0P	3 Credits

Course objectives:

- The objective of the course is to understand the concept of analog and digital modulation techniques and to study various analog modems.
- The course enables the students to understand the need for error control techniques and to study the different error control schemes
- The course explores the role of communication engineering in the realization of smart grids.

MODULE I - ANALOG MODULATION SYSTEMS 9 Hours

Time and frequency domain representation of signals - Amplitude modulation – Spectrum & Power relations, SSB, DSBSC and VSB modulations, AM Modulator and Demodulator circuits – Transistor AMDSBFC modulator, Envelope detector. Frequency modulation – Frequency spectrum & modulation index, NBFM & WBFM. FM Modulator and Demodulator circuits – Reactance modulators, Armstrong Method, Balanced slope detector & Foster Seeley discriminator. Pre Emphasis & De-Emphasis – Super heterodyne receiver.

MODULE II - PULSE AND DIGITAL MODULATION SYSTEMS 9 Hours

PCM system, Delta Modulation-Generation and detection of ASK, FSK and PSK-Bit Error Rate calculation-BER performance comparison- Digital T – Carrier system.

MODULE III - COMMUNICATION TECHNOLOGY 9 Hours

PN sequence, Frequency hopping-Direct sequence spread spectrum systems. FDMA, TDMA and CDMA systems. Error Detection, Error correction- Hamming code, Block code, ARQ Mechanisms.

MODULE IV – CELLULAR COMMUNICATION 9 Hours

TCP/IP Architecture, OSI Architecture, IEEE 802 Architecture, 1G, 2G, 3G Cellular Wireless Networks. WLAN, Bluetooth, Wimax, LTE networks.

MODULE V - POWER LINE COMMUNICATION 9 Hours

Power supply networks, Narrowband & Broadband PLC, Structure of PLC access network, PLC network elements, Connection to core network, Structure of campus communication network and performance issues. Architecture of Smart grid technology.

Total No of Hours: 45

Text books:

1. Wayne Tomasi, 'Electronic Communication Systems', Pearson Education, 3rdEdition, 2001.
2. Roy Blake, 'Electronic Communication Systems', Thomson Delmar, 2nd Edition, 2002.
3. William Stallings, 'Wireless Communication and Networks' Pearson Education, 2003.

Reference books:

1. Janaka Ekanayake, Kithsiri Liyanage, Jianzhong Wu, Nick enkins "SMART GRID Technology and applications" John Wiley & sons Ltd., 2012.
2. Miller, 'Modern Electronic Communication', Prentice Hall of India, 2003.

Course outcomes:

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

- Analog Modulation Techniques and their comparative analysis and applications suitability.
- Process of Modulation and Demodulation.
- Types, characterization and performance parameters of transmission channels.
- Analog to digital conversion and Digital data transmission.

*****

EEPECT - 104	Digital Signal Processing	3L:0T:0P	3Credits

Course Objectives:

- *To introduce the idea of signals and systems in time and frequency domain.*
- *To introduce fundamental principles and applications of signals and filters.*
- *To provide applications of signal processing.*
- *To make understand the basic concepts of signal filter techniques.*
- *To give basic ideas on implementation of DFT and FFT.*

MODULE I - SIGNALS AND SYSTEM 9 Hours

Need and benefits of Digital Signal Processing – Analog signal - Digital signal representation - classification of signals: continuous and discrete - energy and power; mathematical representation of signals spectral density; Classification of systems: linear- causal – stable – dynamic – recursive - time variance; sampling techniques – quantization - quantization error - Nyquist rate - aliasing effect - Analog to digital conversion.

MODULE II - DISCRETE TIME SYSTEM ANALYSIS 9 Hours

Z-transform and its properties - inverse z-transforms - methods; difference equation – Solution by z transform - application to discrete systems - Stability analysis - frequency response – Convolution linear - circular – Discrete Time Fourier transform - magnitude and phase representation.

MODULE III - DISCRETE FOURIER TRANSFORM 9 Hours

Discrete Fourier Transform - properties - relationship between z- transform - DTFT and DFT Frequency analysis of signal using DFT. FFT algorithms - advantages over discrete computation of DFT – radix-2 algorithms - Decimation In Time-Decimation In Frequency - Computation of IDFT using FFT.

MODULE IV - DESIGN OF DIGITAL FILTER 9 Hours

FIR and IIR filter realization – Parallel and cascade forms. FIR design: Windowing Techniques – Need and choice of windows – Linear phase characteristics. IIR Filters -Analog filter design – Butterworth and Chebyshev approximations; digital filter design using impulse invariant and bilinear transformation Warping- pre-warping – Structures for IIR systems - direct form – parallel - cascade and ladder structures.

MODULE V - PROGRAMMABLE DSP CHIPS 9 Hours

Architecture and features of signal processor - Representation of Basic signals- Linear and circular convolution of two sequences - Implementation of DFT and FFT.

Text Books:

1. J. G. Proakis and D.G. Manolakis, "Digital Signal Processing Principles, Algorithms and Applications", Pearson Education, New Delhi, 4th Edition, 2007.
2. A. V. Oppenheim and R.W. Schaffer, "Discrete Time Signal Processing", PHI, 3rd Edition, 2014.

Reference Books:

1. Sanjit K. Mitra, "Digital Signal Processing, A Computer based Approach", Tata McGraw-Hill, 4th Edition, 2017.
2. Rafel Gonzales and Richard Woods, "Digital Image Processing", Pearson Education, 4th Edition, 2018.

Course Outcomes:

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

- Analyze the classifications of signals and systems in the time and frequency domains.
- Perform the stability analysis of discrete time system.
- Acquire knowledge on spectral analysis of signals.
- Design, analyze and compare digital filters for processing of discrete time signals.
- Acquire knowledge on DSP architecture and implement DFT and FFT Algorithms in DSP

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EEPECT-105	ELECTRIC POWER QUALITY	3L:0T:0P	3 Credits

Course objectives:

To impart knowledge about the following topics

- Causes & Mitigation techniques of various PQ events.
- Various Active & Passive power filters.

MODULE I- INTRODUCTION TO POWER QUALITY 9 Hours

Terms and definitions & Sources – Overloading, under voltage, over voltage - Concepts of transients - Short duration variations such as interruption - Long duration variation such as sustained interruption - Sags and swells - Voltage sag - Voltage swell - Voltage imbalance – Voltage fluctuations - Power frequency variations - International standards of power quality – Computer Business Equipment Manufacturers Associations (CBEMA) curve .

MODULE II -VOLTAGE SAG AND SWELL 9 Hours

Estimating voltage sag performance - Thevenin's equivalent source - Analysis and calculation of various faulted condition - Estimation of the sag severity - Mitigation of voltage sag, Static transfer switches and fast transfer switches. - Capacitor switching – Lightning - Ferro resonance - Mitigation of voltage swells.

MODULE III -HARMONICS 9 Hours

Harmonic sources from commercial and industrial loads - Locating harmonic sources – Power system response characteristics - Harmonics Vs transients. Effect of harmonics – Harmonic distortion - Voltage and current distortions - Harmonic indices - Inter harmonics – Resonance Harmonic distortion evaluation, IEEE and IEC standards.

MODULE IV- PASSIVE POWER COMPENSATORS 9 Hours

Principle of Operation of Passive Shunt and Series Compensators, Analysis and Design of Passive Shunt Compensators Simulation and Performance of Passive Power Filters- Limitations of Passive Filters Parallel Resonance of Passive Filters with the Supply System 100 and Its Mitigation. Fundamentals of load compensation – voltage regulation & power factor correction.

MODULE V- POWER QUALITY MONITORING & CONTROLS 9 Hours

Monitoring considerations - Monitoring and diagnostic techniques for various power quality problems - Quality measurement equipment - Harmonic / spectrum analyzer - Flicker meters Disturbance analyzer - Applications of expert systems for power quality monitoring. Principle& Working of DSTATCOM – DSTATCOM in Voltage control mode, current control mode, DVR Structure – Rectifier supported DVR – DC Capacitor supported DVR -Unified power quality conditioner.

Total No of Hours: 45

Text books:

1. Roger. C. Dugan, Mark. F. Mc Granagham, Surya Santoso, H.WayneBeaty, "Electrical Power Systems Quality", McGraw Hill,2003
2. J. Arrillaga, N.R. Watson, S. Chen, "Power System Quality Assessment", (New York : Wiley), 2000.
3. Bhim Singh, Ambrish Chandra, Kamal Al-Haddad," Power Quality Problems & Mitigation Techniques" Wiley, 2015.

Reference books:

1. G.T. Heydt, "Electric Power Quality", 2nd Edition. (West Lafayette, IN, Stars in a Circle Publications, 1994.
2. M.H.J Bollen, "Understanding Power Quality Problems: Voltage Sags and Interruptions", (New York: IEEE Press), 2000.

Course outcomes:

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

- Understand various sources, causes and effects of power quality issues, electrical systems and their measures and mitigation.
- Analyze the causes & Mitigation techniques of various PQ events.
- Study about the various Active & Passive power filters.
- Understand the concepts about Voltage and current distortions, harmonics.
- Analyze and design the passive filters.
- Acquire knowledge on compensation techniques.
- Acquire knowledge on DVR.

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EEPECT-106	ELECTRIC VEHICLE TECHNOLGY	3L:0T:0P	3 Credits

Course objectives:

- *To introduce configurations of EV and HEVs*
- *To design electric vehicle & HEV for various applications*
- *To select appropriate motor and converter for EV applications*
- *To select battery, battery indication system for EV applications*
- *To develop battery charger for an EV*

MODULE I- INTRODUCTION TO ELECTRIC VEHICLES 9 Hours

Configuration of Electric Vehicles, Performance of Electric Vehicles, Traction motor characteristics, Tractive effort and Transmission requirement, Vehicle performance, Tractive effort in normal driving, Energy consumption Concept of Hybrid Electric Drive Trains, Architecture of Hybrid Electric Drive Trains, Series Hybrid Electric Drive Trains, Parallel hybrid electric drive trains.

MODULE II -ENERGY STORAGE FOR EV AND HEV 9 Hours

Energy storage requirements, Battery parameters, Types of Batteries, Modeling of Battery, Fuel Cell basic principle and operation, Types of Fuel Cells, PEMFC and its operation, Modeling of PEMFC, Super capacitors.

MODULE III- ELECTRIC PROPULSION 9 Hours

EV consideration, DC motor drives and speed control, Induction motor drives, Permanent Magnet Motor Drives, Switch Reluctance Motor Drive for Electric Vehicles, Configuration and control of Drives.

MODULE IV-DESIGN OF ELECTRIC AND HYBRID ELECTRIC VEHICLES 9 Hours

Series Hybrid Electric Drive Train Design: Operating patterns, control strategies, Sizing of major components, power rating of traction motor, power rating of engine/generator and design of PPS Parallel Hybrid Electric Drive Train Design: Control strategies of parallel hybrid drive train, design of engine power capacity, design of electric motor drive capacity, transmission design and energy storage design.

MODULE V-POWER ELECTRONIC CONVERTER FOR BATTERY CHARGING

9 Hours

Charging methods for battery, Termination methods, charging from grid, The Z-converter, Isolated bidirectional DC-DC converter, Design of Z- converter for battery charging, High-frequency transformer based isolated charger topology, Transformer less topology.

Total No of Hours: 45

Text books:

1. Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals, Theory, and Design M. Ehsani, Y. Gao, S. Gay and Ali Emadi CRC Press 2005
2. Electric and Hybrid Vehicles: Design Fundamentals Iqbal Husain CRC Press 2003

Reference books:

1. Energy Management Strategies for Electric and Plug-in Hybrid Electric Vehicles Sheldon S. Williamson Springer 2013.
2. Modern Electric Vehicle Technology C.C. Chan and K.T. Chau Oxford University 2001.

Course outcomes:

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

- Explain the working of electric vehicles and recent trends.
- Analyze different power converter topology used for electric vehicle application.
- Develop the electric propulsion unit and its control for application of electric vehicles.
- Design converters for battery charging and explain transformer less topology.

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EEPECT-107	ELECTRICAL ENERGY AUDIT AND MANAGEMENT	3L:0T:0P	3 Credits

Course Objectives:

- To understand the purpose of energy Audit and management.
- To learn about the utility and efficiency of energy.
- To learn the application of energy conservation
- To learn the financial analysis of the energy.

MODULE I - GENERAL ASPECTS OF ENERGY MANAGEMENT AND ENERGY AUDIT

9 Hours

Commercial and Non-Commercial Energy – Final Energy Consumption – Energy Needs of Growing Economy – Energy Pricing – Energy Conservation and its Importance – Re-Structuring of the Energy Supply Sector – Energy Conservation Act-2001 and its Features – Electricity Tariff – Thermal Basics -Need and Types of Energy Audit – Energy Management/Audit Approach-Understanding Energy Costs.

MODULE II - ENERGY MANAGEMENT **9 Hours**

Definition and Objective of Energy Management, Principles of Energy management, Energy Management Strategy, Energy Manager Skills, key elements in energy management, force field analysis, energy policy, format and statement of energy policy, Organization setup and energy management. Responsibilities and duties of energy manager under act 2001. Energy Efficiency Programs. Energy monitoring systems.

MODULE III - ENERGY EFFICIENCY IN ELECTRICAL UTILITIES **9 Hours**

Electrical load management and maximum demand control – power factor improvement and its benefit – selection and location of capacitors – performance assessment of PF capacitors – automatic power factor controllers – transformer losses – losses in induction motors – factors affecting motor performance – rewinding and motor replacement issues – soft starters with energy saver – variable speed drives – Fans and blowers:

MODULE IV - ENERGY CONSERVATION IN APPLICATIONS **9 Hours**

Motive power (motor and drive system).- Illumination - Heating systems (boiler and steam systems) - Ventilation(Fan, Blower and Compressors) and Air Conditioning systems - Pumping System - Cogeneration and waste heat recovery systems - Utility industries (T and D Sector)

MODULE V- FINANCIAL ANALYSIS **9 Hours**

Financial appraisals; criteria, simple payback period, return on investment, net present value method, time value of money, break even analysis, sensitivity analysis and numerical based on it, cost optimization, cost of energy, cost of generation.

Total no of hours: 45

Text books:

1. Moncef Krati, Energy Audit of Building Systems: An Engineering Approach, 2nd Edition, CRC Press, 2016.
2. Sonal Desai, Handbook of Energy Audit, McGraw Hill Education (India) Private Limited, 2015
3. Bureau of Energy Efficiency – Energy Managers and Energy Auditors Guide book, 2006

Reference books:

1. Thomas D.Eastop, Energy Efficiency: For Engineers and Technologists, Logman Scientific and Technical, 1990
2. Larry C. Witte, Philip S.Schmidt, David R.Brown, Industrial Energy Management and Utilization, Springer Berlin Heidelberg, 1988

Course outcomes:

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

- To Analyze the various energy techniques of energy management
- To Electrical load management and maximum demand control

  To analysis in financial purpose

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EEPECT-108	EMBEDDED SYSTEM DESIGN	3L:0T:0P	3 Credits

Course objectives:

- *To gain knowledge about the fundamentals of embedded systems and its communication protocols.*
- *To understand the architectural features of ARM processor.*
- *To learn about the different programming techniques for ARM processor.*
- *To impart knowledge on ARM processor peripherals with device driver and its interface circuits.*
- *To provide a platform for the student to design, implement, integrate, and develop software and hardware applications with the real time system.*

MODULE I – INTRODUCTION **9 Hours**

Introduction to functional building blocks of embedded systems – Register, memory devices, ports, timer, interrupt controllers using circuit block diagram representation for each categories.

MODULE II - ARM ARCHITECTURE **9 Hours**

ARM Programmer's model - Registers – Processor modes - Pipeline - Interrupts – ARM organization - ARM processor families – Instruction sets – Thumb Instruction Set: Register Usage, Other Branch Instructions, Data Processing Instructions – ARM Memory Management.

MODULE III - ARM PROCESSOR PROGRAMMING **9 Hours**

Writing and optimizing the embedded C Code – Profiling and Cycle Counting – Instruction Scheduling –Register Allocation – Conditional Execution – Looping Constructs – Bit Manipulation - Timers and counters - Watchdog timer. Programming Tools: IDE and Programmer Interface.

MODULE IV - EMBEDDED NETWORKS **9 Hours**

Distributed Embedded Architecture – Hardware and Software Architectures, Networks for embedded systems– I2C, CAN Bus, Ethernet, Internet, Network-based design– Communication Analysis, system performance Analysis, Hardware platform design, Allocation and scheduling, Design Example: Elevator Controller.

MODULE V - REAL TIME OPERATING SYSTEM (RTOS) 9 Hours

Introduction to basic concepts of RTOS, Basics of real time & embedded system operating systems, RTOS – Interrupt handling, task scheduling; embedded system design issues in system development process – Action plan, use of target system, emulator, use of software tools.

Total No of Hours: 45

Text books:

1. Rajkamal, 'Embedded System – Architecture, Programming, Design', Tata McGraw Hill, 2003.

2. Brian Amos, "Hands-On RTOS with Microcontrollers: Building Real-time Embedded Systems Using Free RTOS, STM32 MCUs, and SEGGER Debug Tools", Thomas Learning, 1st Edition, 2020.

Reference books:

1. Yifeng Zhu, "Embedded Systems with ARM Cortex-M Microcontrollers in Assembly Language", E-Man Press LLC, 2nd Edition, 2016.

2. Andrew N. Sloss, Dominic Symes, Chris Wright, "ARM Systems Developer's Guides - Designing and Optimizing System Software", Elsevier, 2008.

3. Frank Vahid, 'Embedded System Design – A Unified Hardware & Software Introduction', John Wiley, 2002.

Course outcomes:

Upon completion of this course, students will be able to

- Remember the concepts of process and controllers.
- Apply the concepts for real-time applications.
- Create a real-time system for particular applications

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EEPECT-109	Flexible AC Transmission System (FACTS)	3L:0T:0P	3 Credits

Course Objectives:

• *To introduce the basic concepts, different types of FACTS controllers in power transmission.*

• *To understand the scope and applications of FACTS controllers*

MODULE I - FUNDAMENTAL OF FACTS **9 Hours**

Introduction to FACTS controllers – Reactive power control: Reactive power, uncompensated transmission line, reactive power compensation – Principles of conventional reactive power compensators: Synchronous condensers. Fundamental of AC transmission system, transmission problem and needs, emergence of FACTS-Basic types of FACTS controllers –benefits from FACTS technology – Comparison of HVDC and FACTS.

MODULE II - THYRISTOR CONTROLLED SHUNT COMPENSATION **9 Hours**

Objectives of Shunt Compensation – Methods of Controllable VAR Generation – Static VAR compensators – SVC, STATCOM – Compensator Control – Comparison Between SVC & STATCOM.

MODULE III - THYRISTOR CONTROLLED SERIES COMPENSATION **9 Hours**

Objectives of Series Compensation – Variable Impedance type series compensators – GCSC, TSSC and TCSC – basic control schemes –Switching converter type Series compensator: SSSC – internal and external control.

MODULE IV - VSC BASED SHUNT AND SERIES COMPENSATOR **9 Hours**

Static Synchronous Compensator (STATCOM): Principle of operation, VI Characteristics, Harmonic performance – Steady state model – SSR mitigation. Static Synchronous Series Compensator (SSSC): Principle of operation and characteristics of SSSC – control range and VA rating – capability to provide real power compensation –control scheme for SSSC.

MODULE V - UNIFIED POWER FLOW CONTROLLER **9 Hours**

Basic operating principles – conventional transmission control capability of UPFC – Independent real and reactive power flow control – control scheme for UPFC – Basic control system for P and Q control – dynamic performance.

Total No of Hours: 45

Text Books:

1. Narain G. Hingorani and Laszlo Gyugyi, "Understanding FACTS concepts and technology of flexible AC transmission systems" IEEE power Engineering society Sponsor, IEEE press, 2001.
2. R. Mohan Mathur and Rajiv K. Varma, "Thyristor-Based FACTS Controllers for Electrical Transmission Systems", IEEE press-John Wiley and Sons publications, 2002.
3. Einar V. Larsen, Jaun J. Sanchez-Gasca and Joe H. Chow, "Concepts of design of FACTS Controllers to damp power swings", IEEE Transaction on Power Systems, Vol. 10, no. 2, May 1995.

Reference Books:

1. Yong Hua Song and Allan T Johns, "Flexible AC Transmission System (FACTS)", IEEE Power Engineering Series-IEEE press, 1999.
2. K. R. Padiyar, "HVDC Power Transmission Systems Technology and System Interactions", New Age International (p) Limited, New Delhi, 2003.

Course Outcomes:

Upon completion of the course, the students shall be able to

- Understand various Power flow control issues in transmission lines, for the purpose of identifying the scope and for selection of specific FACTS controllers.
- Apply the concepts in solving problems of simple power systems with FACTS controllers.
- Design simple FACTS controllers.

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EEPECT - 110	Solar Photo Voltaic Systems	3L:0T:0P	3Credits

Course Objectives:

- *To impart fundamental knowledge of solar cell formation, its properties and manufacturing*
- *To understand the various components required in grid connected systems and its importance.*
- *To discuss the various components in standalone PV systems.*
- *To gain knowledge on various solar hybrid systems and their comparisons.*
- *To design the PV systems for various real load applications on cost economics.*

MODULE I – FUNDAMENTALS OF PHOTOVOLTAIC SYSTEMS

9 Hours

Solar Cells: Structure and working - Types, Electrical properties - Cell properties and design - PV cell interconnection and Module fabrication - PV Modules and arrays. Commercial technologies: Mono crystalline and Multi crystalline, Silicon – Wafer based Solar cell, thin film solar cells: A–Si, Cd–Te and CIGS, Concentrated PV cells, developing technologies: Organic cells, Dye sensitized cells – Photovoltaic in global and Indian scenario

MODULE II - SOLAR PV FOR ON-GRID APPLICATIONS 9 Hours

Solar cells to solar array – On–Grid PV system – With and without storage – Balance of system – DC–DC converters – Inverters – Net Metering – Design and analysis – Performance evaluation and monitoring

MODULE III - SOLAR PV FOR OFF-GRID APPLICATIONS 9 Hours

Off-Grid standalone PV system – System sizing – Module and Battery – Storage – Batteries for PV systems – Sun Tracking mechanism – Types of tracking – One–axis, Two–axis – Maximum power point tracking – Design and analysis – Performance evaluation and monitoring

MODULE IV- HYBRID SYSTEMS 9 Hours

Solar, Biomass, Wind and Diesel Hybrid systems - Comparison and selection criteria - simple hybrid systems – storage arrangements - Introduction to Micro grid – Comparison of micro grid with conventional power system – Architecture

MODULE V- COST BENEFIT ANALYSIS FOR SOLAR PV INSTALLATIONS 9 Hours

Cost and manufacturability – Manufacturing economics – Scaling – Pricing – Trends in retail pricing – Energy economics – Grid tied power plant – Solar street lighting system - Simple payback calculation.

Total no. of Hours: 45

Course Outcomes:

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

- Describe the basic concepts of solar cells and its properties.
- Discuss about the selection of interfacing components in solar grid connected systems.\
- Review about the various DC/AC equipments used for stand-alone PV applications through requirements and design calculations.
- Understand the various components required in grid connected systems and its importance.
- Gain knowledge on various solar hybrid systems and their comparisons.
- Design the PV systems for various real load applications on cost economics

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EEPECT - 111	Robotics and Control	3L:0T:0P	3Credits

Course Objectives :

- *To introduce basic Robotic terminologies.*
- *To illustrate the functions of the basic components of a Robot.*
- *To introduce manipulator dynamics and gripper types.*
- *To illustrate kinematics and path planning.*
- *To introduce dynamics and control operation.*

MODULE I - INTRODUCTION 9 Hours

Definition and origin of Robotics – different types of Robotics – various generations of Robots – degrees of freedom – Robot classifications and specifications- Asimov's laws of Robotics – dynamic stabilization of Robots.

MODULE II - MODELING OF ROBOTS 9 Hours

Mechanical structure and notations – Description of links and joints – kinematics modeling of the manipulator – Denavit - Haternberg notation – Kinematic relationship between adjacent links – Manipulator transformation matrix – Inverse matrix

MODULE III - MANIPULATORS AND GRIPPERS DIFFERENTIAL MOTION 9 Hours

Construction of manipulators – manipulator dynamics and force control – electronic and pneumatic manipulator control circuits – end effectors – various types of grippers – design considerations.

MODULE IV - KINEMATICS AND PATH PLANNING 9 Hours

Linear and angular velocities-Manipulator Jacobian-Prismatic and rotary joints–Inverse -Wrist and arm singularity - Static analysis - Force and moment Balance Solution kinematics problem – Robot programming languages

MODULE V - DYNAMICS AND CONTROL AND APPLICATIONS 9 Hours

Lagrangian mechanics-2DOF Manipulator-Lagrange Euler formulation-Dynamic model – Manipulator control problem-Linear control schemes-PID control scheme-Force control of Robotic manipulator. Multiple Robots – machine interface – Robot cell design – selection of Robot – applications.

Total No of Hours: 45

Text Books:

1. Saeed B Niku, "Introduction to Robotics Analysis, Control, Applications", John Wiley and Sons, 2nd Edition 2010.
2. Mittal R K and Nagarath I J, "Robotics and Control", Tata McGraw Hill, 1st Edition 2005.
3. Mikell P. Weiss G.M., Nagel R.N., Odraj N.G., Industrial Robotics, McGraw-Hill Singapore, 2015.

Reference Books :

1. Ashitava Ghoshal, "Robotics-Fundamental Concepts and Analysis", Oxford University Press, 6th Edition 2010.
2. Spyros G Tzafestas, "Introduction to Mobile Robot Control", Elsevier Science,1st Edition 2018

Course Outcomes:

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

- Outline the anatomy of the Robot.
- Represent the kinematic mathematical modeling of Robot.
- Gain knowledge on manipulator and gripper operation.
- Develop kinematic and path planning equations for standard configurations.
- Familiarize in various control schemes of Robotics control.

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EEPECT - 112	High Voltage Engineering	3L:0T:0P	3Credits

Course Objectives:

- *To understand the causes of over voltages and their effects on power system*
- *To familiarize the Breakdown phenomenon in Gas, Liquid, Solid Dielectrics.*
- *To analyze the characteristics of high voltage, current and impulse voltage generator.*
- *To apply suitable methods to measure high voltage, current and impulse voltage*
- *To test the power apparatus as per Indian Standard Specification*

MODULE I - OVER VOLTAGE PHENOMENON AND INSULATION COORDINATION

9 Hours

Causes of over voltages and their effects on power system Lightning, switching and temporary over voltages -Protection against over voltages - Bewley lattice diagram - Insulation Coordination: estimation and control ofelectric stress, Coordination between insulation and protection level.

MODULE II - ELECTRICAL BREAKDOWN OF SOLID, LIQUID AND GAS MEDIUM

9 Hours

Solids dielectrics: Intrinsic, electromechanical and thermal breakdown composite dielectrics – Liquidsdielectrics: Conduction and breakdown in pure and commercial liquids, suspended particle theory, cavitationsand bubble theory, stressed oil volume theory. Gases dielectrics: Ionization process, Townsend's currentgrowth equations and criterion for breakdown. Streamer theory of breakdown, Paschen's law, breakdown innon-uniform fields and corona discharges.

MODULE III - GENERATION OF HIGH VOLTAGES AND CURRENTS **9 Hours**

Generation of high DC voltages: Rectifier and Voltage doubler circuits, Cockroft Walton voltage multiplier,Vande - Graff Generator. Generation of high AC voltages: cascaded transformers, Resonant Transformer, Tesla coils. Generation of impulse and switching surges: Marx circuit - Generation of high impulse current -Tripping and control of impulse generators

MODULE IV- MEASUREMENT OF HIGH VOLTAGES AND CURRENTS 9 Hours

HVDC measurement: Series resistance micro-ammeter, Resistance Potential divider, Generating Voltmeter. Power frequency A.C voltage measurement: Series Impedance Ammeter, Potential divider, Potentialtransformer, Electrostatic Voltmeters. Impulse voltage measurements: sphere gaps, Digital techniques in highvoltage measurement. Impulse current measurement: current transformer, Rogowski coil, pure resistive shunt method.

MODULE V- HIGH VOLTAGE TESTING 9 Hours

Indian Standards / IEC specification for testing - correction factor - testing of insulators, isolators, bushing, circuit breakers, cables, power transformers and surge arresters - radio interference measurement – High voltage laboratory testing facility - safety precautions in H. V. Labs.

Total no of Hours: 45

Text Books:

1. M. S. Naidu and V. Kamaraju, "High Voltage Engineering", Tata McGraw Hill Private Limited, 5th Edition, 2013.
2. E. Kuffel, W. S. Zaengl and J. Kuffel, "High Voltage Engineering: Fundamentals", Elsevier, 2nd Edition, 2000.
3. C. L. Wadhwa, "High Voltage Engineering", New age international, 3rd Edition, 2014.

Reference Books:

1. RavindraArora, Wolfgang Mosch, "High Voltage and Electrical Insulation Engineering", John Wiley and Sons, 2011.
2. L. L. Alston, "High Voltage Technology", Oxford University Press, New Delhi, 1st Indian Edition, 2008.

Course Outcomes:

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

- Demonstrate the causes and effects of over voltages, currents on power system and also discuss the insulation coordination.
- Analyze the various breakdown processes in solid, liquid and gaseous insulating materials.
- Explain the different methods for generation of high voltages and currents.
- Apply the methods of measurement for high voltages and currents in electrical apparatus.
- Test and evaluate the performance of high voltage equipment.

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EEPECT-113	Industrial Automation	3L:0T:0P	3 Credits

Course objectives:

- *To know about the design of a system using PLC.*
- *To study about PLC Programming*
- *To study knowledge on application of PLC*
- *To have an exposure SCADA architecture*
- *To know about the fundamentals of DCS.*

MODULE I - PLC ARCHITECTURE **9 Hours**

Introduction and overview of Industrial automation – Block diagram of PLC – different types of PLC – Type of input and output – Introduction to relay logic- Application of PLC.

MODULE II -PLC PROGRAMMING **9 Hours**

Evaluation of PLC, PLC Architecture, Basic Structure. PLC Programming: Ladder Diagram – Ladder diagram symbols, Ladder diagram circuits. PLC Communications and Networking, PLC Selection: I/O quantity and Type, Memory size and type, Programmer MODULEs. PLC Installation, Advantages of using PLCs.

MODULE III - DISTRIBUTED CONTROL SYSTEM **9 Hours**

Introduction, Overview of Distributed Control System, DCS Software configuration, DCS Communication, DCS Supervisory Computer Tasks, DCS Integration with PLCs and Computers, Features of DCS, Advantages of DCS.

MODULE IV - SCADA **9 Hours**

Introduction to DCS and SCADA - Block diagram – function of each component – Security objective – Operation and engineering station interface – Communication requirements.

MODULE V - APPLICATION AND CASE STUDIES **9 Hours**

Development of different control block using DCS simulation software – Real time control of test rigs using DCS. Introduction to HART, Field bus and PROFIBUS – Application and case studies of large scale process control using DCS.

Total No of Hours: 45

Text books:

1. John W. Webb and Ronald A Reis, "Programmable Logic Controllers - Principles and Applications", Prentice Hall Inc., 5th Edition, 2002.

2. Thomas E. Kissell, 'Industrial Electronics', PHI, 3rd Edition, 2003.

3. Huges T, 'Programmable Controllers', ISA press, 4th Edition, 2005.

Reference books:

1.M. P. Lukcas, "Distributed Control Systems", Van Nostrand Reinhold Co., 1986.

2. Frank D. Petruzella, "Programmable Logic Controllers", McGraw Hill, 4th Edition, 2010.

Course outcomes:

Upon completion of the course, students will be able to

- Implement low cost automation systems using pneumatic and electrical means.
- Learn about the modern techniques and devices used for the monitoring and control of manufacturing systems including programming of programmable logic controllers and their interfacing with various sensors and actuators.
- Design automated assembly system for industrial applications.

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EEPECT - 114	Modern Control Systems	3L:0T:0P	3Credits

Course Objectives:

- *To understand the basic concepts of modern control theory in relation to the stability of a system.*
- *To co relate the concepts of control theory with the field of electrical engineering*

MODULE I - STATE VARIABLE ANALYSIS 9 Hours

Introduction, concepts of state, state variables and state model, state-space representation for linear continuous-time systems and discrete-time systems.Time, domain solution of state equations: Solution of homogeneous state equations, state transition matrix, evaluation of matrix exponential (eAt), solution of non- homogeneous state equations

MODULE II – STATE SPACE REPRESENTATION 9 Hours

State-space representation of highorder differential equations, state space representation of transfer function in controllable, observable and diagonal form, relationship between state equations and transfer function. Signal flow graph of state equations, decomponsition of transfer function, diagonalization, eigen values and eigen vectors, modal matrix.

MODULE III - CONTROLLABILITY AND OBSERVABILITY 9 Hours

Concept of Controllability and Observability; Controllability and Observability tests for continuous time system; Controllability and Observability of discrete time system; Controllability and Observability of state model in Jordan canonical form; Loss of Controllability and Observability for sampling

Unit IV - MODELS OF DIGITAL CONTROL DEVICES AND SYSTEMS 9 Hours

Introduction to z-transform, ROC in z-transform, basic discrete time signals, time domain models of discrete time systems, transfer function models, stability on z-plane and jury stability criteria, z-domain description of sampled continous time plants, , z-domain description of systems with dead time, Implementation of digital controllers, Tunable PID controllers, Methods of tuning industrial PI, PID controllers

MODULE V - NONLINEAR SYSTEMS **9 Hours**

Introduction, common physical nonlinearities-saturation, dead-zone, relay, relay with dead zone, hysteresis, backlash, etc, jump resonance, limit cycle. Phase-plane analysis-phase plane and phase trajectory, singular points, construction of phase trajectory, evaluation of time, stability analysis.

Total No of Hours: 45

Text Books:

1. M Gopal "Digital Control & state variables methods", TMH Company, 2nd Edition, 2006.
2. K. Ogata "Discrete time Control System ", Prentice Hall, 1995.
3. M Gopal "Modern Control SystemTheory ", New Age Publications,.2nd Edition, 2005

Reference Books:

1. Richard C Dorf,"Modern Control Systems ", Pearson, 14th Edition, 2021
2. C.Kuo "Digital control system", Oxford University Press 1995.

Course outcomes:

Upon completion of the course, students will be able to

• Gains an appreciation of recent advances in control engineering such as pole assignment, observers design

• Identify the optimal, adaptive techniques.

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EEPECT-115	Nano Electronics	3L:0T:0P	3 Credits

Course objectives:

To impart knowledge about the following topics of Nano electronics and molecular electronics.

MODULE I - INTRODUCTION TO NANOTECHNOLOGY 9 Hours

Background to nanotechnology: Types of nanotechnology and nanomachines – periodic table – atomic structure – molecules and phases – energy – molecular and atomic size – surface and dimensional space – top down and bottom up; Molecular Nanotechnology: Electron microscope – scanning electron microscope – atomic force microscope – scanning tunnelling microscope – nanomanipulator– atom manipulation – nanodots – self-assembly – dip pen nanolithography. Nanomaterials: preparation – plasma arcing – chemical vapor deposition – sol-gels – electrodeposition – ball milling.

MODULE II – NANODEVICES 9 Hours

Fundamentals of logic devices:- Requirements – dynamic properties – threshold gates; physical limits to computations; concepts of logic devices:- classifications – two terminal devices – field effect devices – coulomb blockade devices – spintronics – quantum cellular automata – quantum computing – DNA computer; performance of information processing systems.

MODULE III - SILICON MOSFETs & QUANTUM TRANSPORT DEVICES 9 Hours

Silicon MOSFETS - Novel materials and alternate concepts:- fundamentals of MOSFET Devices- scaling rules – silicon-dioxide based gate dielectrics – metal gates – junctions & contacts – advanced MOSFET concepts.
Quantum transport devices based on resonant tunneling, Electron tunneling – resonant tunneling diodes – resonant tunneling devices; Single electron devices for logic applications, Single electron devices – applications of single electron devices to logic circuits.

MODULE IV- CARBON NANOTUBES **9 Hours**

Carbon Nanotube: Fullerenes - types of nanotubes – formation of nanotubes – assemblies – purification of carbon nanotubes – electronic properties – synthesis of carbon nanotubes – carbon nanotube interconnects – carbon nanotube FETs – Nanotube for memory applications – prospects of an all carbon nanotube nanoelectronics.

MODULE V - MOLECULAR ELECTRONICS **9 Hours**

Electrodes & contacts – functions – molecular electronic devices – first test systems – simulation and circuit design – fabrication; Future applications: MEMS – robots – random access memory – mass storage devices.

Total No of Hours: 45

Text books:

1. Michael Wilson, Kamali Kannangara, Geoff Smith, Michelle Simmons and Burkhard Raguse, Nanotechnology: Basic Science and Emerging Technologies, Chapman & Hall / CRC, 2002
2. T. Pradeep, NANO: The Essentials – Understanding Nanoscience and Nanotechnology, TMH, 2007
3. Rainer Waser (Ed.), Nanoelectronics and Information Technology: Advanced Electronic Materials and Novel Devices, Wiley-VCH, 2003

Reference books:

1. W. Ranier, ―Nano Electronics and Information Technology‖, Wiley, (2003).
2. K.E. Drexler, ―Nano systems‖, Wiley, (1992). 3. M.C. Petty, ―Introduction to Molecular Electronics‖1995.

Course outcomes:

Upon completion of the course, students will be able to

- Understand advanced concepts and operating principles of Nano electronic devices.
- Understand specialized methods to fabricate Nano scale devices.
- Gain familiarity with the application of advanced techniques needed to characterize and study reliability of materials and Nano scale electronic devices.

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EEPECT - 116	Power System Restructuring and Deregulation	3L:0T:0P	3Credits

Course Objectives:

- To understand the electricity power business and technical issues in a restructured power system in both Indian and world scenario.
- To provide the students a systems perspective of modern electricity markets and a systems approach to address various issues faced by the electricity sector.
- To equip the students to understand the need for restructured power system along with electricity market models
- To impart the students with a knowledge on Indian power sector.

MODULE I - DEREGULATED POWER MARKETS 9 Hours

Introduction – Market Models–Entities– Key issues in regulated and deregulated power markets; Market equilibrium- Market clearing price- Electricity markets around the world- Independent System Operator (ISO)-components-types of ISO - role of ISO.

MODULE II - TECHNICAL CHALLENGES 9 Hours

Operational and planning activities of a GENCO -Electricity Pricing and Forecasting -Price Based MODULE Commitment Design- Total Transfer Capability – Limitations - Margins – Available transfer capability (ATC) - Ancillary Services - Automatic Generation Control (AGC).

MODULE III - CONGESTION MANAGEMENT 9 Hours

Introduction-Components of restructured system-Transmission pricing in Open-access system - Open transmission system operation; Congestion management in Open-access transmission systems- FACTS in congestion management-Open-access Coordination Strategies; Power Wheeling- Transmission Cost Allocation Methods

MODULE IV - ELECTRICITY MARKETS PRICING 9 Hours

Open Access Distribution – Changes in Distribution Operations-The Development of Competition– Maintaining Distribution Planning

MODULE V - INDIAN POWER SECTOR **9 Hours**

Electricity act, 2003, challenges and synergies in the use of Tin power sector and Indian power market - Indian energy exchange and power exchange. - Current Scenario – Regions – Regulatory and Policy development in Indian power Sector – Opportunities for IPP and capacity power producer - Indian Electricity Grid Code - Open access issues – Reforms in the near future

Total No of Hours: 45

Text Books:

1. Loi Lei Lai, 'Power System Restructuring and Deregulation', John Wiley& Sons Inc., New York, HRD Edition, 2001.
2. Mohammad Shahidehpour, Hatim Yamin, 'Market Operations in Electric Power Systems', John Wiley & Sons Inc., 2002.
3. Dr. Rajib Mishra, V. K. Khanija and P. P. Wahi, "Indian Power Market (Electricity Marketing Simplified)" Central Board of Irrigation and Power (CBIP), Govt of India, 2016

Reference Books:

1. Mohammad Shahidehpour, Muwaffaq Alomoush, 'Restructured Electrical Power Systems', Marcel Dekker, INC., New York, 1st Edition, 2001.
2. Philipson, L. and Willis, H. L., "Understanding Electric Utilities and Deregulation" 2nd Edition, Florida, MODULE Edition States: CRC Press, 2005

Course Outcomes:

Upon completion of the course, students will be able to

1. Understand the structure of an electricity market in either regulated or deregulated market conditions.
2. Describe the operational activities in Generation, Transmission and Distribution system in the restructured environment
3. Interpret the impact of open access in distribution system.
4. Outline the Indian power sector.

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EEPECT-117	Protection and Switchgear	3L:0T:0P	3 Credits

Course Objectives:

- *To understand the different protection zones and protection schemes in power system.*
- *To impart knowledge on various types of relays including Distance and differential protection schemes.*
- *To impart knowledge on protection schemes for generator, transformer, motor, feeder and transmission lines*
- *To acquire knowledge on various circuit breakers (AC and DC) used in power systems.*
- *To acquaint the various types of surge protection and earthing.*

MODULE I - PROTECTION SCHEMES 9 Hours

Principles and need for protective schemes – Nature and causes of faults – Types of faults – Methods of Grounding - Zones of protection and essential qualities of protection – CTs and PTs and their applications.

MODULE II - RELAYS 9 Hours

Operating Principles of the Relay - Classification of Relays - Universal relay – Torque equation – R-X diagram, Electromagnetic Relays – Over current, IDMT, Directional, Distance, Differential, Negative sequence and under frequency relays, Introduction to static relays, Phase, Amplitude, Comparators –Synthesis of various relays using Static comparators. Microprocessor relay - Applications

MODULE III - APPARATUS AND LINE PROTECTION 9 Hours

Generator Capability Curve – Short circuit Calculations – Ground fault and unbalanced current Protection –Over excitation and Abnormal Frequency Protection - Field winding Protection – Loss of Synchronism – Motor Protection, Transformer Protection – Differential, Inrush and Over Current - Bus zone Protection - Protection of Transmission Lines – Concept of Wide Area Monitoring and Protection.

MODULE IV - CIRCUIT BREAKERS 9 Hours

Functions of switchgear - Principles of arc extinction - Arc control devices - Fuses: types – selection -discrimination – Resistance switching - Recovery voltage and restriking voltage - current chopping and capacitance current breaking – Oil circuit breakers, air break, air blast, and sulphur Hexafluoride and vacuum circuit breakers – HVDC breakers – Rating of Circuit Breaker.

MODULE V - SURGE PROTECTION AND EARTHING 9 Hours

Causes of overvoltage - Lightning phenomenon – Over voltage due to lightning - Protections against lightning -Lightning arresters – Types - Lightning arrester selection - Surge absorbers – Current limiting reactor -Insulation coordination. Solid, resistance and reactance Earthing - Arc suppression coil - Earthing transformers -Earth wires - Introduction to Indian Electricity rules.

Total No of Hours: 45

Text Books:

1. Sunil S. Rao, "Switch Gear Protections", Khanna Publications, Delhi, 14th Edition, 2019.

2. Bhuvanesh A. Oza, N. C. Nair, R. P. Mehta, V.H. Makwana, "Power System Protection and Switchgear", Tata McGraw - Hill, New Delhi, 1st Edition, 2017.

3. A. Wright, C. Christopoulos, "Electrical Power System Protection", Springer, 2nd Edition, 2013.

Reference Books:

1. T. S. Madhav Rao, "Power system protection static relays with microprocessor Applications", Tata McGraw hill Publication, 15th Edition, 2015.

2. Badri Ram, D. N. Vishwakarma, "Power System Protection and Switchgear", Tata Mc Graw Hill, 2nd Edition, 2013.

Course Outcomes:

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

- Identify the equipment's for protection scheme on Power Systems.
- Analyze the different applications of the relays in power system.
- Interpret the protection of transformer, Bus bar and transmission line.
- Comprehend the various circuit breakers (AC and DC) used in power system.
- Analyze the protection against over voltages and working of lightning arrester.

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EEPECT – 118	Smart Grid	3L:0T:0P	3Credits

Course Objectives:

- *To familiarize with the fundamentals of smart grids technologies.*
- *To get exposure on Communication infrastructure and protocols.*
- *To study about the Wide Area Measurement Systems, Energy storage technologies for smart grid.*
- *To know about the various stability assessment tools in smart grid.*
- *To familiarize with the Power Quality issues of Grid connected Renewable Energy Sources.*

MODULE I – INTRODUCTION TO SMART GRID 9 Hours

Evolution of Electric Grid, Concept, Definitions and Need for Smart Grid, Smart grid drivers, functions, opportunities, challenges and benefits, Difference between conventional & Smart Grid, National and International Initiatives in Smart Grid.

MODULE II – SMART GRID TECHNOLOGIES 9 Hours

Technology Drivers, Smart energy resources, Smart substations, Substation Automation, Feeder Automation, Transmission systems: EMS, FACTS and HVDC, Wide area monitoring, Protection and control, Distribution systems: DMS, Volt/VAR control, Fault Detection, Isolation and service restoration, Outage management, High-Efficiency Distribution Transformers, Phase Shifting Transformers, Plugin Hybrid Electric Vehicles(PHEV).

MODULE III – SMART METERING AND COMMUNICATION 9 Hours

Smart meters – Communications infrastructure, protocols and hardware – Automatic Meter Reading (AMR) and Advanced Metering Infrastructure (AMI) drivers – benefits – Power line communication (PLC) – Machine to-machine communication models – Home Area Networks (HAN), Wide Area Networks (WAN) and Neighborhood Area Networks (NAN) – Wired and Wireless communication technologies – Cryptosystem – Internet of things (IOT).

MODULE IV- INTEGRATION, CONTROL AND OPERATION OF DISTRIBUTED GENERATION **9 Hours**

Distributed Generation Technologies – benefits – Utilization Barriers – integration to power grid – Renewable Energy Technologies – Micro grids – Storage Technologies – Advantages and disadvantages of DG – Vehicle to Grid technology and Grid to vehicle technology – Performance and stability analysis in smart grid.

MODULEV – POWER QUALITY MANAGEMENT IN SMART GRID **9 Hours**

Power Quality & EMC in Smart Grid, Power Quality issues of Grid connected Renewable Energy Sources, Power Quality Conditioners for Smart Grid, Web based Power Quality monitoring, Power Quality Audit

Total no. of Hours : 45

Text Books:

1. Janaka Ekanayake, Kithsiri Liyanage, Jianzhong Wu, Akihiko Yokoyama**,** Nick Jenkins, "Smart Grid Technology and Applications", John Wiley and Sons Publication, 1st Edition, 2015.
2. Stuart Borlase, "Smart Grids: Infra structure, Technology and Solutions", CRC Press, 1st Edition, 2013.
3. James A. Momoh, "Smart Grid: Fundamentals of Design and Analysis", Wiley-IEEE Press, 1st Edition, 2012.

Reference Books:

3. Jean Claude Sabonnadiere, NouredineHadjsaid, "Smart Grids", Wiley Blackwell,1st Edition, 2012
4. Fereidoon. P. Sioshansi, "Smart grid – integrating renewable, distributed and efficient energy", Academic Press, 1st Edition, 2011.

Course Outcomes:

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

- Compare the conventional electrical grid concepts with smart grid.
- Outline about the protocols and networks used in Smart grid.
- Explain the importance of WAM and energy storage technologies used in smart grid.
- Acquire knowledge on distributed generation and micro grids in smart grid.
- Analyze the power quality issues in smart grid.

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EEPECT-119	SPECIAL ELECTRICAL MACHINES	3L:0T:0P	3 Credits

Course objectives:

- The objective of the course is to explore the students to the construction, principle of operation and performance of special electrical machines as an extension to the study of basic electrical machines.
- The main objective is to impart knowledge on constructions, working and performance of fractional HP machines, switched reluctance motor, PMSM and PMBL DC motors, construction, working and principle of operation, control and closed loop operation of stepper motors.

MODULE I - STEPPER MOTORS **9 Hours**

Constructional features-principle of operation-Types of motors– Modes of operation–Drive system and circuit control of Stepper motor –Static and Dynamic Characteristics and Applications.

MODULE II- SWITCHED RELUCTANCE MOTORS **9 Hours**

Constructional details-principles of operation- Static and dynamics Torque production–drive circuits–Current regulation–Torque speed characteristics– Speed and torque control– Static observers for rotor position sensing– volt- ampere requirements– Applications.

MODULE III - SYNCHRONOUS RELUCTANCE MOTORS **9 Hours**

Constructional features – Types – Axial and radial air gap motors – Operating principle – Reluctance– Phasor diagram-Characteristics – Vernier motor.

MODULE IV - PERMANENT MAGNET BRUSHLESS DC MOTORS **9 Hours**

Commutation in DC motors– Difference between mechanical and electronic commutators– Principle of operation- Construction and drive circuits–Torque and emf equation– Torque and Speed characteristics– sensors and sensor less systems– controllers and applications.

MODULE V - PERMANENT MAGNET SYNCHRONOUS MOTORS **9 Hours**

Principles of operation–Constructional features– Phasor diagram–torque speed characteristics – torque and emf equations–vector controllers- applications. Doubly Fed Induction Generator– Principle – construction, characteristics and applications.

Total No of Hours: 45

Text books:

1. P.P.Acarnley," Stepping Motors, A Guide to Modern theory and practice", Peter Peregrines, London, 2002.
2. Venkataratnam K, “Special Electrical Machines”, Universities Press, Hyderabad, 3rd Edition 2009.
3. R.K.Rajput, "Electrical Machines "Laxmi Publications, New Delhi, 2009

Reference books :

1. A. Hughes,"Electric Motors and Drives", Affiliated East-West Press Pvt., Ltd., 2007
2. R.Krishnan,"Electric Motor Drives Modeling, Analysis, and Control" Prentice Hall of India Pvt Ltd, 2003.

Course outcomes:

- To Maintain different types induction machines for different applications
- To Maintain different types synchronous machines for different applications
- To Maintain different types of fractional horsepower motors
- To Maintain various types of Small specialized electric machines.

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EEPECT-120	WIND AND SOLAR ELECTRICAL SYSTEMS	3L:0T:0P	3 Credits

Course Objectives:

- *To study the concepts of wind energy system*
- *To understand the new developments in solar energy system*
- *To provide students with a solid foundation in mathematical, scientific and engineering fundamentals required to solve wind and solar energy problems*
- *To discuss the solar thermal power generation*
- *To identify the network integration issues*

MODULE I – FUNDAMENTALS OF WIND ENERGY SYSTEM 9 Hours

Wind source–wind statistics-energy in the wind –turbine power characteristics - aerodynamics – rotor types – parts of wind turbines– braking systems–tower- control and monitoring system. General characteristics of induction generators– grid-connected and self-excited systems–steady state equivalent circuit-performance predetermination–permanent magnet alternators–steady-state performance

MODULE II- WIND ENERGY CONVERSION 9 Hours

Wind resources – Nature and occurrence of wind – Power in the wind – Wind characteristics – Principles of wind energy conversions – Components of wind energy conversion system (WECS) – Classification of WECS – Advantages and disadvantages of WECS.

MODULE III - SOLAR CONCENTRATING COLLECTORS 9Hours

Concentrating collectors – types – reflectors – solar thermal power stations – principle and applications – Solar energy storage systems – thermal – sensible and latent heat, chemical, electrical, electro-magnetic energy storage – selection of materials for energy storage – Solar distillation – application – Solar stills – types – Solar pond – performance – characteristics - applications – Solar refrigeration.

MODULE IV - PHOTO VOLTAIC ENERGY CONVERSION SYSTEM 9 Hours

Basic photo voltaic system for power generation – Advantages and disadvantages of photo voltaic solar energy conversion –Application of solar photo voltaic system – Components of PV systems- Design of PV systems- Power conditioning and storage arrangement – Maximum power point tracking (MPPT) - Introduction to string inverters.

MODULE V - RECENT ADVANCEMENTS IN WIND AND PV SYSTEMS 9 Hours

Wind farms and grid connections – Grid related problems on absorption of wind – Grid interfacing arrangement – Operation, control and technical issues of wind generated electrical energy – Interconnected operation – Hybrid systems. Recent Advances in PV Applications: Building Integrated PV systems, Grid Connected PV systems, Hybrid systems, solar cars, solar energy storage system and their economic aspects.

Total No of Hours: 45

Text books:

1. G.N. Tiwari, "Solar Energy: Fundamentals, Design, Modeling & Application", Narosa Publishing House, 2013.
2. G.D. Rai, "Non-conventional Energy Resources", Sixth Ed., Khanna Publishers, 2018.
3. D.S.Chauhan, S.K. Srivastava, "Non – Conventional Energy Resources", New Age Publishers, 3rd Edition, 2012.

Reference books:

1. T. Ackermann, Wind Power in Power Systems, John Wiley and Sons Ltd., 2005.
2. D.P.Kothari and K.C.Singhal,"RenewableEnergy Sources and Emerging Technologies", P.H.I. 2nd Edition, 2011.

Course outcomes:

- Understand the basics of wind energy conversion systems & solar energy conversion systems. Implement the appropriate power extraction techniques.
- Apply power electronics to the renewable energy systems.
- Understand the grid integration techniques, and power quality issues.
- Apply the technology & techniques in variety of applications.

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OPEN ELECTIVES
(OE)

EEOET-101	Analog and Digital Electronics	3L:0T:0P	3 Credits

Course Objectives:

• To understand the concepts of analog and digital circuits.

• To impart knowledge on signal generation and measuring equipment.

MODULE I - ANALOG DEVICES **9 Hours**

Review of analog devices – Rectifier circuits - Wave shaping circuits - Clippers and Clampers – Regulators - Zener and op-amp based regulator circuits - Introduction to switched mode power supplies.

MODULE II - DIGITAL COMPONENTS **9 Hours**

Review of digital components - Code converters- Programmable logic devices- CPLDs and FPGAs- Introduction to hardware description languages.

MODULE III - OSCILLATORS & SIGNAL GENERATOR CIRCUITS **9 Hours**

Function generator circuit - Pulse generator circuit - AM/FM signal generator circuit – Qualitative analysis.

MODULE IV - DISPLAY UNITS **9 Hours**

Display Units - optoelectronic devices – Seven-segment displays - LCD and LED display units and applications.

MODULE V - SPECIAL ELECTRONIC CIRCUITS **9 Hours**

UJT Sawtooth generator circuit – Schmitt trigger – Analog-to-digital converter – Digital-to-analog converter circuits.

Text Books:

1. David A Bell, 'Fundamentals of Electronic Devices and Circuits', Oxford University Press, Incorporated, 25- Jun-2009.

2. Bouwens A. J., 'Digital Instrumentation', Tata McGraw Hill Publications, 16th Reprint (2008).

Reference Books:

1. Kalsi H.S, 'Electronic Instrumentation', Tata McGraw-Hill Education, 3rdEdition, 2010.

2. Morris Mano.M, 'Digital Logic and Computer Design', Prentice Hall of India, 3rdEdition, 2005.

Course Outcomes:

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

- Design and develop circuits using analog and digital components.
- Understand the different generators and analyzers.
- Appreciate the use of display units.
- Identify the suitable oscilloscope for measurement.

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EEOET-102	Basics of Electrical Circuits	3L:0T:0P	3 Credits

Course Objectives:

To *make the student learn about*

- *Basic characteristics of R, L, C parameters, their Voltage and Current Relations and Various combinations of these parameters.*
- *The Single-Phase AC circuits and concepts of real power, reactive power, complex power, phase angle and phase difference*
- *Series and parallel resonances, bandwidth, current locus diagrams*
- *Network theorems and their applications*
- *Network Topology and concepts like Tree, Cut-set, Tie-set, Loop, Co-Tree.*

MODULE I - INTRODUCTION TO ELECTRICAL & MAGNETIC CIRCUITS 9 Hours

Electrical Circuits: Circuit Concept – Types of elements – Source Transformation-Voltage – Current Relationship for Passive Elements. Kirchhoff's Laws – Network Reduction Techniques-Series, Parallel, Series Parallel, Star-to-Delta or Delta-to-Star Transformation. Examples Magnetic Circuits: Faraday's Laws of Electromagnetic Induction-Concept of Self and Mutual Inductance-Dot Convention-Coefficient of Coupling-Composite Magnetic Circuit-Analysis of Series and Parallel Magnetic Circuits, MMF Calculations.

MODULE II - NETWORK TOPOLOGY 9 Hours

Definitions – Graph – Tree, Basic Cutset and Basic Tieset Matrices for Planar Networks – Loop and Nodal Methods of Analysis of Networks & Independent Voltage and Current Sources – Duality & Dual Networks.Nodal Analysis, Mesh Analysis.

MODULE III - SINGLE PHASE A.C CIRCUITS 9 Hours

R.M.S, Average Values and Form Factor for Different Periodic Wave Forms – Sinusoidal Alternating Quantities – Phase and Phase Difference – Complex and Polar Forms of Representations, j-Notation, Steady State Analysis of R, L and C (In Series, Parallel and Series Parallel Combinations) with Sinusoidal ExcitationResonance – Phasor diagrams – Concept of Power Factor- Concept of Reactance, Impedance, Susceptance and Admittance-Apparent Power, Active and Reactive Power, Examples.

MODULE IV - NETWORK THEOREMS **9 Hours**

Superposition, Reciprocity, Thevenin's, Norton's, Maximum Power Transfer, Millmann's, Tellegen's, and Compensation Theorems for D.C and Sinusoidal Excitations.

MODULE V - THREE PHASE A.C. CIRCUITS **9 Hours**

Introduction – Analysis of Balanced Three Phase Circuits – Phase Sequence- Star and Delta Connection –Relation between Line and Phase Voltages and Currents in Balanced Systems – Measurement of Active and Reactive Power in Balanced and Unbalanced Three Phase Systems. Analysis of Three Phase Unbalanced Circuits – Loop Method – Star Delta Transformation Technique – for balanced and unbalanced circuits – Measurement of Active and reactive Power – Advantages of Three Phase System.

Text Books:

1. Circuit Theory Analysis & Synthesis A. Chakrabarti, Dhanpat Rai & Sons, 7th Revised Edition, 2018.
2. Fundamentals of Electric Circuits Charles K. Alexander and Matthew. N. O. Sadiku, Mc Graw Hill, 5th Edition, 2013.
3. Engineering circuit analysis William Hayt and Jack E. Kemmerly, Mc Graw Hill Company, 7th Edition, 2006.

Reference Books

1. Electrical Engineering Fundamentals V. Del Toro, Prentice Hall International, 2nd Edition, 2019.
2. Electric Circuits- Schaum's Series, Mc Graw Hill, 5th Edition, 2010

Course Outcomes:

After completing the course, the student should be able to

- Determine the current through any element and voltage across and power through any element.
- Determine the real power, reactive power, power factor etc,.
- Apply the network theorems suitably
- Develop the Cut Set and Tie-set Matrices for a given Circuit. Also understand various basic definitions and concepts

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EEOET-103	Control System Engineering	3L:0T:0P	3 Credits

Course Objectives:

- *To provide the use of transfer function models for analysis of physical systems.*
- *To provide adequate knowledge in the time response of systems and error analysis.*
- *To provide basic knowledge for obtaining the open loop and closed-loop frequency responses of systems.*
- *To get an exposure in the design of P/I/D controllers.*
- *To introduce about the state variable representation and stability analysis.*

MODULE I-MODELING OF LINEAR TIME INVARIANT SYSTEMS 9 Hours

Control systems - Open loop and Closed loop – Feedback control system characteristics - Mathematical modeling of Electrical, Mechanical and Electro-Mechanical systems - electrical analogues systems - Block diagrams reduction techniques - Signal flow graphs - Transfer functions.

MODULE II- TIME DOMAIN ANALYSIS 9 Hours

Standard test signals – Transient analysis of first and second order systems using step input - Time responses –Time domain specifications – Error Analysis - Stability analysis - Concept of stability – Routh Hurwitz stability criterion - Root locus Techniques - Effect of adding poles and zeros.

MODULE III - FREQUENCY DOMAIN ANALYSIS 9 Hours

Frequency response analysis – Correlation between frequency response and time-response analysis - frequency domain specifications - Bode plot - Polar plot - Nyquist stability criterion.

MODULE IV- CONTROLLER DESIGN 9 Hours

Introduction to controllers - P-I-D controllers - Tuning methods - Ziegler-Nichol's Tuning - Performance criteria –Compensator design - Lead, Lag, Lead-Lag compensation using Bode Plot.

MODULE V- STATE VARIABLE ANALYSIS **9 Hours**

State Space Representation, Concept of state variables – State models for linear and time invariant Systems –Controllable, Observable, Jordan Canonical Forms - Solution of State Equation, State Transition Matrix –controllability and observability – Transfer function to State space model.

Text Books

1. I. J. Nagarath and M. Gopal, "Control Systems Engineering", New Age International Publishers, 6th Edition (Multi colour Edition), 2018.

2. Katsuhiko Ogata, "Modern Control Engineering", Pearson, 5th Edition, 2015.

3. Benjamin C. Kuo, "Automatic Control Systems", PHI Learning Private Ltd, 9th Edition 2014.

Reference Books

1. Richard C. Dorf and Robert. H. Bishop, "Modern Control Systems", Pearson Education, 12th Edition, 2011.

2. John J. D'Azzo, Constantine H. Houpis and Sttuart N. Sheldon, "Linear Control System Analysis and Design with MATLAB", CRC Taylor and Francis Reprint, 6th Edition, 2014.

Course Outcomes

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

- Develop the transfer function for the block diagram / signal flow graph model of electrical / mechanical / elector-mechanical systems.
- Analyze the performance of control system using time-domain approach.
- Analyze performance characteristics of system using Frequency response methods.
- Design P/I/D controllers for the System in order to meet design specifications.
- Express the control systems into state space models and analyze the performance of the system

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EEOET-104	Electric Power Utilization	3L:0T:0P	3 Credits

Course Objectives:

To understand the principles of operation and utilization of power in domestic and industrial appliances.

MODULE I - ILLUMINATION **9 Hours**

Terminology, Laws of illumination, lighting calculations. Electric lamps – Different types of lamps, LED lighting and Energy efficient lamps, Design of lighting schemes - factory lighting - flood lighting – street lighting.

MODULE II - REFRIGERATION **9 Hours**

Domestic refrigerator and Air coolers, Air-Conditioner – circuit diagram, types and principle of operation.

MODULE III - DOMESTIC UTILIZATION OF ELECTRICAL ENERGY **9 Hours**

House wiring, Induction based appliances, Online and OFF-line UPS, Earthing – domestic, industrial and sub-station.

MODULE IV- ELECTRIC HEATING **9 Hours**

- Types of heating and applications, Electric furnaces - Resistance, inductance and Arc Furnaces, Electric welding and sources of welding.

MODULE V - ELECTRIC DRIVES AND TRACTION SYSTEM **9 Hours**

Type of drives and loads, Rating and heating of the motors, Types of Traction, Speed-Time curves, recent trends in traction.

Total no. of Hours: 45

Text Books:

1. Uppal S.L. and Prof. S. Rao, 'Electrical Power Systems', Khanna Publishers, New Delhi, 2009.

2. Rajput R.K.,'Utilisation of Electrical Power', Laxmi Publications, 1st Edition, 2007.

3. N.V Suryanarayana, 'Utilization of Electric Power' New Age International Publishers, Reprinted 2005.

Reference Books:

1. C.L.Wadhwa, 'Generation, Distribution and Utilization of Electrical Energy', New Age International Publishers, 4th Edition, 2011.
2. Gupta, J.B., 'Utilisation of Electrical Energy and Electric Traction', S.K.Kataria and Sons, 10th Edition, 1990.

Course Outcomes:

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

- Develop a clear idea on various illumination techniques and hence design lightening scheme for specific applications.
- Construct an electric connection for any domestic appliance like refrigerator and air conditioner units.
- Evaluate domestic wiring connection and debug any faults occurred.
- Identify an appropriate method of heating and welding for any particular industrial application.
- Realize the appropriate type of electrical supply system as to evaluate the performance of tractions and electrical drives.

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EEOET-105	Electrical Machines	3L:0T:0P	3 Credits

Course Objectives:

- *To understand the performance characteristics of Transformers.*
- *To equip the students to test and analyze the characteristics of DC machines.*
- *To get familiar with performance characteristics of AC machines*
- *To get familiar with performance characteristics of Special machines*
- *To equip the students to analyze the utilization of different home appliances.*

MODULE I – TRANSFORMERS **9 Hours**

Transformers - Principle of operation – Single Phase transformer – Equivalent circuit – Regulation – Losses and Efficiency – Introduction to 3 phase transformers – Autotransformers.

MODULE II – DC MACHINES **9 Hours**

Construction, Principles of operation of DC Generators – types - EMF equation – No load and Load characteristics of series and shunt generators – DC motor – Torque – Speed – Torque characteristics of series and shunt motors – Speed control methods and application.

MODULE III – AC MACHINES **9 Hours**

Principle of operation of 3-phase Induction Motor – Torque, slip characteristics – Speed control methods – Single-phase Induction motor starting methods – Principle of operation of Alternators.

MODULE IV – SPECIAL MACHINES **9 Hours**

Servo motor – DC and AC servomotors; stepper motors – variable reluctance and permanent magnet stepper motors; single phase synchronous motor – reluctance motor and hysteresis motor – universal motor – Repulsion motor –synchronous motor.

MODULE V – UTILISATION **9 Hours**

Domestic wiring – principle of electrical heating – The laws of illumination – Electric lamps – Photometers – Electroplating – Electric Traction – Air conditioning – Earthing.

Total no. of Hours: 45

Text Books:

1. B.L. Theraja, “Electrical Technology Vol.II AC/DC Machines”, S. Chand, 2008

2. A.Chakrabarti, M.I.Soni, P.V.Gupta,“Textbook on power sytems engineering”,DhanpatRai, 2008.

3. G.C.Garg, “Utilisation of Electric power and electric traction” Khanna Publications (p) Ltd, Delhi, 2006.

Reference Books:

1. Battacharya S K,“Electrical Machines”, Technical Teachers Training institute”, 2nd Edition 2003.

2. S.L.Uppal, “Electrical power” Khanna Publications (p) Ltd, Delhi, 2002.

Course Outcomes:

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

- Analyze the performance of transformers under various operating conditions using their characteristics.
- Interpret the efficiency of DC machines by conducting Suitable tests.
- Interpret the efficiency of AC machines by conducting Suitable tests.
- Understand the concepts of special machines.
- Analyze the utilization of different home appliances

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EEOET-106	Power Electronics in Power systems	3L:0T:0P	3 Credits

Course objectives:

- To introduce characteristics of power electronic devices, design of various power converter circuits and speed control concepts of AC and DC drives.
- To understand the different power converters for renewable energy systems
- To gain knowledge on stand-alone and grid connected renewable energy systems.

MODULE I – POWER CONVERTER **9 Hours**

Power Semiconductor Devices - Power Converters – AC to DC, AC to AC converters. - PWM based Power Converters: DC to DC, DC to AC converters.

Principle of operation: line commutated converters (inversion-mode) - Boost and buck-boost converters- selection of inverter, battery sizing, array sizing.

MODULE II – DRIVE SYSTEM **9 Hours**

Introduction to motor drives – Solid-state speed control of DC motor drive system. - Solid-state speed control of induction motor drive system.

MODULE III- RENEWABLE ENERGY CONVERSION **9 Hours**

Environmental aspects of electric energy conversion – impacts of renewable energy generation on environment – qualitative study of different renewable energy resources – Modeling and analysis of Doubly Fed Induction Generator – Permanent Magnet Synchronous Generator – Squirrel Cage Induction Generator.

MODULE IV -ANALYSIS OF WIND AND PV SYSTEMS **9 Hours**

Stand-alone operation of fixed and variable speed wind energy conversion systems and solar system- Grid connection Issues -Grid integrated PMSG, SCIG Based WECS, grid Integrated solar system

MODULE V - HYBRID RENEWABLE ENERGY SYSTEMS **9 Hours**

Need for Hybrid Systems- Range and type of Hybrid systems- Case studies of Wind-PV Maximum Power Point Tracking

Total No of Hours: 45

Text Books:

1. M.D.Singh and K.B.Kanchandhani, 'Power Electronics', Tata McGraw-Hill Publishing Company Limited, 2nd Edition, 2006.
2. K. Venkataratnam, "Special Electrical Machines", Universities Press, 1st Edition, 2008.
3. M. H. Rashid, "Power Electronics Hand book", Academic press, 4th Edition, 2017.

Reference Books:

1. Andrzej M. Trzynnadlowski, "Introduction to Modern Power Electronics", Wiley, India Pvt. Ltd, 2nd Edition, 2012.
2. P.S. Bimbhra, 'Power Electronics', Khanna Publishers, 3rd Edition, 13th Reprint, 2004.

Course outcomes:

- Understand the principle of operation of commonly employed power electronic converters.
- Analyze non -linear circuits with several power electronic switches.
- Design different power converters for renewable energy systems.
- Analyze standalone and grid connected operating modes of wind, solar energy systems.
- Implement maximum power point tracking algorithm and gain knowledge on hybrid systems.

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EEOET-107	Introduction to Robotics and Automation	3L:0T:0P	3 Credits

Course Objectives:

- To design automatic manufacturing cells with robotic control.
- To understand the electronic control system in metal machining and other manufacturing process.
- To understand the features and operation of automation products.
- To understand ethical and professional responsibilities
- To communicate effectively and work in interdisciplinary groups

MODULE I - ROBOT BASICS **9 Hours**

Robot-Basic concepts, Need, Law, History, Anatomy, specifications. Robot configurations-cartesian, cylinder, polar and articulate. Robot wrist mechanism, Precision and accuracy of robot. Robot elements end effectors-Classification, Types of Mechanical actuation, Gripper design, Robot drive system Types, Position and velocity feedback devices-Robot joints and links-Types, Motion interpolation.

MODULE II – ROBOT KINEMATICS AND CONTROL **9 Hours**

Robot kinematics – Basics of direct and inverse kinematics, Robot trajectories, 2D and 3D Transformation-Scaling, Rotation, Translation Homogeneous transformation. Control of robot manipulators – Point to point, Continuous Path Control, Robot programming

MODULE III – ROBOT SENSORS **9 Hours**

Sensors in robot – Touch Sensors-Tactile sensor – Proximity and range sensors. Force sensor-Light sensors, Pressure sensors, Introduction to Machine Vision and Artificial Intelligence.

MODULE IV - FUNDAMENTAL CONCEPTS OF INDUSTRIAL AUTOMATION 9 Hours

Fundamental concepts in manufacturing and automation, definition of automation, reasons for automating. Types of production and types of automation, automation strategies, levels of automation.

MODULE V - TRANSFER LINES AND AUTOMATED ASSEMBLY 9 Hours

General terminology and analysis, analysis of transfer lines without storage, partial automation. Automated flow lines with storage buffers. Automated assembly-design for automated assembly, types of automated assembly systems, part feeding devices, analysis of multi-station assembly machines. AS/RS, RFID system, AGVs, modular fixturing. Flow line balancing.

Total no. of Hours: 45

Text Books:

1. Mikell P Groover, "Industrial Robots – Technology Programmes and Applications" , McGraw Hill , New York, USA. 2000.

2. Deb.S.R and Sankha Deb, "Robotics Technology and Flexible Automation", Tata McGraw Hill Publishing Company Limited, 2010.

3. Klafter.R.D, Chmielewski.T.A, and Noggin's., "Robot Engineering: An Integrated Approach"', Prentice Hall of India Pvt. Ltd., 1994

Reference Books:

1. Fu.K.S, Gonzalez.R.C&Lee.C.S.G, "Robotics control, sensing, vision and intelligence", Tata-McGraw Hill Pub. Co., 2008

2. Yu. "Industrial Robotics", MIR Publishers Moscow, 1985.

Course Outcomes:

Upon the completion of this course the student will be able to

- Design automatic manufacturing cells with robotic control.
- Understand the electronic control system in metal machining and other manufacturing process.
- Understand the features and operation of automation products.
- Understand ethical and professional responsibilities
- Communicate effectively and work in interdisciplinary groups

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EEOET-108	Power System Engineering	3L:0T:0P	3 Credits

Course Objectives:

To impart knowledge on power generation, transmission, distribution and protection systems, and overview of power system economics and regulations.

MODULE I - OVERVIEW OF GENERATION SYSTEMS 9 Hours

Sources of Energy, Steam, Diesel, Nuclear and Hydro power plants – site selection - Layout – essential components and operation.

MODULE II- MODES OF TRANSMISSION AND DISTRIBUTION 9 Hours

HVAC and HVDC Transmission system – overhead lines – towers, conductors and insulators, underground cables – types – laying methods and fault location, comparison of over-head and underground systems, distribution system – classification – components, power factor correction.

MODULE III - BASIC PROTECTION AND SWITCHGEARS 9 Hours

System faults and abnormal conditions, system grounding, need for protection system, overview of apparatus protection, switch gear mechanisms – fuse, switch, isolator and circuit breakers.

MODULE IV- ECONOMICS ON POWER SYSTEMS 9 Hours

Factors affecting cost of generation – load curve – load factor – diversity, base load and peak load stations – reduction of generation cost by interconnection of stations, price of electricity – types of tariff for HT and LT consumers.

MODULE V - REGULATION / ELECTRICITY ACT 9 Hours

Evolution of Indian electricity act – regulator commissions, grid code, Introduction to restructuring of power system – GenCo, TransCo and DisCo, Independent power producers, Introduction to smart grid.

Total no. of Hours: 45

Text Books:

1. R K Rajput, 'Power System Engineering', Laxmi Publications Ltd., 2006.
2. A Chakrabarti, M L Soni, P V Gupta and U S Bhatnagar, 'Power System Engineering', Dhanpat Rai & Co., Ltd., 2010.
3. S N Singh. 'Electric Power Generation, Transmission and Distribution', PHI Publications, 2008.

Reference Books:

1. B.R. Gupta, 'Power System Analysis and Design', S. Chand Limited, 5th Edition, 2008.
2. Hadi Saadat, "Power System Analysis", Tata McGraw Hill Education Pvt. Ltd., New Delhi, 21st Reprint, 2010.

Course Outcomes:

Upon the completion of this course the student will be able to

- Illustrate the layout and operation of various power plants.
- Infer the modes of transmission and distribution of electrical energy.
- Select the appropriate protection scheme for various power apparatus.
- Identify tariff structure and calculate the energy pricing.
- Discuss about Indian electricity act and regulations.

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EEOET-109	Energy Engineering	3L:0T:0P	3 Credits

Course Objectives:

- To impart knowledge on various energy sources.
- To gain adequate knowledge on Conventional Energy Sources
- To outline about the Hydro and Ocean Energy Electric Technologies
- To provide knowledge on Wind, Solar Energy and DG Technologies.
- To provide knowledge on Energy Conservation And Management

MODULE I - ENERGY RESOURCES 9 Hours

Perspective of energy resources- Forms of Energy- World's energy status- Energy reserves of India- India's Power Scenario- Renewable Energy Sources- Energy parameters- Energy Intensity Gross Domestic product.

MODULE II - CONVENTIONAL ENERGY SOURCES 9 Hours

Coal fired steam thermal power plant– layout, working principle- Gas turbine power plant–various options, layout, working principle- Nuclear power plants: fuels, nuclear fuel cycle, reactors, nuclear power plant, and nuclear waste management.

MODULE III - HYDRO AND OCEAN ENERGY ELECTRIC TECHNOLOGIES 9 Hours

Hydro Electric plants – Types, energy conversion schemes, power equation, environmental aspects– Hydro-Thermal co-ordination-Ocean Energy Technology- Power plant-limitations.

MODULE IV - WIND, SOLAR ENERGY AND DG TECHNOLOGIES 9 Hours

Wind turbine types and construction– wind energy conversion systems- grid connection environmental aspects. Solar energy basics- Solar PV plant- Distributed Generation- Impacts Benefits.

MODULE V - ENERGY CONSERVATION AND MANAGEMENT 9 Hours

Principle of energy conservation- waste heat recovery –Heat Exchanger– Economics of energy Conservation-co generation- Definition and Objectives of Energy Management, Energy Management System, Top management support, Energy policy purpose, Roles and responsibilities of energy manager.

Total no. of Hours: 45

Text books:

1. S.Raoand Dr.B.B.parulekar, "Energy Technology", Khanna pub.,Third edition, 1999.

2. Non-conventional energy resources by B.H.Khan,TMH, 2006.

3. Desai,AV,"EnergyDemand:Analysis,ManagementandConservation",Wiley Eastern Limited, 1990.

Reference books:

1. G.D.Rai, "Non-conventional energy sources", Khanna pub. Fourth Edition, 2002.

2. Abbasik"Renewable Energy Sources and their Environment", PHI, 2008.

. **Course Outcomes:**

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

- Analyze the national and international energy scenario of renewable energy Sources.
- Design the aerodynamics of wind turbines and calculate their energy production.
- Analyze electrical power generation from biomass, geothermal, tidal, wave etc.
- Analyze technical and sustainability issues involved in the integration of renewable energy systems
- Compare the cost economics of using renewable energy sources with non-renewable energy sources.

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EEOET-110	Sensors and Transducers	3L:0T:0P	3 Credits

Course Objectives:

- *To introduce students to the principle of various Transducers, their construction, applications and principles of operation, standards and units of measurements.*
- *To provide students with opportunities to develop basic skills in the design of electronic equipment.*

MODULE I - INTRODUCTION **9 Hours**

Transducers and sensors- Accuracy and precisions, types of errors, statistical analysis, probability of errors, limiting errors, sensitivity, linearity, hysteresis, resolution, reproducibility, transfer function.

MODULE II - ANALOG SIGNAL CONDITIONING **9 Hours**

Signal conditioning, Loading effects, Bridges for measurement techniques, Wheatstone, Wein, Kelvin's, Maxwell bridge and Hey bridge, Attenuators and Amplifiers, Passive filters, Op-amp based signal conditioning circuits, Inverting and Non-Inverting Amplifiers, Linearization, Differential amplifiers and Instrumentation amplifiers.

MODULE III - DIGITAL SIGNAL CONDITIONING **9 Hours**

Digital measuring techniques, Sample and Hold Circuits, Comparator, Buffers, D/A Conversion and A/D Conversion, Weighted Resistor DAC, R-2R ladder DAC, Dual Slope, Parallel-comparator Successive Approximation ADC techniques, Single channel and multi-channel Data Acquisition System (DAS).

MODULE IV - TEMPERATURE SENSORS **9 Hours**

Resistance Vs Temperature characteristics for different materials, Thermistors, Thermo-couples - thermo electric effects for thermo couples, thermocouple tables, RTD, Other Thermal Sensors.

MODULE V – TRANSDUCER MEASUREMENT **9 Hours**

Capacitive and inductive transducers, Displacement Sensor (LVDT), Strain Sensors – strain gauges, its principle, applications, types of strain gauges, Load cells, Piezo-electric sensors, Motion sensors.

Total no. of Hours: 45

Text Books:

1. Sensors and Transducers Ian R. Sinclair Newnes 3 rd Edition, 2001.
2. Electronic Instrumentation – by H S Kalsi TMH 2nd Ed 2004.
3. ShawhneyA.K."A Course In Electrical and Electronics Measurements and Instrumentation", Dhanpat Rai & Sons, 11th Ed., 1999.

Reference Books:

1. Curtis D. Johnson, "Process Control Instrumentation Technology", Prentice Hall India.
2. D.V.S. Murty, "Transducers and Instrumentation", Prentice Hall India.

Course Outcomes:

At the end of this course students will be able to:

- Understand the terminology of Instrumentation and analyze various sensors.
- Able to apply signal conditioning for measurements.
- Explain various measurements techniques for industrial applications based on transducers.

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EEOET-111	Power Plant Engineering	3L:0T:0P	3 Credits

Course Objectives:

- *To understand the basic knowledge of various types of power plants and the factors considered for site selection*
- *To have a clear idea about the operation of Steam Power Plants with detailed study of the associated equipment's and machineries*
- *To know the working principle, basic components and various modern reactors of the nuclear power plants*
- *To get a clear knowledge about how power is generated using diesel, gas and combined cycle power plants*
- *To know the importance in selection of equipments and various tariff structures involved with power plants.*

MODULE I - INTRODUCTION **9 Hours**

Conventional and Non-Conventional Sources of Energy and their availability in India -Different Types of Power Plants - Choice of Power Generation - Basic schemes and constituents of Steam, Nuclear, Diesel and Gas Turbine power stations - Factors to be considered for selection of site - Power Plants in India.

MODULE II - STEAM POWER PLANTS **9 Hours**

Layout and types of Steam Power Plants - Fuel and Ash handling systems - Dust collectors – combustion equipment for steam boilers – Economizer and Air pre heater - Mechanical stokers – Pulverizes – Electrostatic precipitator – Draughts – Steam condensers - Cooling Ponds and Cooling Towers - Pollution Controls - Methods of Feed water treatment – Generating efficiency - Power generation capacities of various plants in India.

MODULE III - NUCLEAR POWER PLANTS **9 Hours**

Nuclear energy - Fission and Fusion reaction - Layout and subsystems of Nuclear Power Plants, Working of Nuclear Reactors - Boiling Water Reactor , Pressurized Water Reactor -Uranium reactor, Breeder Reactor, Gas Cooled and Liquid Metal Cooled Reactors - Safety measures for Nuclear Power plants - Case study: Comparison of various nuclear power plants in India.

MODULE IV- DIESEL, GAS TURBINE AND COMBINED CYCLE POWER PLANTS

9 Hours

Layout of Diesel power plants and components - Selection of engine – types and applications - Gas Turbine power plant – Classifications - Layout – Merits – fuels – Combined Cycle Power Plants - Integrated Gasified based Combined Cycle systems - Introduction to Energy storage – Case study: Decentralized Power technologies.

MODULE V - POWER PLANT ECONOMICS **9 Hours**

Economics of Power generation - Cost of Electrical Energy, Expression for cost of electrical energy, interest, depreciation - Power tariff - types - Load distribution parameters - Load curve - load duration Curve – Effect of load on power plant design – Load forecasting – Peak load pricing - Comparison of site selection criteria -Relative merits and demerits - Capital and Operating Cost of different power plants.

Total No of Hours: 45

Text Books

1. El-Wakil, "Power Plant Technology", McGraw-Hill, 1st Edition, 2010.

2. Frederick T. Morse, "Power Plant Engineering", Affiliated East-West Press Pvt Ltd, 7th Edition, 2008.

3. R. K. Rajput, "Power Plant Engineering", Laxmi Publications, 4th Edition, 2016.

Reference Books

1. Leonjard L. Grigsby, "Electric Power Generation, Transmission and Distribution", CRC Press, 3rd Edition, 2012.

2. P.K. Nag, "Power plant Engineering", Tata McGraw-Hill, 4th Edition, 2017.

Course Outcomes

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

- Relate the various conventional energy systems and factors affecting their site selection.
- Illustrate power generation using steam power plants along with the detailed review on its equipments used.
- Explain about the nuclear energy production, its equipments and reactors model inside the plant.
- Express and compare the construction, working principle of various equipments used with diesel, gas turbine and combined cycle power plants.
- Evaluate economic feasibility and importance of equipment selection to formulate tariff structure for power generating units.

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MINOR ELECTIVE SUBJECTS

(MI)

EEMIT-101	Consumer Electronics	3L:0T:0P	3 Credits

Course Objectives:

- *To enable the troubleshoot of different types of microphones and loudspeakers.*
- *To make the students to analyze the working of digital console, digital FM tuner and troubleshoot audio systems.*
- *To train and test the working of various colour TV.*
- *To empower them to troubleshoot colour TV receivers.*
- *To equip them to maintain various electronic home and office appliances.*

MODULE I- AUDIO DEVICES 9 Hours

Basic characteristics of sound signal, Microphone - working principle, sensitivity, nature of response. Types of Microphone, Loud speaker - working principle, Woofers and Tweeters, characteristics. Types of Loudspeaker. Sound recording.

MODULE II - AUDIO SYSTEMS 9 Hours

Introduction to audio system, Digital Console- Block diagram, working principle, applications, FM tuner- concepts of digital tuning, ICs used in FM tuner TD702IT, PA address system- Planning, speaker impedance matching, characteristics, power amplifier specification.

MODULE III - TELEVISION SYSTEMS 9 Hours

Monochrome TV standards, Components of TV system, scanning process, aspect ratio, persistence of vision and flicker, interlace scanning, picture resolution. Composite video signal, Colour TV standards, colour theory, hue, brightness, saturation, luminance and chrominance. Different types of TV camera.

MODULE IV- TELEVISION RECEIVERS AND VIDEO STANDARDS 9 Hours

Colour TV receiver- block diagram, Digital TVs- LCD, LED , PLASMA, HDTV, 3-D TV, projection TV, DTH receiver, Video interface: Composite, Component, Separate Video, Digital Video, SDI, HDMI, Digital Video Interface, CD and DVD player: working principles, interfaces

MODULE V- HOME AND OFFICE APPLIANCES 9 Hours

Microwave Oven: Types, technical specifications. Washing Machine: hardware and software. Air conditioner and Refrigerators: Components features, applications, and technical specification. Digital camera and cam coder: - pick up devices, picture processing, picture storage.

Total No of Hours: 45

Text Books:

1. Bali S.P., "Consumer Electronics", Pearson Education India, 1st Edition 2008.

2. Bali R and Bali S.P. "Audio video systems: principle practices & troubleshooting", Khanna Book Publishing Co. (P) Ltd.2014.

3. Gulati R.R., "Modern Television practices", New Age International Publication (P) Ltd, 5th Edition, 2015.

Reference Books:

1. Gupta R.G., 'Audio video systems', Tata Mcgraw Hill, New Delhi, India, 2nd Edition, 2017

2. Whitaker Jerry & Benson Blair, 'Mastering Digital Television', McGraw-Hill Professional, 2006

Course Outcomes:

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

- Describe the fundamental audio characteristics and measurements, operating principles of microphone and loudspeaker.
- Explain the working of digital console, digital FM tuner and troubleshoot the audio systems.
- Distinguish the salient features of colour TV and Monochrome and troubleshoot TV camera.
- Demonstrate various interfaces in digital TV, the working of DTH receiver, CD/DVD players.
- Explain the working of FAX, Microwave oven, Washing machine, Air conditioner, Refrigerators and camera.

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EEMIT -102	Electrical and Electronics Instruments	3L:0T:0P	3 Credits

Course Objectives:

- *To have an adequate knowledge in the measurement techniques for current, voltage, power and energy.*
- *Elaborate discussion about potentiometer & instrument transformers.*
- *Detailed study of resistance and impedance measuring methods.*
- *An exposure is given to the student about signal generation and analysis.*
- *In-depth knowledge is given to the student about cathode ray oscilloscope.*
- *Emphasis is laid on display and recording devices*

MODULE I- MEASUREMENT OF VOLTAGE, CURRENT, POWER AND ENERGY

9 Hours

Galvanometers – Ballistic, D'Arsonval galvanometer – Theory, calibration, application-Principle, construction, operation and comparison of moving coil, moving iron meters, dynamometer, induction type & thermal type meter, rectifier type – Extension of range and calibration of voltmeter and ammeter– Errors and compensation Electrodynamometer type wattmeter – Theory & its errors – Methods of correction – LPF wattmeter – Phantom loading – Induction type KWH meter – Calibration of wattmeter, energy meter.

MODULE II- POTENTIOMETERS & INSTRUMENT TRANSFORMERS: 9 Hours

DC potentiometer – Basic circuit, standardization – Laboratory type (Crompton's) – AC potentiometer – Drysdale (polar type) type – Gall-Tinsley (coordinate) type – Limitations & applications – Magnetic measurements – Ballistic Galvanometer, Grassot flux meter – testing of ring specimen – method of reversal and step by step method – testing of bar specimen – Hopkinson's permeameter – Iron loss measurement by Lloyd Fisher square. AC test on magnetic materials. C.T and V.T construction, theory, operation, phasor diagram, characteristics, testing, error elimination – Applications.

MODULE III - RESISTANCE AND IMPEDANCE MEASUREMENT 9 Hours

Measurement of low, medium & high resistance – Ammeter, voltmeter method – Wheatstone bridge – Kelvin double bridge – Series and shunt type ohmmeter –High resistance measurement – Megger – Direct deflection methods – Price's guard-wire method – Loss of charge method – Earth resistance measurement.A.C bridges– Measurement of inductance, capacitance – Q of coil – Maxwell Bridge – Wein's bridge – Hey's bridge – Schering bridge – Anderson bridge –Campbell bridge to measure mutual inductance –Introduction to cable fault and eddy current measurement.

MODULE IV SIGNAL GENERATORS AND ANALYZERS **9 Hours**

Sine wave generator – Frequency synthesized sine wave generator – Sweep frequency generator, pulse and square wave generator – Function generator – Wave analyzer – Applications – Harmonic distortion analyzer – Spectrum analyzer – Applications – Audio Frequency generator – Noise generator.

MODULE V- CATHODE RAY OSCILLOSCOPE, RECORDERS AND DISPLAYS

9 Hours

General purpose oscilloscope – Screens for CRT graticules – Vertical & horizontal deflection systems – Delay line – Multiple trace – Dual beam & dual trace – Probes – Oscilloscope techniques – Special oscilloscopes – Storage oscilloscopes – Sampling oscilloscope. X-Y Plotters, magnetic tape recording , direct , FM , digital recording, – Data loggers. Display devices : LED – LCD – Annunciators, Numerics, Alphanumerics.

Total No of Hours: 45

Text books:

1. A.K. Sawhney, 'Electrical & Electronic Measurements and Instrumentation', Dhanpath Rai & Co (P) Ltd, 2004.

2 Albert D. Helfrick & William D. Cooper, 'Modern Electronic Instrumentation & Measurement Techniques', Prentice Hall of India, 2002.

3. E.W.Golding & F.C.Widdis, 'Electrical Measurements & Measuring Instruments', A.H.Wheeler & Co, 1994.

Reference books:

1. Patranabis, "Principles of Electronic Instrumentation" - PHI, 2007

2. J.B.Gupta, 'A Course in Electronic and Electrical Measurements and Instrumentation', S.K. Kataria & Sons, Delhi, 2003.

Course Outcomes:

- Develop the knowledge of theoretical and mathematical principles of electrical measuring instruments.
- Examine various real life situations in domestic or industrial scenario where measurements of electrical quantities are essential.
- Choose the proper type and specification of measuring procedure and measuring instruments for different industrial/commercial/domestic appliances.
- Assess fault conditions in electrical installations and identify necessary remedial measures. Design new sensing and measuring schemes for various electrical and electronic applications

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EEMIT-103	Electrical Energy Audit and Conservation	3L:0T:0P	3 Credits

Course Objectives

- *To know the necessity of conservation of energy.*
- *To understand the energy management schemes in motors.*
- *To understand the energy management methods in lighting schemes.*
- *To illustrate the metering schemes for energy management.*
- *To learn economic analysis and management techniques*.

MODULE I - INTRODUCTION 9 Hours

Basics of energy – need for energy management – energy accounting – energy monitoring – targeting and reporting – energy audit – definitions – types of energy audit – audit instruments – audit of process industry – Case studies.

MODULE II- ENERGY MANAGEMENT AND COGENERATION 9 Hours

Energy management for electric motors: energy efficient controls and starting efficiency – motor efficiency and load analysis – selection of motors – energy efficient motors. Energy management by cogeneration: forms of cogeneration – electrical interconnection.

MODULE III- LIGHTING SYSTEMS 9 Hours

Energy management in lighting systems: task and the working space – light sources – ballasts – lighting controls – optimizing lighting energy – reactive power management – capacitor sizing – degree of compensation – capacitor losses –effect of harmonics – lighting and energy standards.

MODULE IV -METERING FOR ENERGY MANAGEMENT 9 Hours

Metering for energy management: units of measure – utility meters – demand meters – paralleling of current transformers – instrument transformer burdens – multi tasking solid state meters – metering location vs requirements – power analyzer – metering techniques and practical examples.

MODULE V -ECONOMIC ANALYSIS 9 Hours

Power system tariffs – Economic analysis: cash flow model – Time value of money – pay-back method – utility rate structures – cost of electricity – loss evaluation – load management – demand control techniques – utility monitoring and control system – economic analysis of HVAC systems.

Total No of Hours : 45

Text Books:

1. Barney L. Capehart, Wayne C. Turner, and William J. Kennedy, "Guide to Energy Management", The Fairmont Press, Inc., 5th Edition, 2006.

2. Frank Kreith, D. Yogi Goswami, "Energy Management and Conservation Handbook", CRC Press, 2nd Edition, 2016.

3. Wayne C. Turner, "Energy Management Handbook", The Fairmont Press, 4th Edition, 2001.

References Books:

1. P. Venkataseshaiah K.V. Sharma, "Energy Management and Conservation", Dreamtech Press, 1stEdition, 2020.

2. ICAI, "Electricity in buildings good practice guide", McGraw-Hill Education, 1st Edition, 2017.

Course Outcomes:

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

- Outline about the energy audit process and instruments.
- Apply the energy efficient methods for improving efficiency of electric motors.
- Develop good illumination systems and analyze the power factor.
- Acquire knowledge on various meters used for energy management
- Analyze and evaluate cost effective model in electrical equipment.

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EEMIT -104	Electric Traction	3L:0T:0P	3 Credits

Course Objectives:

- *To understand the Traction systems and its mechanics for train movement.*
- *To identify the power supply equipment suited for traction systems and differentiates AC and DC traction drives.*
- *To analyze various types of equipment used in protection of locomotive system*
- *To familiarize about various systems of track electrification and power supply system.*
- *To understand the working of various railway signaling system.*

MODULE I - INTRODUCTION OF ELECTRIC TRACTION 9 Hours

Indian Scenario of Electric traction, Advantages of Electric Traction over other systems of traction, selection of traction system - Electric and Diesel-Electric. Mechanics of train movement- Speed - time curve for train movement- Requirement of tractive effort and T-N curve of a typical train load, Specific energy consumption and Coefficient of adhesion- Suspension and mechanism of torque transmission Concept of Weight Transfer & Effect of un-sprung mass and wheel diameter.

MODULE II -TRACTION MOTOR DRIVES 9 Hours

Type of traction motor- characteristics- Optimization of design and construction features- Tractive Effort and Drive Ratings- Important Features of Traction Drives- conventional DC and AC Traction drives- Converter Controlled Drives- DC Traction using Chopper Controlled Drives- Poly phase AC /DC Traction Motors- Traction control of DC locomotives and EMU's- Traction control system of AC locomotives- Control gear

MODULE III -PROTECTION OF LOCOMOTIVE EQUIPMENT & CIRCUITS 9 Hours

Broad strategy for protection, Surge protection, Overload protection of main power circuits, Earth fault protection of power auxiliary circuits- Protection from over-voltage and under-voltage, Differential protection of traction circuits- Protection against high and low air pressure in the compressed air circuit- Temperature monitoring, Protection of transformer by Buchholz relay- Protection against accidental contact with HT equipment Protection against fires.

MODULE IV-ELECTRIC TRACTION SUB-SYSTEMS (OVERHEAD EQUIPMENT)

9 Hours

Overhead Equipment (OHE), Sectionalizing, Bonding of Rails and Masts, Materials Employed in OHE Electric Traction Sub-Systems- Power Supply Installations- Layout design of Traction Substation/ Protection, Booster Transformers and Return Conductor- SCADA System.

MODULE V- RAILWAY SIGNALLING **9 Hours**

Block Section Concept-Track Circuits, Interlocking Principle- Train speed and signaling- Solid state Interlocking- Automatic Warning Systems.

Total No of Hours: 45

Text Books:

1. Upadhayay J, Mahindra S.N, "Electric Traction", Allied Publishers Ltd., 1st Edition, 2000.

2. Andreas Steimel, "Electric Traction-Motive Power and Energy Supply, Deutscher Industrieverlag publishers, 2nd Edition, 2014.

3. H. Partab, "Modern Electric Traction", Dhanpat Rai & Sons, 2017.

Reference Books:

1. P.S. Rao, "Principle of 25 KV Overhead Equipments", Printpack Pvt. Ltd., 1st Edition, 2000.

2. Gopal K Dubey, "Fundamentals of Electric Drives", Narosa Publishing, 2nd Edition, 2010.

Course Outcomes:

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

- Familiarize the basics of Electric Traction System and its mechanics for train movements.
- Outline about the different Traction Drives and controlling techniques.
- Differentiate the best suited protection system for Electric Locomotive
- Design the Electric Traction Sub-Systems.
- Apply the solid state interlocking principle in railway signaling system

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EEMIT-105	ELECTRIC VEHICLES	3L:0T:0P	3 Credits

Course objectives:

- To familiarize with the fundamental concept of electric vehicle
- To overview the energy storage technologies used for electric vehicle.
- To determine various electric drives suitable for electric vehicles.
- To understand about the different power converter topologies used in electric vehicle
- To understand the concept of electric vehicle architecture, component sizing and electric motor drive.

MODULE I - INTRODUCTION TO EV 9 Hours

History of hybrid and electric vehicles - social and environmental importance - impact of modern drive - trains on energy supplies - Fundamentals of vehicle propulsion and Braking: Dynamic Equation - Power train tractive effort - Vehicle Power Plant and Transmission Characteristics - Vehicle Performance.

MODULE II - ENERGY MANAGEMENT STRATEGIES 9 Hours

Introduction to energy management strategies used in electric vehicle, classification of different energy management strategies, comparison of different energy management strategies, implementation issues of energy strategies.

MODULE III - ELECTRIC PROPULSION DRIVE SYSTEMS 9 Hours

Electric drives used in EV/HEV: Induction motor drives - DC motor drives - Permanent magnet motor drives - their Configuration - SRM Drives.

MODULE IV – EV CONFIGURATIONS 9 Hours

Configurations of EV - advantages - EV transmission configuration: Transmission components - gear ratio - EV motor sizing - EV market.

MODULE V - STORAGE TECHNOLOGY 9 Hours

Battery Types - Parameters - Technical characteristics – modelling and equivalent circuit - Methods of battery charging - Fuel cells: Types - Fuel cell electric vehicle – Ultra capacitors - Hydrogen storage systems – Flywheel technology.

Total No of Hours: 45

Text books:

1. Mehrdad Ehsani, Yimin Gao, Sebastien E.Gay, Ali Emadi, "Modern Electric, Hybrid Electric and Fuel Cell Vehicles", CRC Press, 3rd Edition, 2019.
2. Iqbal Hussain, "Electric and Hybrid Vehicles – Design Fundamentals", CRC Press, 2nd Edition, 2011.

Reference books:

1. K. T. Chau, "Electric vehicle machines and drives: Design, analysis and application", John Willey and Sons Singapore pte. ltd., 1st Edition, 2015.
2. J. Larminie and J. Lowry, "Electric vehicle technology explained", John Willey & Son ltd., 2nd Edition, 2012.

Course outcomes:

- Summarize the basics of electric vehicle and its working principle.
- Combine the different energy storage technologies and its implementation in electric vehicle.
- Develop the hybrid electric vehicle with different power converter topology.
- Review the working of different configurations of electric vehicle and its concepts
- Describe the working of different configurations of electric vehicles.

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EEMIT -106	AI Techniques in Electrical Engineering	3L:0T:0P	3 Credits

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.

MODULE I - ARTIFICIAL NEURAL NETWORKS 9 Hours

Introduction, Models of Neuron Network-Architectures –Knowledge representation, Artificial Intelligence and Neural networks–Learning process -Error correction learning, Hebbian learning –Competitive learning-Boltzman learning, supervised learning-Unsupervised learning– Reinforcement learning-Learning tasks.

MODULE II - ANN PARADIGMS 9 Hours

Multi-layer perceptron using Back propagation Algorithm (BPA), Self –Organizing Map (SOM),

Radial Basis Function Network-Functional Link Network (FLN), Hopfield Network.

MODULE III - FUZZY LOGIC 9 Hours

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.

MODULE – IV GENETIC ALGORITHMS 9 Hours

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

MODULE V - APPLICATIONS OF AI TECHNIQUES 9 Hours

Load forecasting, Load flow studies, Economic load dispatch, Load frequency control, Single area system and two area system, Reactive power control, Speed control of DC and AC Motors.

Text Books:

1. S. Rajasekaran and G.A.V. Pai Neural Networks, Fuzzy Logic & Genetic Algorithms, PHI, New Delhi, 2003.

2. Rober J. Schalkoff, Artificial Neural Networks, Tata McGraw Hill Edition, 2011.

3.Saifullah "Applications of Artificial Intelligence in Electrical Engineering" Business Science Reference 2020.

Reference Books:

1. Kevin Warwick "Artificial Intelligence Techniques in Power Systems", Institution of Engineering and Technology 1997

Course Outcomes:

Upon the completion of this course, the student will be able to

- Understand feed forward neural networks, feedback neural networks and learning techniques.
- Understand fuzziness involved in various systems and fuzzy set theory.
- Develop fuzzy logic control for applications in electrical engineering
- Develop genetic algorithm for applications in electrical engineering

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EEMIT-107	INDUSTRIAL ELECTRICAL SYSTEM	3L:0T:0P	3 Credits

Course objectives:

- To import basic ideas on electrical control components and electrical safety practices
- To provide the electrical wiring for residential and commercial buildings.
- To study on various illumination systems for commercial applications.
- To explain about the various components used for installation purpose.
- To import knowledge on modern techniques used for the monitoring and control.

MODULE I : ELECTRICAL CONTROL COMPONENTS 9 Hours

LT system wiring components - selection of cables – wires – switches - distribution box - metering system - Tariff structure - protection components – Fuse – MCB – MCCB – ELCB - inverse current characteristics – symbols - single line diagram (SLD) of a wiring system – Contactor - Isolator – Relays – MPCB - Electric shock and Electrical safety practices.

MODULE II: WIRING SYSTEMS 9 Hours

Types of residential and commercial wiring - general rules and guidelines for installation – load calculation and sizing of wire - rating of main switch - distribution board and protection devices - earthing systems - requirements of commercial installation - lighting schemes - selection - sizing of components.

MODULE III: ILLUMINATION SYSTEMS 9 Hours

Light – lumen – intensity - candle power - lamp efficiency - specific consumption – glare - space to height ratio- waste light factor - depreciation factor - various illumination schemes - Incandescent lamps and modern luminaries like CFL - LED and their operation - energy saving in illumination systems - design of a lighting scheme - flood lighting.

MODULE IV: INDUSTRIAL INSTALLATION COMPONENTS 9 Hours

HT connection - industrial substation - Transformer selection - Industrial loads - motors - Cable and Switchgear selection - Lightning Protection - Earthing design - Power factor correction – KVAR calculations - type of compensation - Introduction to PCC- MCC panels. Specifications of LT Breakers - MCB and other LT panel components. DG (Diesel Generator) Systems - Electrical Systems for the elevator - Battery banks - Sizing the DG - UPS System - Online and OFF line UPS - Battery Banks- Selection of UPS and Battery Banks.

MODULE V: INDUSTRIAL AUTOMATION **9 Hours**

Study of basic PLC - Role of automation-advantages of process automation - PLC based control system design - Panel Metering - Introduction to distributed control system (DCS) and SCADA system for distribution automation.

Text Books:

1. H. Partab , "Art and Science of Utilization of Electrical Energy", , Dhanpat Rai and Co., , 2nd Edition, 2017
2. B. P. Patil, M. A. Chaudhari, "Industrial Electrical Systems - I", Nirali Prakashan publications, 2nd Edition, 2015
3. R. K. Rajput, "Utilization of Electrical Power", Laxmi Publications., 2nd Edition, 2016.

Reference Books:

1. Frank Lamb, "Industrial Automation: Hands On", McGraw-Hill Professional, 1st Edition, 2013.
2. C. L. Wadhwa, "Generation, Distribution and Utilization of Electrical Energy", New Age International, 4th Edition, 2017.

Course outcomes:

- Acquire knowledge on electrical components used in industries.
- Design residential and commercial wiring connection.
- Design the different illumination systems for industries.
- Acquire knowledge on selection of installation components for industries.
- Apply the PLC and SCADA system for the automation of industries.

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EEMIT-108	Industrial Safety	3L:0T:0P	3 Credits

Course Objectives:

- To Understand the Introduction and basic Terminologies safety.
- To enable the students to learn about the Important Statutory Regulations and standards.
- To enable students to Conduct and participate the various Safety activities in the Industry.
- To have knowledge about Workplace Exposures and Hazards.
- To assess the various Hazards and consequences through various Risk Assessment Techniques.

MODULE I - SAFETY TERMINOLOGIES 9 Hours

Hazard-Types of Hazard- Risk-Hierarchy of Hazards Control Measures-Lead indicators- lag Indicators-Flammability- Toxicity Time-weighted Average (TWA) - Threshold Limit Value (TLV) - Short Term Exposure Limit (STEL)- Immediately dangerous to life or health (IDLH)- acute and chronic Effects- Routes of Chemical Entry-Personnel Protective Equipment- Health and Safety Policy-Material Safety Data Sheet MSDS

MODULE II - STANDARDS AND REGULATIONS 9 Hours

Indian Factories Act-1948- Health- Safety- Hazardous materials and Welfare- ISO 45001:2018 occupational health and safety (OH&S) - Occupational Safety and Health Audit IS14489:1998- Hazard Identification and Risk Analysis- code of practice IS 15656:2006

MODULE III - SAFETY ACTIVITIES 9 Hours

Toolbox Talk- Role of safety Committee- Responsibilities of Safety Officers and Safety Representatives- Safety Training and Safety Incentives- Mock Drills- On-site Emergency Action Plan- Off-site Emergency Action Plan- Safety poster and Display- Human Error Assessment

MODULE IV- WORKPLACE HEALTH AND SAFETY 9 Hours

Noise hazard- Particulate matter- musculoskeletal disorder improper sitting poster and lifting Ergonomics RULE & REBA- Unsafe act & Unsafe Condition- Electrical Hazards- Crane Safety- Toxic gas Release

MODULE V - HAZARD IDENTIFICATION TECHNIQUES 9 Hours

Job Safety Analysis-Preliminary Hazard Analysis-Failure mode and Effects Analysis- Hazard and Operability- Fault Tree Analysis- Event Tree Analysis Qualitative and Quantitative Risk Assessment- Checklist Analysis- Root cause analysis- What-If Analysis- and Hazard Identification and Risk Assessment

Total No of Hours: 45

Text Books

1. R.K. Jain and Prof. Sunil S. Rao Industrial Safety, Health and Environment Management Systems Khanna Publishers, 4th Edition, 2000

2. L. M. Deshmukh "Industrial Safety Management: Hazard Identification and Risk Control" McGraw-Hill Education,7th Edition, 2008

3. John Ridley & John Channing "Safety at Work": Routledge, 7th Edition, 2008

References Books

1. Frank Lees "Loss Prevention in Process Industries." Butterworth-Heinemann publications, UK, 4th Edition. 2012

2. Dan Petersen "Techniques of Safety Management: A System Approach".4th Edition, 2003

Course Outcomes:

On completion of this course the student will be able to

- Understand the basic concept of safety.
- Obtain knowledge of Statutory Regulations and standards.
- Know about the safety Activities of the Working Place.
- Analyze on the impact of Occupational Exposures and their Remedies
- Obtain knowledge of Risk Assessment Techniques.

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EEMIT-109	Introduction to Microcontroller	3L:0T:0P	3 Credits

Course objectives:
Students will try to learn

- *To develop background knowledge and core expertise of microcontroller.*
- *To know the importance of different peripheral devices and their interfacing to microcontrollers.*
- *To know the design aspects of microcontrollers.*
- *To write assembly language programs of microcontrollers for various applications.*

MODULE I - 8051 MICROCONTROLLER **9 Hours**

Microprocessor Vs Microcontroller, Embedded Systems, Embedded Microcontrollers, 8051 Architecture- Registers, Pin diagram, I/O ports functions, Internal Memory organization. External Memory (ROM & RAM) interfacing.

MODULE II- INSTRUCTION SET **9 Hours**

Addressing Modes, Data Transfer instructions, Arithmetic instructions, Logical instructions, Branch instructions, Bit manipulation instructions. Simple Assembly language program examples (without loops) to use these instructions.

MODULE III- STACKS, I/O PORT INTERFACING AND PROGRAMMING **9 Hours**

8051 Stack, Stack and Subroutine instructions. Assembly language program examples on subroutine and involving loops. Interfacing simple switch and LED to I/O ports to switch on/off LED with respect to switch status.

MODULE IV- TIMERS AND SERIAL PORT **9 Hours**

8051 Timers and Counters – Operation and Assembly language programming to generate a pulse using Mode-1 and a square wave using Mode- 2 on a port pin. 8051 Serial Communication- Basics of Serial Data Communication, RS- 232 standard, 9 pin RS232 signals, Simple Serial Port programming in Assembly and C to transmit a message and to receive data serially.

MODULE V- INTERRUPTS AND INTERFACING APPLICATIONS 9 Hours

8051 Interrupts. 8051 Assembly language programming to generate an external interrupt using a switch, 8051 C programming to generate a square waveform on a port pin using a Timer interrupt. Interfacing 8051 to ADC-0804, DAC, LCD and Stepper motor and their 8051 Assembly language interfacing programming.

Total No of Hours: 45

TEXT BOOKS:

1. "The 8051 Microcontroller and Embedded Systems – using assembly and C", Muhammad Ali Mazidi and Janice Gillespie Mazidi and Rollin D. McKinlay; PHI, 2006 / Pearson, 2006.

2. "The 8051 Microcontroller", Kenneth J. Ayala, 3rd Edition, Thomson/Cengage Learning.

REFERENCE BOOKS:

1. "The 8051 Microcontroller Based Embedded Systems", Manish K Patel, McGraw Hill, 2014,

2. "Microcontrollers: Architecture, Programming, Interfacing and System Design", Raj Kamal, Pearson Education, 2005.

Course outcomes:

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

- Explain the difference between Microprocessors & Microcontrollers, Architecture of 8051
- Microcontroller, and Interfacing of 8051 to external memory and Instruction set of 8051.
- Explain the Interrupt system, operation of Timers/Counters and Serial port of 8051.
- Interface simple switches, simple LEDs, ADC 0804, LCD and Stepper Motor to 8051 using 8051 I/O ports.

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EEMIT-110	SMPS and UPS	3L:0T:0P	3 Credits

Course objectives:

- *To learn the working of isolated & non-isolated DC-DC converters*
- *To design isolated & non-isolated DC-DC converters.*
- *To drive the equations related with converter dynamics*
- *To different voltage and harmonics reduction techniques used for DC-AC converters.*
- *To knowledge on the techniques used to improve the power quality and design of filters for UPS.*

MODULE I - ANALYSIS OF NON-ISOLATED DC-DC CONVERTERS 9 Hours

Basic topologies: Buck, Boost and Buck-Boost - Principles of operation – Continuous conduction mode– Concepts of volt-sec balance and charge balance – Analysis and design based on SteadyState relationships – Introduction to discontinuous conduction mode.

MODULE II - SWITCHED MODE POWER CONVERTERS 9 Hours

SMPS Types: Self-Oscillating Fly back, Forward, Push pull, Luo, Half bridge and full bridge converters- control circuits and PWM techniques - SMPS with multiple outputs - Choice of switching frequency – Device Selection - State space modeling.

MODULE III - DC – AC CONVERTERS 9 Hours

Single phase and three phase inverters - control techniques, harmonic elimination techniques - Multilevel inverters -Concepts - Types: Diode clamped, Flying capacitor, Cascaded types; Switched Inductor and Capacitor multilevel Inverter - Applications.

MODULE IV - CONTROLLER DESIGN 9 Hours

Review of P, PI, and PID control concepts – gain margin and phase margin – Bode plot-based analysis – Design of controller for buck, boost and buck-boost converters.

MODULE V -POWER CONDITIONERS AND UPS 9 Hours

Introduction – Power line disturbances – Power conditioners – UPS: Offline and On-line – Need for filters – Filter for PWM VSI – Front-end battery charger – boost charger.

Total No of Hours: 45

Text books:

1. Simon Ang, Alejandro Oliva, "Power-Switching Converters", CRC Press, 3rd Edition, 2010.
2. Kjeld Thorborg, "Power Electronics – In theory and Practice", Overseas Press India Private Ltd, 1st Edition, 2005.
3. Power Electronics handbook, Industrial Electronics series, S.K.Varenina, CRC press, 2002.

Reference books:

1. Philip T Krein, "Elements of Power Electronics", Oxford University Press, 2nd Edition, 2014
2. Erickson, W. Robert, "Fundamentals of Power Electronics", Springer, 2nd Edition, 2010.

Course outcomes:

- Design the DC-DC converters for different applications.
- Analyze, design and select the converters used for switched mode power supplies in Computers, Laptop, and TV.
- Describe the importance of resonant Converters in reducing power loss and improving the life time of the power semiconductor device.
- Demonstrate the P, PI and PID controller performance analytically and by simulation for buck boost and buck- boost converters.
- Compare the different topologies of UPS and also simulate them

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HONOURS

EEHT-101	Computer Relaying and Phasor Measurement Unit	3L:0T:0P	3 Credits

Course Objectives:

• To understand and analyze the basic architecture of Digital Relay.

• Understand the basics of Phasor Measurement unit (PMU).

• Applications of PMUs in power system.

MODULE I - INTRODUCTION **9 Hours**

Mathematical background to protection algorithms-Finite difference technique-Numerical differentiation-Least Squares Method-Fourier analysis-Fourier analysis of analog signals- Fourier analysis of discrete signals-Walsh function analysis.

MODULE II - DIGITAL PROTECTION **9 Hours**

Basic elements of digital protection-Signal conditioning subsystem-Transducers-Surge protection circuits-Analog filtering-Analog multiplexers-Conversion subsystem-Sampling theorem-Signal aliasing error-Sample and hold circuit-Digital multiplexing-Digital-to-Analog Conversion-Analog-to-Digital Conversion-Processor-Data and Program memory-Digital relay hardware unit.

MODULE III - PHASOR ESTIMATION **9 Hours**

– Introduction- Phasor representation of sinusoids- Phasor Estimation of Nominal Frequency Signals- Formulas for updating phasors – Non recursive updates-Recursive updates- Frequency Estimation.

MODULE IV - APPLICATIONS **9 Hours**

Phasor Measurement Applications-State Estimation-History- Operator's load flow- Weighted least square - Linear weighted least squares; Nonlinear weighted least squares- Static state estimation-State estimation with Phasor measurements- linear state estimation.

MODULE V - ADAPTIVE PROTECTION **9 Hours**

Overview of Adaptive protection- Differential and distance protection of transmission lines-Adaptive out-of-step protection.

Text Books:

1. Arun G. Phadke, James S. Thorp, 'Computer Relaying for Power Systems', A John Wiley and Sons Ltd., Research Studies Press Limited, 2009.

2. A.G. Phadke, J.S. Thorp, 'Synchronized Phasor Measurements and Their Applications', Springer, 2008.

Reference Books:

1. A. T. Johns and S. K. Salman, 'Digital Protection for Power Systems', Peter Peregrinus Ltd, 1997.

Course Outcomes:

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

- Understand the operation of computer relay.
- Understand the basics of phasor measurement unit.
- Understand the different applications of PMUs in power systems.

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EEHT-102	VLSI Design	3L:0T:0P	3 Credits

Course Objectives:

To enrich the student with the concepts of VLSI devices and its fabrication and also to develop Different electronic circuits.

MODULE I - INTRODUCTION 9 Hours

MOS characteristics: NMOS characteristics, inverter action – CMOS characteristics, inverter action - models and second order effects of MOS transistors – Current equation – MOSFET Capacitances - MOS as Switch, Diode/ resistor – current source and sink – Current mirror.

MODULE II - FABRICATION TECHNIQUES 9 Hours

CMOS Fabrication – n-well, p-well, twin-tub processes – fabrication steps – crystal growth – photolithography – oxidation – diffusion – Ion implantation – etching – metallization.

MODULE III - CMOS LOGIC CIRCUITS 9 Hours

CMOS Logic Circuits: Implementation of logic circuits using n MOS and CMOS, Pass transistor and transmission gates – Implementation of combinational circuits – parity generator – magnitude comparator – stick diagram – layout design.

MODULE IV - MEMORY DESIGN 9 Hours

Memory design – SRAM cell – 6T SRAM – DRAM – 1T, 3T, 4T cells, CMOS Sequential circuits: Static and Dynamic circuits – True Single-phase clocked registers – Clocking schemes.

MODULE V - ASIC AND ITS DESIGN 9 Hours

ASIC - Types of ASICs - Design flow – Design Entry – Simulation – Synthesis – Floor planning – Placement – Routing - Circuit extraction – Programmable ASICs.

Total No. of Hours: 45

Text books:

1. Neil Weste, David Harris, ‘CMOS VLSI Design: A Circuits and Systems Perspective’, Addison Wesley, 4th Edition, 2010.

2. Debaprasad Das, ‘VLSI Design’, Oxford University Press, 2010.

3. Peter Van, ‘Microchip Fabrication’, Mc-Graw Hill Professional, 6th Edition, 2014.

Reference books:

1. M. J. S. Smith, ‘Application Specific Integrated Circuits’, Addison Wesley, 1997.

2. Uyemura, ‘Introduction to VLSI Circuits and Systems’, Wiley, 1st Edition, 2012.

Course outcomes:

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

1. To understand the insights of the MOS devices and its characteristics.
2. To appreciate the different VLSI process technologies.
3. To design the CMOS combinational logic circuits and its layout.
4. To develop the sequential circuits and clocking schemes.
5. To realize the Design flow of application-specific Integrated circuit.

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EEHT-103	Distribution System Automation	3L:0T:0P	3 Credits

Course Objectives:

- *To understand and appreciate the basic control techniques involved in distribution automation*
- *Introduced to the various communication systems involved in distribution automation.*
- *The course is to enable the students capable of analyzing the economics behind the automation of distribution system automation.*

MODULE I - INTRODUCTION 9 Hours

Introduction to Distribution Automation, Control System Interfaces, Control and Data requirements, Centralized (Vs) Decentralized Control, Distribution Automation System, DAS Hardware, DAS Software, DA Capabilities, Automation system computer facilities.

MODULE II - MONITORING AND CONTROL 9 Hours

Layout of substations and feeders - design considerations. Distribution system load flow - optimal siting and sizing of substations - optimal capacitor placement. Distribution system monitoring and control - SCADA, Remote metering and load control strategies - Optimum feeder switching

MODULE III - COMMUNICATION SYSTEMS 9 Hours

DA Communication Requirements - reliability, Cost Effectiveness, Data Rate Requirements, Two Way Capability - outages and faults, Ease of operation and maintenance - Communication Systems used - Distribution line carrier (Power line carrier), Telephone, Cable TV, Radio, AM Broadcast, FM SCA, VHF Radio, UHF Radio etc.

MODULE IV - BENEFIT CATEGORIES 9 Hours

DA Benefit Categories - Capital Deferred Savings - Operation and Maintenance Savings - Interruption Related Savings - Customer-related Savings - Operational savings. Improved operation - Function Benefits.

MODULE V - ECONOMIC IMPACTS 9 Hours

Automation on Distribution Systems, Integration of benefits into economic evaluation. Development and Evaluation of Alternate plans - Operation and Maintenance Cost Evaluation, Evaluation of Alternatives.

Text Books:

1. Momoh A. Momoh, James A. Momoh., 'Electric Power Distribution, Automation, Protection, and Control', CRC Press, 2007.

2. Gonen., 'Electric Power Distribution System Engineering', BSP Books, Pvt. Ltd, 2007.

EEHT-104	EHV AC and DC Transmission	3L:0T:0P	3 Credits

Reference Books:

1. D. Bassett, K. Clinard, J. Grainger, S. Purucker, and D. Ward, 'Tutorial Course: Distribution Automation', IEEE Tutorial Publication 88EH0280-8-PWR, 1988.

2. IEEE Working Group on 'Distribution Automation'.

Course Outcomes:

- Upon completion of the course the students would be able to
- Understand the Distribution Automation Systems and the Control techniques involved.
- Develop a clear idea on the layout of the substations and feeders and also on the various management techniques viz., load management and voltage management.
- Identify an appropriate method of communication for any particular distribution system with a view of automation.
- Evaluate the economic aspects of any distribution system with automation.

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Course Objectives:

• To understand and analyze the HVAC and HVDC transmission systems.

• To plan an appropriate transmission system between two destinations based on the load requirement and anticipated technical performance of power transmission.

MODULE I -INTRODUCTION 9 Hours

Design aspects of HVAC – conductor, tower, insulator and substation structure design, mechanical design - sag-tension calculations, design of EHVAC lines based on steady state limits and transient over voltages - design of extra HV cables - XLPE cables and gas insulated cables.

MODULE II - POWER FLOW 9 Hours

Real and reactive power flows in HVAC systems – reactive power compensation, FACTS devices in EHV Transmission, short circuit level & real power transfer capacity. Stability- voltage stability and control. Theory of travelling and stationary waves.

MODULE III - HVDC TRANSMISSION 9 Hours

Introduction to HVDC transmission - Bridge converters – rectifier and inverter operation, equivalent circuit representation, power reversal, desired features of control and actual control characteristics.

MODULE IV - CONTROLLERS **9 Hours**

Basic HVDC controllers, converter faults, commutation failure, bypass action in bridges, protection issues in HVDC - DC reactors, voltage and current oscillations, DC circuit breakers and over voltage protection.

MODULE V - HARMONICS **9 Hours**

Harmonics in HVDC - characteristics and uncharacteristic harmonics, troubles due to harmonics, harmonic filters – active and passive filters. Introduction to Hybrid HVDC and Off-shore wind power evacuation schemes.

Text Books:

1. S.Rao, 'EHV-AC, HVDC Transmission and Distribution Engineering', Khanna Publishers, 3rd Edition, 2012.
2. Rakosh Das Begamudre, 'Extra High Voltage AC Transmission Engineering', New Age International Publishers, 3rd Edition, 2009.

Reference Books:

1. Padiyar K.R., 'HVDC Transmission Systems', New Age International Publishers, 2nd Revised Edition, 2012.

Course Outcomes:

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

- Distinguish between the usage of EHVAC and HVDC transmission systems.
- Judge when and where to use EHAV / HVDC transmission systems in practice.
- Design implementation circuitry for various controllers used in HVDC transmission systems.
- Plan an appropriate electric power transmission system between two destinations to satisfy the pre-defined load requirement without compromising the technical performance

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EEHT-105	Energy Storage Technology	3L:0T:0P	3 Credits

Course Objectives:

- To understand the purpose of energy storage systems.
- To learn the different energy storage techniques.
- To learn about the different types of batteries available for energy storage.
- To impart knowledge regarding on the advanced energy storage systems.
- To learn about the different vehicular energy storage schemes**.**

MODULE I - INTRODUCTION TO ENERGY STORAGE IN POWER SYSTEMS 9 Hours

Need and role of energy storage systems in power system, General considerations, Energy and power balance in a storage unit, Mathematical model of storage system: modelling of power transformation system (PTS)-Central store (CS) and charge–discharge control system (CDCS), Econometric model of storage system.

MODULE II - OVERVIEW ON ENERGY STORAGE TECHNOLOGIES 9 Hours

Thermal energy: General considerations -Storage media- Containment- Thermal energy storage in a power plant, Potential energy: Pumped hydro-Compressed Air, Kinetic energy: Mechanical- Flywheel, Power to Gas: Hydrogen - Synthetic methane

MODULE III – STORAGE DEVICES 9 Hours

Electrochemical energy : Batteries- Battery parameters: C-rating -SoC- DoD- Specific Energy-Specific power (numerical examples), Fuel cells, Electrostatic energy (Super Capacitors), Electromagnetic energy (Super conducting Magnetic Energy Storage), Comparative analysis, Environmental impacts of different technologies.

MODULE IV - ENERGY STORAGE AND RENEWABLE POWER SOURCES 9 Hours

Types of renewable energy sources: Wave - Wind – Tidal – Hydroelectric - Solar thermal technologies and Photovoltaics, Storage role in isolated power systems with renewable power sources, Storage role in an integrated power system with grid-connected renewable power sources

MODULE V - ENERGY STORAGE APPLICATIONS 9 Hours

Smart grid, Smart microgrid, Smart house, Mobile storage system: Electric vehicles – Grid to Vehicle (G2V)-Vehicle to Grid (V2G), Management and control hierarchy of storage systems - Aggregating energy storage systems and distributed generation (Virtual Power Plant Energy Management with storage systems), Battery SCADA, Hybrid energy storage systems: configurations and applications.

Text Books:

1. A.G.Ter-Gazarian, “Energy Storage for Power Systems”, Second Edition, The Institution of Engineering and Technology (IET) Publication, UK

2. Francisco Díaz-González, Andreas Sumper, Oriol Gomis-Bellmunt,” Energy Storage in Power Systems” Wiley Publication, ISBN: 978-1-118-97130-7, Mar 2016.

3. P. Nezamabadi and G. B. Gharehpetian, "Electrical energy management of virtual power plants in distribution networks with renewable energy resources and energy storage systems”, IEEE Power Distribution Conference, 2011.

Reference Books:

1. Electric Power Research Institute (USA), “Electricity Energy Storage Technology Options: A White Paper Primer on Applications, Costs, and Benefits” (1020676), December 2010.

2. Paul Denholm, Erik Ela, Brendan Kirby and Michael Milligan, “The Role of Energy Storage with Renewable Electricity Generation”, National Renewable Energy Laboratory (NREL) -a National Laboratory of the U.S. Department of Energy.

Course Outcomes:

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

- Identify the role of energy storage in power systems
- Classify thermal, kinetic and potential storage technologies and their applications
- Compare Electrochemical, Electrostatic and Electromagnetic storage technologies
- Illustrate energy storage technology in renewable energy integration
- Summarise energy storage technology applications for smart grids.

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EEHT-106	Optimization Techniques for Electric Power Systems	3L:0T:0P	3 Credits

Course Objectives:

To learn the concepts and techniques of evolutionary and optimization techniques in power system applications.

MODULE I - CLASSIFICATION OF OPTIMIZATION PROBLEMS 9 Hours

Definition- Unconstrained and Constrained Optimization-Optimality Conditions-Classical Optimization techniques (Linear and nonlinear programming, Quadratic programming, Mixed integer programming)-Intelligent Search methods (Optimization neural network, Evolutionary algorithms, Tabu search, Particle swarm optimization, Application of fuzzy set theory).

MODULE II - GENETIC ALGORITHM 9 Hours

Evolution in nature-Fundamentals of Evolutionary Algorithms-Working Principles of Genetic Algorithm- Evolutionary Strategy and Evolutionary Programming-Genetic Operators-Selection, Crossover and Mutation-Issues in GA implementation- GA based Economic Dispatch Solution-Fuzzy Economic Dispatch including losses- Tabu search algorithm for unit commitment problem-GA for unit commitment-GA based Optimal power flow- GA based state estimation.

MODULE III - PSO 9 Hours

Fundamental principle - Velocity Updating - Advanced operators - Parameter selection - Hybrid approaches (Hybrid of GA and PSO, Hybrid of EP and PSO) -Binary, discrete and combinatorial PSO-Implementation issues - Convergence issues - PSO based OPF problem and unit commitment-PSO for reactive power and voltage control-PSO for power system reliability and security.

MODULE IV - OPTIMIZATION ALGORITHM 9 Hours

Simulated annealing algorithm- Tabu search algorithm - SA and TS for unit commitment - Ant colony optimization - Bacteria Foraging optimization.

MODULE V - PARETO OPTIMALITY 9 Hours

Concept of pareto optimality - Conventional approaches for MOOP - Multi objective GA - Fitness assignment - Sharing function - Economic Emission dispatch using MOGA – Multi objective PSO (Dynamic neighborhood PSO, Vector evaluated PSO) – Multi objective OPF problem.

Text Books:

1. Soliman Abdel Hady, Abdel Aal Hassan Mantawy, “Modern Optimization Techniques with Applications in Electric Power Systems”, Springer, 2012.

2. D.P.Kothari and J.S.Dhillon, “Power System Optimization”, 2nd Edition, PHI Learning Private Limited, 2010.

Reference Books:

1. Kalyanmoy Deb, “Multi Objective Optimization using Evolutionary Algorithms”, Wiley India Pvt ltd, 2010.

2. Kalyanmoy Deb, “Optimization for Engineering Design”, Prentice Hall of India, 2nd Edition, 2012.

Course Outcomes:

Upon completion of this course the students will be able to

- Understand the concept of optimization techniques.
- Apply evolutionary algorithms for unit commitment and economic dispatch problems.
- Interpret hybrid approach for power system reliability and security.

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EEHT-107	Non-linear Control Systems	3L:0T:0P	3 Credits

Course Objectives:

The aim of this course is to introduce the concept of non-linear controller design to the undergraduate student.

MODULE I – INTRODUCTION **9 Hours**

Open and closed sets, compact set, dense set, Continuity of functions, Lipschitz condition, smooth functions, Vector space, norm of a vector, normed linear space, inner product space.

MODULE II - MATHEMATICAL MODELING **9 Hours**

Mathematical modeling of simple mechanical and electrical systems, concept of equilibrium points, isolated equilibrium points and limit cycles.

MODULE III - STABILITY ANALYSIS **9 Hours**

Stability analysis of nonlinear systems – Lyapunov stability, asymptotic stability, relative stability, finite-time stability and exponential stability. Lasalles invariance principle.

MODULE IV - FEEDBACK ANALYSIS **9 Hours**

Feedback linearization- dynamic feedback linearization, flatness and back stepping controllers design.

MODULE - CONTROLLER DESIGN **9 Hours**

Sliding mode controller design, Lyapunov redesign and energy based controller design.

Text Books:

1. Khalil H.K., 'Nonlinear Systems', Prentice Hall, 3rd Edition, 2002.

2. Vidyasagar M., 'Nonlinear System Analysis', Prentice Hall, 2nd Edition, 2002.

3. A. Isidori, 'Nonlinear Control Systems', Communications and Control Engineering, Springer Science & Business Media, 3rd Edition, 2013.

Reference Books:

1. Jean - Jacques. E. Slotine and W. Li, 'Applied Nonlinear Control', Prentice Hall, Englewood Cliffs, NJ, 1991.

2. Zhihua Qu, 'Robust Control of Nonlinear Uncertain Systems', John Wiley & Sons, Interscience Division, New York, 1998.

Course Outcomes:

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

- Understand the concept of non-linear system.
- Design non-linear controller for electrical system.

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EEHT-108	Power Switching Converters	3L:0T:0P	3 Credits

Course Objectives:

- *This course aims at modeling, analysis and control of various power converter circuits.*

MODULE I - BASIC CONVERTER TOPOLOGIES **9 Hours**

Buck, Boost, Buck-Boost converter, steady state converter analysis - Equivalent circuit modelling.

MODULE II - STATE SPACE CONVERTERS **9 Hours**

State space averaging of converters- Transfer function of converters- Design of feedbac compensators-voltage and current loop.

MODULE III - DESIGN CONSTRAINTS **9 Hours**

Design constraints of reactive elements in Power Electronic Systems: Design of inductor, transforme and capacitors for power electronic applications, Input filter requirement.

MODULE IV - ISOLATED CONVERTERS **9 Hours**

Forward converter, push-pull converter, fly back converter, half bridge and full bridge converte operating principles.

MODULE V - SOFT-SWITCHING DC - DC CONVERTERS **9 Hours**

Zero-voltage-switching converters, zero-current switching converters, Multi-resonant converters an Load resonant converters-operating principles.

Text Books:

1. Simon Ang, Alejandro Oliva, 'Power Switching Converters', Taylor & Francis, 3rd Edition, 2010.

2. Robert W. Erickson, Dragan Maksimovic, 'Fundamentals of Power Electronics', Springer Scienc & Business Media, 2nd Edition, 2007.

Reference Books:

1. Ned Mohan, Tore M. Undeland, and William P.Robbins, 'Power Electronics: Converter Applications, and Design', 3rd Edition, Wiley Publishers, 2002.

2. M. Rashid, 'Power Electronics: Circuits, Devices, and Applications', Pearson Education,4 Edition 2013.

Course Outcomes:

Upon completion of this course the students will be able to

- Understand the classification and operation of different types of DC-DC converters.

EEHT-109	Power System Dynamics	3L:0T:0P	3 Credits

- Analyze the Steady-state operation of DC-DC converter circuits.
- Develop the transfer function of DC-DC converter circuits.
- Design the compensator and reactive elements of DC-DC converter circuits.
- Illustrate different soft switching techniques in DC-DC converter circuits

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Course Objectives:

• *To explain the power system stability problem.*

• *To understand the behavior of synchronous and induction machines during disturbance.*

• *To employ mathematical tools for power system stability analysis*.

MODULE I - INTRODUCTION 9 Hours

Dynamic modeling requirements- angle stability - equal area criterion- Critical fault clearing time and angle-numerical integration techniques.

MODULE II - ANALYSIS OF SYNCHRONOUS MACHINE 9 Hours

Park's transformation – flux linkage equations – formulation of normalized equations – state space current model – simplified models of the synchronous machine – turbine, Generator – steady state equations and phasor diagrams.

MODULE III - DYNAMICS OF SYNCHRONOUS MACHINES 9 Hours

Mechanical relationships – electrical transient relationships – adjustment of machine models – Park's equation in the operational form.

MODULE IV - EQUIVALENT CIRCUITS AND PARAMETERS 9 Hours

Induction motor equivalent circuits and parameters - free acceleration characteristics – dynamic performance – effect of three phase short circuit and unbalanced faults.

MODULE V - TRANSIENT AND DYNAMIC STABILITY 9 Hours

Transient and dynamic stability distinction – linear model of unregulated synchronous machine and its oscillation modes – distribution of power impacts – effects of excitation on stability – supplementary stabilization signals.

Text Books:

1. P. M. Anderson, 'A Fouad, 'Power System Control and Stability', John Wiley & Sons, 1st Edition, 2008.

2. Yao-Nan Yu, 'Electric Power System Dynamics', Academic Press, 1983

3. Ramanujam R, 'Power System Dynamics', PHI Learning Pvt. Ltd., New Delhi, 2009.

Reference Books:

1. Krause P.C., 'Analysis of Electric Machinery', McGraw-Hill, 3rd Revised Edition, 2013.
2. T. Kenjo, 'Stepping Motors and Their Microprocessor Controls', Clarendon Press London, 1995.

Course Outcomes:

Upon completion of the course, the students will have acquired

- Understanding of the dynamic phenomena of the power system operation.
- Knowledge to employ modeling techniques for investigating the response of system during disturbance.
- Ability to interpret results coming from the simulation of differential - algebraic systems.

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EEHT-110	Vehicular Electric Power Systems	3L:0T:0P	3 Credits

Course Objectives:

- *This course introduces the fundamental concepts, principles and analysis of hybrid and electric vehicles.*

MODULE I – HISTORY **9 Hours**

History of hybrid and electric vehicles, social and environmental importance of hybrid and electric vehicles, impact of modern drive-trains on energy supplies. Basics of vehicle performance, vehicle power source characterization, transmission characteristics, mathematical models to describe vehicle performance, Capabilities, Automation system computer facilities.

MODULE II - ELECTRIC COMPONENTS **9 Hours**

Introduction to electric components used in hybrid and electric vehicles- Configuration and control of DC Motor drives, Induction Motor drives, Permanent Magnet Motor drives, and Switched Reluctance Motor drives- drive system efficiency.

MODULE III - STORAGE TECHNOLOGIES **9 Hours**

Energy storage technologies in hybrid vehicles-flywheel, hydraulic, fuel cell and hybrid fuel cell energy storage system-ultra capacitors- comparison- battery charging control.

MODULE IV - ENERGY MANAGEMENT STRATEGIES **9 Hours**

Introduction to energy management strategies used in hybrid and electric vehicle, classification of different energy management strategies, comparison of different energy management strategies, implementation issues of energy strategies.

MODULE V - APPLICATIONS **9 Hours**

Electrical power system in air craft, sea and undersea vehicles, space vehicles-hybrid vehicle control strategies-supporting subsystem.

Total No Of Hours:45

Course Outcomes:

On completion of the course, the student would be able to

- Understand the various aspects of hybrid and electric vehicles.
- Plan the selection of electrical machines for hybrid and electric vehicles.
- Select various energy storage technologies for hybrid and electric vehicles.
- Implement energy management techniques for hybrid and electric vehicles.
- Demonstrate the power system of various vehicular systems.

Text Books:

1. Ali Emadi, Mehrdad Ehsani, John M. Miller, 'Vehicular Electric Power Systems: Land, Sea, Air, and Space Vehicles', CRC Press, 2003.
2. Sandeep Dhameja, 'Electric Vehicle Battery Systems', Newnes, 2002.
3. Chris Mi, M. Abul Masrur, David Wenzhong Gao, 'Hybrid Electric Vehicles: Principles and Applications with Practical Perspectives', Wiley, 2011.

Reference Books:

1. Ion Boldea and S.A Nasar, 'Electric drives', CRC Press, 2005.
2. Iqbal Husain, 'Electric and Hybrid Vehicles: Design Fundamentals', CRC Press, 2nd Edition, 2010.

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