BIRLA VISHVAKARMA MAHAVIDYALAYA

(ENGINEERING COLLEGE)

(AN AUTONOMOUS INSTITUTION)

VALLABH VIDYANAGAR – 388120, GUJARAT

AFFILIATED TO GUJARAT TECHNOLOGICAL UNIVERSITY

ACADEMIC REGULATIONS

AND

COURSES OF STUDY

FOR

FOUR YEAR DEGREE PROGRAMMES LEADING TO BACHELOR OF TECHNOLOGY (B. TECH.)

IN

ELECTRICAL ENGINEERING

Implemented from the batch admitted in academic year 2018-19

Contents

Institute Vision

“Produce globally employable innovative engineers with core values.”

Institute Mission

- Re-engineer curricula to meet global employment requirement
- Promote innovative practices at all levels.
- Imbibe core values
- Reform policies, systems and processes at all levels.
- Develop faculty and staff members to meet the challenges

Core Values

Quality, Creativity, Team Work, Lifelong Learning, Pro-activeness, Cost Consciousness, Sharing, Transparency

B.Tech. Electrical programme offered by Department of Electrical Engineering

Programme Vision

"Produce globally employable innovative electrical engineers with core values"

Programme Mission

1. Implement dynamic curriculum through reform policies and systems to provide its students with the skills, knowledge and attitudes that will allow its graduates to succeed as engineers and leaders.
2. Conduct research activities which provides its students and faculty with opportunities for innovation and radiance of knowledge.
3. Prepare its graduates for life-long learning to meet professional, intellectual and ethical tasks.

Program Educational Objectives (PEO's):

The objectives of the Electrical Engineering department at BVM Engineering College are to produce graduates with several defining abilities:

PEO1: To pursue scientific and technical careers beginning with entry-level electrical engineering positions in industry or government, in India or abroad.

PEO2: To impart concept, information, knowledge, training and problem solving skills with regard to electrical engineering and multi-disciplinary products & projects.

PEO3: To augment comprehension, analytical, creative, technical and soft skills to pursue continuing education through graduate studies in electrical or other engineering fields, as well as, management, entrepreneurship, laws etc.

PEO4: To foster amongst the students, professional and ethical attitude, effective communication skills, and teamwork skills and instill a sense of responsibility toward the society.

PEO5: To provide student with an academic environment to stimulate desire & joy for learning, Endeavour for excellence & leadership and perception of life-long learning required for a successful professional career.

PROGRAM OUTCOMES (POs)

Engineering Graduates will be able to:

1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex electrical engineering problems.
2. Identify, formulate, review research literature, and analyse complex electrical engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
3. Design solutions for electrical engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health & safety, cultural and societal & environmental considerations.
4. Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions
5. Apply appropriate techniques, resources, modern engineering and IT tools including prediction and modelling to electrical engineering activities with an understanding of their limitations.
6. Apply reasoning informed by the contextual knowledge to assess societal, health & safety, legal & cultural issues and the consequent responsibilities relevant to the professional electrical engineering practice.
7. Understand the impact of the professional electrical engineering solutions in societal and environmental contexts, demonstrate the knowledge of the same and need for sustainable development.
8. Apply ethical principles& commit to professional ethics and responsibilities & norms of the electrical engineering practice.
9. Function effectiveness an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
10. Communicate effectively on electrical engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
11. Demonstrate knowledge and understanding of the electrical engineering and management principles and apply those to one's own work, as a member and leader in a team, to manage electrical engineering projects in multidisciplinary environments
12. Recognize the need for, have the preparation and ability to engage in independent and life-long learning in the broadest context of electrical engineering technological changes.

PROGRAM SPECIFIC OUTCOMES (PSO)

Graduate of the Electrical Engineering Program will demonstrate:

1. Knowledge and hands-on competence in the application of circuit analysis and design, building, operation, and testing of electrical and electronics systems.
2. In-depth understanding in the domain of electromagnetic fields, signals and systems, electrical machines, electrical & electronic measurements, analog & digital electronics, and power electronics & drives. That graduates will be able to analyze, design and implement industrial automation and control systems, microcontroller based applications, with the use of hardware and software.
3. Thorough exploration of state-of-the-art technologies in power systems monitoring, protection, operation and control, renewable energy engineering, utilization of energy and energy management systems to address the current and future energy issues.

Academic Regulations (Major) – UG.18

FOR **UNDER GRADUATE** PROGRAMMES (FULL TIME)

UG.18.1 ADMISSION

UG.18.1.1 A candidate seeking admission to the four year degree programme for Bachelor of Technology must have eligibility as per the Gujarat Government/ Admission Committee for Professional Courses (ACPC) / Gujarat Technological University (GTU)/ Charutar Vidya Mandal (CVM) rules.

UG.18.1.2 Admission granted to an applicant is to be considered provisional until all the fees are paid and all the prescribed documents are in order. BVM Engineering College DISCLAIMS ALL RESPONSIBILITIES**,** if any, of the documents required as per ACPC/ GTU norms, which are not submitted or found unacceptable by it. The institute will not accept any responsibility for students who do not submit the expected examination / registration / enrollment forms in time.

UG.18.2 PROGRAMMES OF STUDY

UG.18.2.1 A student shall undergo the prescribed courses as given in the programme of studies to obtain his/her degree in major in which he/she is admitted. These courses for various programmes are listed in Annexure – I.

UG.18.2.2 A student shall undergo the courses as prescribed by the respective Board of Studies from time to time to obtain minor engineering degree in the respective programme(s). For awarding minor degree, regulations are annexed here as Annexure – III.

UG.18.3 COURSE LEVELS

UG.18.3.1 At the commencement of each semester a student shall register for the set of courses offered during the semester. For the registration process, refer UG.18.9.

UG.18.3.2 All courses offered are divided into four levels: Level 1 to Level 4. The levels correspond to successive years of study of a typical B. Tech. student, i.e. a regular student will complete his/her Level-1 courses during his/her first year, Level-2 courses during his/her second year, and so on.

UG.18.4 COURSE CATEGORIES

Courses taken by a student to complete his/her degree programme are divided into Humanities and Social Science, Basic Science, Engineering Science, Mandatory Courses, Professional Core Courses, Programme Elective Courses, Open Elective Courses, Project Work, Seminar and Internship.

UG.18.4.1 COMPULSORY COURSES

Each programme of studies contains a certain number of compulsory courses, they are categorized as Programme core courses, seminar and project work / dissertation.

UG.18.4.2 PROGRAMME ELECTIVE COURSES

Each programme of studies contains a certain number of programme elective courses. Programme elective courses will be offered under each discipline at corresponding level from which a student may choose course(s).

UG.18.4.3 **OPEN ELECTIVE COURSES**

Open elective courses are courses offered by a discipline for students other than the corresponding discipline.

UG.18.4.4 **MANDATORY NON CREDIT COURSES**

Each programme of studies contains a certain number of mandatory non-credit courses decided by respective Board of Studies.

UG.18.5 DEFINATION OF STATUS OF COURSE

UG.18.5.1 **REGULAR COURSES**

Each programme of studies contains a certain number of courses (including elective courses and mandatory non-credit courses) to be studied in respective semester decided by respective Board of Studies.

UG.18.5.2 **BACKLOG COURSES**

The courses in which student has not obtained letter grade DD or above / PP at first attempt (Refer UG.18.13).

UG.18.6 PRE-REQUISITES

UG.18.6.1 A student shall not be allowed to enroll for any course at Level-4 unless he/she has completed all his/her course requirements at Level-1 with acceptable grades (Refer UG.18.13).

UG.18.7 COURSE CREDITS

UG.18.7.1 Each course offered has **L-T-P** structure, where "**L"** means number of theory lecture hours per week, **T** means number of tutorial hours per week and "**P"** means number of practical hours per week.

UG.18.7.2 Total course credits for a course are obtained by adding credits of theory lectures, tutorials and practical together. e.g. 1 hr. Lecture = 1 credit, 1 hr. Tutorial = 1 credit & 1 hr. Practical = 0.5 credit.

UG.18.8 FACULTY COUNSELOR

UG.18.8.1 Each student is assigned to a Faculty Counselor who will advise and counsel him/her regarding the selection of courses to be registered in a given semester as well as monitor his/ her holistic growth.

UG.18.8.2 Each student must obtain approval for "Backlog" courses (Refer UG.18.5.2) from the Faculty Counselor.

UG.18.9 REGISTRATION

UG.18.9.1 To earn course credits in a semester a student must register for the courses at the commencement of the semester.

UG.18.9.2 At the commencement of each semester the **first working day** is designated as the Registration Day. A student must complete his/her registration formalities on that day as per the procedure laid down by the institute.

UG.18.9.3 A further period of 12 working days is designated as late registration period. During this period a student shall require to pay late registration fees, as decided by the institute from time to time to complete his/her registration. Late registration will only

be permitted on genuine reasons, (Refer UG.18.12.3) subject to the approval of the Principal.

UG.18.9.4 Student shall not be permitted to attend classes without registration.

UG.18.9.5 The registration must be completed by the student in person.

UG.18.9.6 A student who has completed all the requirements for his/her B. Tech. degree (Refer UG.18.19) will not be allowed to register in any further courses.

UG.18.9.7 All registrations in every semester must be duly approved by the Principal.

UG.18.9.8 Student should obtain approval from Faculty Counsellor to register any Backlog course(s) within 10 days of declaration of results of the previous semester or first 10 days of the commencement of semester, whichever is later.

UG.18.9.9 Total number of credits for Backlog courses should not be more than 24.

UG.18.10 WITHDRAWAL

UG.18.10.1 Student may withdraw all the courses registered in a semester before four weeks of commencement of End Semester examination. Further, on genuine reasons (Refer UG.18.12.3) a student can withdraw at any time during the entire semester. In such cases NO FEES will be refunded.

UG.18.11 ASSESSMENT OF STUDENT PERFORMANCE IN A COURSE

UG.18.11.1 The performance of a student in a course will be evaluated based on (i) continuous assessment of theory and tutorial/practical work and (ii) end-semester theory and tutorial / practical examinations.

UG.18.11.2 The end- semester theory examination in a course has a weightage of 60 % of total theory marks. Out of the remaining 40 % of theory marks, 30 % of marks will be evaluated based on mid semester examination and remaining 10 % based on continuous assessment carried out during the semester as declared by the course coordinator in first week of beginning of the semester.

UG.18.11.3 The end-semester tutorial/practical examination in a course has a weightage of 40 percent of total tutorial/practical marks and continuous assessment of the same carries the remaining 60 % of total tutorial/practical marks. Tutorial/practical work (both end-semester and continuous) shall be evaluated on the basis of the following instruments of assessment: observation of experimental skills, reports, oral examination, quizzes, end-semester practical examination and attendance.

Continuous assessment (tutorial/practical) scheme is given below:

Term work	30 % (Equal weightage for every practical. At least 10 practical/tutorial need to be performed or mini project)
Quiz/Assignment/ Viva/ active learning component	30 %
Total	**60 %**

The respective Board of Studies shall decide the list of the courses in which end semester practical evaluation is feasible. In such courses evaluation shall be based on practical as well as viva for 40 % marks of end semester tutorial/practical. If

practical performance is not feasible then 40 % of marks as end semester tutorial/practical evaluation will be based only on viva**.**

UG.18.11.4 The overall performance of a student in a course is assessed on the principle of "single head of passing", i.e., there will be a single grade for a course based upon the aggregate of marks obtained by the student in theory and tutorial/practical components in continuous assessment as well as end semester examination. However, a student must score minimum 35% marks in end semester theory and tutorial/practical examination to make himself/ herself gradable.

UG.18.12 EXAMINATIONS

UG.18.12.1 The end-semester examination for all courses offered in an academic year will be conducted by the institute for awarding 60 % of marks out of the total theory marks.

UG.18.12.2 No student shall be allowed to appear in the end semester examination unless he/she has attended 100% of theory and tutorial/practical classes of each course and will be awarded letter grade FA (Refer UG.18.13) in all the courses he/she has registered in the corresponding semester, except backlog courses.

However, a maximum 25 % relaxation in attendance is permissible with prior intimation, along with required documents, from concerned authorities. The relaxation includes medical, co-curricular and extra-curricular activities, genuine social engagements etc.

UG.18.12.3 The institute will conduct two continuous assessment of theory (mid semester examination) in a semester for each course for the evaluation of 30 % of total theory marks. The average marks of two mid semester examinations shall be considered as the final marks for mid semester examination.

A student who remains absent in any of the two mid semester examination for whatsoever reason(s) shall be awarded with zero marks in the respective mid semester examination.

However, if a student remains absent due to any of the following genuine reasons, for such students a special examination may be conducted by the department and marks obtained in the special examination will be considered as marks of the mid semester examination in which he/she has remained absent. Such student should obtain prior approval from the Principal.

a) A student is critically ill or injured and certified by Civil Surgeon.
b) Death of direct blood relation relative.
c) A student representing Gujarat state in national level events and/or India in International events organized by official boards.

UG.18.12.4 The institute will conduct only one continuous assessment of theory (mid semester examination) for all courses of the semester in the following cases.

a) First Semester of B. Tech. programme.
b) Third semester of B. Tech. programme for the students who are admitted in the second year of B. Tech. Diploma to Degree students.
c) Corresponding semester of the year of transfer for transferred students or international students, if the admission of such students is five weeks later than commencement of academic calendar.

UG.18.12.5 No student shall be allowed to appear in the end semester examination of a course unless he/she has scored at least 35% marks in mid semester examination and will be considered in "NOT PERMITTED TO APPEAR (NPTA)" status for the respective course and letter grade "NA" will be awarded (Refer UG.18.13).

The NPTA student(s) shall appear in mid semester remedial examination of the next semester.

UG.18.12.6 The End Semester tutorial/practical examination shall be rearranged for a student who is not able to appear in the regular schedule due to genuine reason(s) (Refer UG.18.12.3). Such student should obtain prior approval from the Principal.

However, such rearrangement should be confined within the Academic Calendar of the respective semester.

UG.18.13 LETTER GRADES

UG.18.13.1 The overall performance of a student in credit courses is represented by a letter grade from AA to FP, FA, NA and WD with the following meaning and equivalent grade points:

LETTER GRADE	EQUIVALENT GRADE POINTS	REMARK
AA	10	Outstanding
AB	9	Excellent
BB	8	Very Good
BC	7	Good
CC	6	Average
CD	5	Satisfactory
DD	4	Pass
FP	0	Failure due to Performance
FA	0	Failure due to Attendance
NA	0	Not Permitted To Appear
WD	0	Withdrawal

For non-credit courses the evaluation will be PASS or FAIL and for that the letter grade will be awarded PP or FP, respectively.

UG.18.13.2 A credit course is said to be completed successfully, only if a letter grade DD or better (in grade points) is obtained in that course.

UG.18.13.3 A non-credit course is said to be completed successfully only if a letter grade PP is obtained in that course.

UG.18.13.4 The scheme of awarding letter grades and the letter grades awarded in each course are subjected to scrutiny and approval by the Academic Council.

UG.18.14 FAILURE IN A COURSE

UG.18.14.1 A student earns **zero** credit for a course when he/she gets letter grade FP, NA, FA or WD in that credit course.

UG.18.14.2 If letter grade FA is obtained in an elective course, the student may change the elective.

UG.18.14.3 A student with letter grade FA/WD in courses should re-register the courses subsequently whenever offered.

UG.18.14.4 A student with letter grade FP should appear, at the earliest, in the end semester theory as well as practical/ viva exam and should obtain a letter grade DD or better (in grade points) in credit courses and PP in non-credit courses.

UG.18.14.5 A student having more than six Backlog courses (Refer UG.18.6.2) will not be allowed to move to the next level.

UG.18.15 SEMESTER PERFORMANCE INDEX (SPI)

UG.18.15.1 The performance of a student in a semester is expressed in terms of the semester Performance Index (SPI).

UG.18.15.2 The semester Performance Index is the weighted average of course grade points obtained by the student in the regular courses (Refer UG.18.6.1) registered in the semester. The weights assigned to course grade points are the credits carried by the respective courses.

That is,

$$SPI = \frac{\sum_{i=1}^{n} g_i c_i}{\sum_{i=1}^{n} c_i}$$

where, g_i is the equivalent grade point of i^{th} course,
c_i is the credit of the course
n is total number of regular courses registered by the student in a semester

UG.18.16 **CUMULATIVE PERFORMANCE INDEX (CPI)**

UG.18.16.1 The cumulative performance of student is expressed in terms of the Cumulative Performance Index (CPI). This index is defined as the weighted average of course grade points obtained by the student for all courses taken since his/her entry to the programme. The weights are defined in same way as in UG.18.15.2.

UG.18.16.2 If a student repeats a course, only the grade points obtained in the latest attempt is counted towards the Cumulative Performance Index (CPI).

UG.18.17 ADMISSION BY TRANSFER

UG.18.17.1 Any student aspiring for admission by transfer in any B.Tech. programme is not eligible for the same after 5th Semester of the respective B.Tech. programme.

UG.18.17.2 For a student admitted by transfer to any B.Tech. programme after completing part of his/her degree requirements elsewhere or under the previous academic regulations of BVM, he/she will be allowed to continue in subsequent level after completing all the requirements of previous levels of the respective institute or previous academic regulation. He/She will be exempted from all courses upto the completed levels. For these courses "EXEMPTED" status will be shown in the Transcript.

UG.18.17.3 The remaining requirements must be completed by the student as per UG.18.18.

UG.18.17.4 The CPI of such a student will be calculated only on the basis of the courses taken after transfer.

UG.18.18 REQUIREMENTS FOR THE AWARD OF B. Tech. DEGREE

UG.18.18.1 To be eligible for the award of the degree of Bachelor of Technology a student must earn total credits as prescribed by respective Board of Studies.

UG.18.18.2 The total credits requirements for the degree of B. Tech. must be completed in not more than 16 semesters from the date of admission. However, for a student admitted by transfer or Diploma to Degree (D2D) the maximum permissible duration shall be 100 % more than the period prescribed for completion of the programme at the time of admission.

UG.18.19 AWARD OF CLASS

UG.18.19.1 The class awarded to a student with his B. Tech. degree is decided by his final CPI as per the following table:

FIRST CLASS WITH DISTINCTION	- CPI not less than 7.10
FIRST CLASS	- CPI less than 7.10 but not less than 6.50
SECOND CLASS	- CPI less than 6.50 but not less than 5.50
PASS CLASS	- CPI less than 5.50

A candidate who passes in all courses and all heads of passing in the examination shall be given a gracing of the required CPI for getting second class/first class/first class with distinction, subject to a maximum of CPI 0.10, in concurrence with rules and guidelines of AICTE/ GTU.

UG.18.20 TRANSCRIPT

UG.18.20.1 The Transcript will be issued to the student as and when required and will contain a consolidated record of all the courses undergone by him/her, grades obtained and CPI upto the date of issue of transcript.

UG.18.20.2 Only last letter grade obtained in a course by the student upto the date of issue of transcript will be shown in the Transcript.

UG.18.21 EXAMINERS

UG.18.21.1 The respective board of studies shall appoint at least two examiners for end semester theory as well as practical/viva examination. For each end semester theory examination, there shall be two paper setters. One paper setter out of the two shall be from outside the institute (external examiner). The end semester practical examination of each subject shall be conducted by an internal (Examiner from the institute) and an external examiner. For 4^{th} level courses, each end semester theory examination evaluation shall be made by an internal and an external examiner. One of the internal examiner/s shall be appointed as convener who shall co-ordinate the examination procedure for end semester examinations of the respective subject.

UG.18.21.2 In the end semester practical examination maximum upto 60 students can be examined per day per examiner for first, second and third level courses and upto 45 students can be examined per day per examiner for fourth level courses.

UG.18.21.3 In the end semester practical examinations of Projects maximum upto 12 groups can be examined per day per examiner.

In the end semester practical examinations of Seminars maximum upto 20 groups can be examined per day per examiner

UG.18.22 REVIEW OF ESE THEORY ANSWER BOOKS

UG.18.22.1 A student shall apply for review of end semester theory answer book(s) within 7 working days after declaration of semester results. The student will have to pay the fees for the same as decided from time to time.

The answer book(s) of the student(s) who has applied for the review will be shown to him/her.

If student is satisfied with the assessment then he/she shall sign the answer book with a remark "Seen and Satisfied".

If student is not satisfied with the assessment, then the respective Board of Studies shall appoint two examiners (Convener of original exam and a new examiner) for the review of the end semester examination (theory) both sections. Both examiners shall jointly review both the sections and marks awarded in the previous assessment shall be kept open.

The marks obtained by the candidate after the review shall be considered for grading, only if, the change in mark is more than or equal to 10% of total mark of End Semester (Theory) Examination.

If change in grade is found after review, the review fees shall be refunded.

UG.18.23 GRADING

UG.18.23.1 The office of Controller of Examinations shall prepare the histogram of each course for the purpose of grading after the completion of assessment of the course.

UG.18.23.2 The convener of the respective course shall grade the students based on the histogram provided by the Controller of Examinations.

UG.18.24 GRADE REVIEW

UG.18.24.1 The Academic Council shall appoint a Grade Review Committee for each semester. The Grade Review Committee shall comprise of following members:

(a) Principal
(b) All Board of Studies Chairman
(c) University Nominee
(d) Dean, Academics
(e) Associate Dean, Academics
(f) Controller of the Examinations
(g) Joint Controller of Examinations
(h) Member Secretary, Academic Council
(i) Officer-in-Charge of Credit System

UG.18.24.2 The Grade Review Committee shall meet immediately after results of all courses are completed and review the grades awarded by the convener of respective course. The revision of the grade suggested by the Grade Review committee shall be considered as final grade and binding.

UG.18.24.3 The Grade Review Committee can grace upto 10 % of total marks of theory examination in marks of end semester theory exam to make a student gradable. However grace marks shall not be counted in the aggregate marks obtained by the student for the grade.

ANNEXURE – I: Programme of studies leading to the degree of the Bachelor of Technology (Electrical Engineering)

Semester 1

Sr. No.	Course Code and Course Title	L	T	P	H	C
1	**BS111: ADVANCED CALCULUS**	3	1	0	4	4
2	**BS104: SEMICONDUCTOR PHYSICS**	3	0	2	5	4
3	**ES104: ELECTRICAL WORKSHOP**	0	0	2	2	1
4	**ES109: ENGINEERING GRAPHICS AND DESIGN**	2	0	4	6	4
5	**ES110: BASIC MECHANICAL ENGINEERING**	3	0	2	5	4
6	**HS112: ENVIRONMENTAL SCIENCE**	2	0	0	2	0
	Total	**13**	**1**	**10**	**24**	**17**

*For Students admitted in AY 2018-19, **BS101: ADVANCED CALCULUS** (LTP:3,2,0)

$For Students admitted in AY 2018-19, **HS102: ENVIRONMENTAL SCIENCE** (LTP:2,2,0)

Semester 2

Sr. No.	Course Code and Course Title	L	T	P	H	C
1	**BS112: LINEAR ALGEBRA AND FOURIER SERIES**	3	1	0	4	4
2	**BS105: ELECTROMAGNETIC PHYSICS**	3	0	2	5	4
3	**ES105: PROGRAMMING FOR PROBLEM SOLVING**	3	0	2	5	4
4	**ES112: BASICS OF MANUFACTURING PRACTICES**	0	0	2	2	1
5	**ES103: BASIC ELECTRICAL ENGINEERING**	3	0	2	5	4
6	**HS101: ENGLISH**	2	0	2	4	3
	Total	**14**	**1**	**10**	**25**	**20**

For Students admitted in AY 2018-19, **BS102: LINEAR ALGEBRA AND FOURIER SERIES** (LTP:3,2,0)

Semester 3

Sr. No.	Course Code and Course Title	L	T	P	H	C
1	**2EE01: ELECTRICAL CIRCUIT ANALYSIS**	3	0	2	5	4
2	**2EE02: ANALOG ELECTRONICS**	3	0	0	3	3
3	**2EE03: ANALOG ELECTRONICS LABORATORY**	0	0	2	2	1
4	**2EE04: ELECTRICAL MACHINES - I**	3	0	0	3	3
5	**2EE05: ELECTRICAL MACHINES LABORATORY-I**	0	0	2	2	1
6	**2BS01: ORDINARY DIFFERENTIAL EQUATIONS AND STATISTICS**	3	1	0	4	4
7	**2HS02: ECONOMICS AND MANAGEMENT**	3	0	0	3	3
	Total	**15**	**1**	**6**	**22**	**19**

Semester 4

Sr. No.	Course Code and Course Title	L	T	P	H	C
1	**2EE06: DIGITAL ELECTRONICS**	3	0	0	3	3
2	**2EE07: DIGITAL ELECTRONICS LABORATORY**	0	0	2	2	1
3	**2EE08: ELECTRICAL MACHINES –II**	3	0	0	3	3
4	**2EE09: ELECTRICAL MACHINES LABORATORY – II**	0	0	2	2	1
5	**2EE10: POWER ELECTRONICS**	3	0	0	3	3
6	**2EE11: POWER ELECTRONICS LABORATORY**	0	0	2	2	1
7	**2EE12: ELECTRICAL AND ELECTRONICS MEASUREMENT**	3	0	0	3	3
8	**2EE13: ELECTRICAL AND ELECTRONICS MEASUREMENT LABORATORY**	0	0	2	2	1
9	**2BS04: PROBABILITY AND NUMERICAL ANALYSIS**	3	1	0	4	4
10	**2HS01: PROFESSIONAL SOFT SKILLS**	1	0	2	3	2
	Total	**16**	**1**	**10**	**27**	**22**

	EEIT1: Summer Internship – I (Three Weeks)	-	-	-	-	**0**

Semester 5

Sr. No.	Course Code	Name of Course	L	T	P	H	C
1	3EE01	Electromagnetic Fields	3	0	0	3	3
2	3EE02	Power Systems–I	3	0	0	3	3
3	3EE03	Power Systems-I Laboratory	0	0	2	2	1
4	3EE04	Signals and Systems	3	0	0	3	3
5	3EE05	Signals and Systems Laboratory	0	0	2	2	1
6	3EE06	Microprocessors & Microcontrollers	3	0	0	3	3
7	3EE07	Microprocessors & Microcontrollers Laboratory	0	0	2	2	1
8	3EE08	High Voltage Engineering	3	0	2	5	4
9		Open Elective - I	3	0	0	3	3
10	3HS01	Ethics and Constitution of India#	2	0	0	2	0
		Total	**20**	**0**	**8**	**28**	**22**

#Non-Credit Mandatory course

Open Elective - I

1	3EE81	Energy Audit & Conservation	3	0	0	3	3
2	3EE83	Installation and Commissioning of Electrical Equipments	3	0	0	3	3

Semester 6

Sr. No	Course Code	Name of Course	L	T	P	H	C
1	3EE09	Control Systems	3	0	0	3	3
2	3EE10	Control Systems Laboratory	0	0	2	2	1
3	3EE11	Power Systems –II	3	0	0	3	3
4	3EE12	Power Systems – II Laboratory	0	0	2	2	1
5	3EE13	Industrial Automation and Control	3	0	0	3	3
6	3EE14	Industrial Automation and Control Laboratory	0	0	2	2	1
7	3EE15	Electrical Power Utilization & Traction	3	0	0	3	3
8	3EE31	Electronics Design Laboratory (Mini Project)	0	0	4	4	2
9		Open Elective – II	3	0	2	5	4
		Total	**15**	**0**	**12**	**27**	**21**

Open Elective - II

1	3EE82	Renewable Energy Technology	3	0	2	5	4
2	3EE84	Industrial Automation	3	0	2	5	4
	EEIS2	Internship – II(Three Weeks)#	-	-	-	-	0
		#Non-Credit Mandatory course					

Semester 7

Sr. No	Course Code	Name of Course	L	T	P	H	C
1	4EE01	Power System Protection	3	0	0	3	3
2	4EE02	Power System Protection Laboratory	0	0	2	2	1
3	4EE03	Computer Aided Electrical Machine Design	2	0	2	4	3
4	4EE04	Hardware and Software Skills Laboratory	0	0	2	2	1
5		Program Elective – I	3	0	0	3	3
6		Program Elective - II	3	0	0	3	3
7		Program Elective – III	3	0	2	5	4
8	4EE32	Project Stage – I	0	0	4	4	2
		Total	**14**	**0**	**12**	**26**	**20**

Program Elective – I & II

1	4EE42	High Voltage DC Transmission Systems	3	0	0	3	3
2	4EE43	Power Quality and FACTS	3	0	0	3	3
3	4EE44	Industrial Electrical Systems	3	0	0	3	3
4	4EE45	Power System Dynamics and Control	3	0	0	3	3
5	4EE46	Digital Control Systems	3	0	0	3	3
6	4EE47	Digital Signal Processing	3	0	0	3	3
7	4EE49	Condition Monitoring of Electrical Equipments	3	0	0	3	3
8	4EE50	Distributed Generation	3	0	0	3	3
9	4EE51	Restructuring of Power Systems	3	0	0	3	3
10	4EE52	Smart Grid	3	0	0	3	3
11	4EE53	Commissioning of Electrical Equipments	3	0	0	3	3

Semester 8 [Scheme A]

Sr. No.	Course Code	Name of Course	L	T	P	H	C
1		Program Elective –IV	3	0	2	5	4
2		Program Elective -V	3	0	2	5	4
3	4EE33	Project Stage-II	0	0	20	20	10
		Total	**6**	**0**	**24**	**30**	**18**

Program Elective –III, IV & V							
1	4EE54	Industrial Instrumentation	3	0	2	5	4
2	4EE55	Electrical Drives	3	0	2	5	4
3	4EE56	Electrical Switchgear and Transients	3	0	2	5	4
4	4EE57	Power System Practice and Design	3	0	2	5	4
5	4EE58	Non-Conventional Energy Sources	3	0	2	5	4
6	4EE59	Power System Operation and Control	3	0	2	5	4
7	4EE60	Electrical Energy Conservation and Auditing	3	0	2	5	4
8	4EE61	Embedded Systems	3	0	2	5	4
9	4EE62	Optimization of Power Systems	3	0	2	5	4
10	4EE63	Electrical and Hybrid Vehicles	3	0	2	5	4
11	4EE64	Wide Area Measurement Systems (WAMS) and Applications	3	0	2	5	4
12	4EE65	Artificial Intelligence (AI) Applications to Electrical Engineering	3	0	2	5	4

OR

Semester 8 [Scheme B]

Sr. No.	Course Code	Name of Course	L	T	P	H	C
1	4EE34	External Project - II	0	0	36	36	18

Total Credits Distribution	**108**	**4**	**102**	**214**	**159**

L=Lecture Hrs./wk; T=Tutorial Hrs./wk; P=Practical Hrs./wk; H=Total Contact Hrs./wk; C=Credits of Course

ANNEXURE –II: Syllabi for the courses offered in programme of studies leading to the degree of Bachelor of Technology (Electrical Engineering)

BS111: ADVANCED CALCULUS
CREDITS - 4 (LTP:3,1,0)

Course Objectives:

The basic necessity for the Foundation of Engineering & Technology being Mathematics, the main aim is, to teach Mathematical concepts, develop Mathematical skills & enhance thinking power of students.

Teaching and Assessment Scheme:

Teaching Scheme (Hours per week)			Credits	Assessment Scheme				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE	CE	ESE	CE	150
3	1	0	4	60	40	20	30	

Course Contents:

Unit No.	Topics	Teaching Hours
1	Evolutes and involutes; Evaluation of definite and improper integrals; Beta and Gamma functions and their properties; Applications of definite integrals to evaluate surface areas and volumes of revolutions.	08
2	Rolle's theorem, Mean value theorems, Taylor's and Maclaurin theorems with remainders; Differentiation of Hyperbolic and Inverse Hyperbolic functions, Successive differentiation, standard forms, Leibnitz's theorem and applications, power series, expansion of functions, Indeterminate forms and L'Hospital's rule; Maxima and minima.	08
3	Limit, continuity and partial derivatives, directional derivatives, total derivative; Tangent plane and normal line; Maxima, minima and saddle points; Method of Lagrange multipliers; Gradient, curl and divergence.	10
4	Multiple Integration: double and triple integrals (Cartesian and polar), change of order of integration in double integrals, Change of variables (Cartesian to polar), Applications: areas and volumes by (double integration) Center of mass and Gravity (constant and variable densities). Theorems of Green, Gauss and Stokes, orthogonal curvilinear coordinates, Simple applications involving cubes, sphere and rectangular parallelepipeds.	10
5	Sequence and Their Convergence, Convergence and Divergence of Infinite Series, Geometric Series, P-Test, A Necessary Condition for Convergence, Comparison Test, Ratio Test.	06
	Total	**42**

List of References:

1. Weir, M.D. et al., *Thomas' Calculus (*11*th Edition*), Pearson Education, 2008.
2. Grewal B. S., "*Higher Engineering Mathematics*", Khanna Publisher, New Delhi, (Latest Edition).
3. Sastry S. S., "*Engineering Mathematics – Vol. I and II*", Prentice Hall of India.
4. Stuart J., "*Calculus*", Cengage Learning, India Pvt. Ltd. (2008).

BS101: ADVANCED CALCULUS
CREDITS = 5 (L=3, T=2, P=0)

Course Objectives:
The basic necessity for the Foundation of Engineering & Technology being Mathematics, the main aim is, to teach Mathematical concepts, develop Mathematical skills & enhance thinking power of students.

Teaching and Assessment Scheme:

Teaching Scheme			Credits	Assessment Scheme				Total Marks
				Theory Marks		Tutorial / Practical Marks		
L	T	P	C	ESE	CE	ESE	CE	
3	2	0	5	70	30	30	20	150

Course Contents:

Unit No.	Topics	Teaching Hours
1	Evolutes and involutes; Evaluation of definite and improper integrals; Beta and Gamma functions and their properties; Applications of definite integrals to evaluate surface areas and volumes of revolutions.	08
2	Rolle's theorem, Mean value theorems, Taylor's and Maclaurin theorems with remainders; Differentiation of Hyperbolic and Inverse Hyperbolic functions, Successive differentiation, standard forms, Leibnitz's theorem and applications, power series, expansion of functions, Indeterminate forms and L'Hospital's rule; Maxima and minima.	08
3	Limit, continuity and partial derivatives, directional derivatives, total derivative; Tangent plane and normal line; Maxima, minima and saddle points; Method of Lagrange multipliers; Gradient, curl and divergence.	10
4	Multiple Integration: double and triple integrals (Cartesian and polar), change of order of integration in double integrals, Change of variables (Cartesian to polar), Applications: areas and volumes by (double integration) Center of mass and Gravity (constant and variable densities). Theorems of Green, Gauss and Stokes, orthogonal curvilinear coordinates, Simple applications involving cubes, sphere and rectangular parallelepipeds.	10
5	Sequence and Their Convergence, Convergence and Divergence of Infinite Series, Geometric Series, P-Test, A Necessary Condition for Convergence, Comparison Test, Ratio Test.	06
	TOTAL	42

List of References:

1. Weir, M.D. et al., Thomas' Calculus (11th Edition), Pearson Education, 2008.
2. Grewal B. S., "Higher Engineering Mathematics", Khanna Publisher, New Delhi, (Latest Edition).
3. Sastry S. S., "Engineering Mathematics – Vol. I and II", Prentice Hall of India.
4. Stuart J., "Calculus", Cengage Learning, India Pvt. Ltd. (2008).

BS104: SEMICONDUCTOR PHYSICS
CREDITS - 4 (LTP:3,0,1)

Course Objective:

1. To understand the fundamentals of basic semiconductor physics which includes the,
2. Electronic materials, Semiconductors,.
3. To understand the basic materials and properties of semiconductors
4. To provide problem solving experience and learning of concepts through it in Semiconductor Physics, in both the classroom and the laboratory learning environment.

Teaching and Examination Scheme:

Teaching Scheme (Hours per week)			Credits	Assessment Scheme				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE	CE	ESE	CE	
3	0	2	4	60	40	20	30	150

Course Contents:

Unit No	Topics	Teaching Hours
1.	**Electronic materials** Free electron theory, Density of states and energy band diagrams, Kronig-Penny model (to introduce origin of band gap), Energy bands in solids, E-k diagram, Direct and indirect bandgaps, Types of electronic materials: metals, semiconductors, and insulators, Density of states, Occupation probability, Fermi level, Effective mass, Phonons.	12
2.	**Semiconductors** Intrinsic and extrinsic semiconductors, Dependence of Fermi level on carrier-concentration and temperature (equilibrium carrier statistics), Carrier generation and recombination, Carrier transport: diffusion and drift, p-n junction, Metal-semiconductor junction (Ohmic and Schottky), Semiconductor materials of interest for optoelectronic devices.	12
3.	**Light-semiconductor interaction** Optical transitions in bulk semiconductors: absorption, spontaneous emission, and stimulated emission; Joint density of states, Density of states for photons, Transition rates (Fermi's golden rule), Optical loss and gain; Photovoltaic effect, Exciton, Drude model. Laser, Einstein's theory of matter radiation interaction and A and B coefficients, Amplification of light by population inversion, different types of lasers: gas laser(He-Ne, CO_2), Solid state laser (Ruby, Neodymium), Dye laser, Properties of laser beams, Monochromaticity, Coherence, directionality and brightness, Applications of laser in science and medicines.	12
4.	**Measurements** Four-point probe and van der Pauw measurements for carrier density, resistivity, and hall mobility; Hot-point probe measurement, capacitance-voltage measurements, parameter extraction from diode I-V characteristics, DLTS, band gap by UV-Vis spectroscopy, absorption/transmission.	6
	Total	**42**

List of References:

1. J. Singh, "*Semiconductor Optoelectronics: Physics and Technology*", McGraw-Hill Inc. (1995). 2. B. E. A. Saleh and M. C. Teich, "*Fundamentals of Photonics"*, John Wiley & Sons, Inc., (2007). 3. S. M. Sze, "*Semiconductor Devices: Physics and Technology*", Wiley (2008).
4. A. Yariv and P. Yeh, Photonics: "*Optical Electronics in Modern Communications*", Oxford University Press, New York (2007).
5. P. Bhattacharya, "*Semiconductor Optoelectronic Devices*", Prentice Hall of India (1997).
6. Online course: "*Semiconductor Optoelectronics*" by M R Shenoy on NPTEL
7. Online course: "*Optoelectronic Materials and Devices*" by Monica Katiyar and Deepak Gupta on NPTEL

ES104: ELECTRICAL WORKSHOP
CREDITS - 1 (LTP:0,0,1)

Course Objectives:

1. This course aims to provide Basic Electrical and Electronics Engineering concepts.
2. The main objective is to make the students able to understand, design and prepare electrical and electronics circuits using basic concepts.

Teaching and Assessment Scheme:

Teaching Scheme (Hours per week)			Credits	Assessment Scheme				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE	CE	ESE	CE	
0	0	2	1	0	0	40	60	100

Course Contents:

Unit No.	Topics	Teaching Hours
1	**Measurement:** Measuring of various electrical quantities like resistance, voltage, current, frequency, phase difference, amplitude, power, power factor for a. c. supply. Use of various analog, digital meters, Signal Generator, Cathode Ray Oscilloscope and Storage CRO	
2	**Wiring:** Single phase wiring; Tube-light wiring, Staircase wiring etc, Measurement of earthing resistance using megger.	
3	**Constructional Features:** Demonstration of construction & maintenance of electrical machines; appliances like fan, air- conditioner, refrigerators, UPS, Personal Computer etc.	
4	**Protective Devices:** Testing of characteristics of Fuse, MCB, and ELCB for a given Circuit.	
5	**Layout and Drawing:** Study of layout and circuit diagram of electrical wiring installation, panels and distribution boards of multi-storied buildings using IEEE Electrical symbols.	
6	**Rating and Specifications:**	

Unit No.	Topics	Teaching Hours
	Comparison of ratings and specification of various electrical circuit components and devices like motors, transformers, appliances and power supplies	
7	**Electrical Safety Standards:** Electrical safety standards, equipment and practices.	
8	**Introduction to Electronics Components:** Resistor, Capacitor, Inductor, Diode, LEDs, Transistor, MOSFET, Thyristor, Relays, Op-Amp, ICs, Breadboard etc. Soldering techniques.	
9	**Hands-on Soldering Techniques and PCB Design:** Soldering and testing. Simulation of the same experiment using Open Source software like Eagle, EasyEDA, Kicad, LTspice etc.	
10	**Introduction to Proteus Software:** Basic circuit design for embedded systems with simulation of microcontroller along with program implementation and output check	
	Total	

List of References:

1. P. Tiwari, S. Gairola, "*Electrical Engineering Laboratory Practice*", S. K. Kataria Publication
2. P K Kharbanda, S B Bodkhe, S D Naik and S G Tarnekar, *"Laboratory Courses in Electrical Engineering"*, 5/e, S. Chand Publishing
3. Dr. V. Ganesh and Dr. K. Venkat Reddy, *"Electrical Machines Lab Manual/Student Hand Book"*, Mudranik Technologies Pvt. Ltd.
4. B. L. Theraja, Volume- II, *"Electrical Technology"*, S. Chand
5. Jean Andrews; "Enhanced Guide to managing and maintain your PC", Edition , 2001, Course Technology – Thomso n learning publishers

ES109: ENGINEERING GRAPHICS AND DESIGN
CREDITS - 4 (LTP: 2,0,2)

Course Objectives:

To enable students to acquire and use engineering drawing skills as a means of accurately and clearly communicating ideas, information and instructions

Teaching and Assessment Scheme:

Teaching Scheme (Hours per week)			Credits	Assessment Scheme				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE	CE	ESE	CE	
2	0	4	4	30	20	40	60	100

Course Contents:

Unit No.	Topics	Teaching Hours
1	**Introduction to Engineering Graphics:** Drawing instruments and accessories, BIS – SP 46.	2 (Lab Hours)
2	Use of plane scales, Diagonal Scales.	2
3	**Orthographic Projections:** Fundamental of projection along with classification, Projections from the pictorial view of the object on the principal planes for view from front, top and sides using first angle projection method and third angle projection method, full sectional view	4
4	**Engineering Curves:** Classification and application of Engineering Curves, Construction of Conics, Cycloidal Curves, Involutes and Spirals along with normal and tangent to each curve	4
5	**Projections of Points and Lines:** Introduction to principal planes of projections, Projections of the points located in same quadrant and different quadrants, Projections of line with its inclination to one reference plane and with two reference planes. True length and inclination with the reference planes	4
6	**Projections of Planes:** Projections of planes (polygons, circle and ellipse) with its inclination to one reference plane and with two reference planes, Concept of auxiliary plane method for projections of the plane	4
7	**Projections of Solids, Section of Solids and Development of Surfaces:** Classification of solids. Projections of solids (Cylinder, Cone, Pyramid and Prism) along with frustum with its inclination to one reference plane and with two reference planes, Section of such solids and the true shape of the section, Development of surfaces	7
8	**Isometric Projections and Isometric View or Drawing:** Isometric Scale, Conversion of orthographic views into isometric projection, isometric view or drawing of objects	3
9	**Computer Aided Drawing:** Design concepts**,** Introduction to AutoCAD, Basic commands for 2D drawing like: Line, Circle, Polyline, Rectangle, Hatch, Fillet, Chamfer, Trim, Extend, Offset, Dimension style, etc. Industrial Drawing symbols, Program specific commands and tools.	6 (Lab Teaching)
	Total	**28**

List of References:

1. N.D.Bhatt, *"Engineering Drawing*", 53rd Edition, 2014, Charotar Publishing house Pvt. Ltd. Anand and Gujarat.
2. P.J.Shah, *"A Text Book of Engineering Graphics"* S.Chand & Company Ltd. New Delhi.
3. P.S.Gill, *"A Text Book of Engineering Drawing, S*.K.Kataria & Sons, Delhi.
4. B. Agrawal and C M Agrawal, "*Engineering Drawing*", Tata McGraw Hill, New Delhi.

ES110: BASIC MECHANICAL ENGINEERING
CREDITS - 4 (LTP:3,0,1)

Course Objectives:

To Study the fundamentals of mechanical systems and appreciate significance of mechanical engineering in different fields of engineering.

Teaching and Assessment Scheme:

Teaching Scheme (Hours per week)			Credits	Assessment Scheme				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE	CE	ESE	CE	
3	0	2	4	60	40	20	30	150

Course Contents:

Unit No.	Topics	Teaching Hours
1	**Introduction:** Prime movers and its types, Concept of Force, Torque, Pressure, Energy, Work, Power, System, Heat, Temperature, Specific heat capacity, Change of state, Path, Process, Cycle, Internal energy, Enthalpy, Statements of Zeroth law and First law	4
2	**Energy:** Introduction and applications of Energy sources like Fossil fuels, Nuclear fuels, Hydro, Solar, Wind, and Bio-fuels, Environmental issues like Global warming and Ozone depletion	3
3	**Properties of gases:** Gas laws, Boyle's law, Charle's law, Combined gas law, Gas constant, Relation between c_p and c_v, Various non-flow processes like constant volume process, constant pressure process, Isothermal process, Adiabatic process, Polytropic process	5
4	**Properties of Steam:** Steam formation, Types of steam, Enthalpy, Specific volume, Internal energy and dryness fraction of steam, use of steam tables, steam calorimeters	6
5	**Heat Engines:** Heat engine cycle and Heat engine, working substances, Classification of heat engines, Description and thermal efficiency of Carnot; Rankine; Otto cycle and Diesel cycles	5
6	**Steam Boilers:** Introduction, Classification, Cochran, Lancashire and Babcock and Wilcox boiler, Functioning of different mountings and accessories	-
7	**Internal Combustion Engines:** Introduction, Classification, Engine details, four-stroke/ two-stroke cycle Petrol/Diesel engines, Indicated power, Brake Power, Efficiencies	4
8	**Pumps:** Types and operation of Reciprocating, Rotary and Centrifugal pumps, Priming	3
9	**Air Compressors:** Types and operation of Reciprocating and Rotary air compressors, significance of Multistaging	3

Unit No.	Topics	Teaching Hours
10	**Refrigeration & Air Conditioning:** Refrigerant, Vapor compression refrigeration system, Vapor absorption refrigeration system, Domestic Refrigerator, Window and split air conditioners	4
11	**Couplings, Clutches and Brakes:** Construction and applications of Couplings (Box; Flange; Pin type flexible; Universal and Oldham), Clutches (Disc and Centrifugal), and Brakes (Block; Shoe; Band and Disc)	-
12	**Transmission of Motion and Power:** Shaft and axle, Different arrangement and applications of Belt drive; Chain drive; Friction drive and Gear drive	-
13	**Engineering Materials:** Types, properties and applications of Ferrous & Nonferrous metals, Timber, Abrasive material, silica, ceramics, glass, graphite, diamond, plastic and polymer	4
	Total	**41**

Note: Topic No. 6, 11 and 12 of the above syllabus are to be covered in Practical Hours.

List of References:

1. N M Bhatt and J R Mehta, "*Elements of Mechanical Engineering*", Mahajan Publishing House
2. Pravin Kumar, "*Basic Mechanical Engineering"*, Pearson Education
3. G.S. Sawhney, "*Fundamental of Mechanical Engineering"*, PHI Publication New Delhi
4. Sadhu Singh, "*Elements of Mechanical Engineering"* S. Chand Publication
5. B.K. Agrawal, "*Introduction to Engineering Materials"* McGraw Hill Publication, New Delhi

HS112: ENVIRONMENTAL SCIENCE
CREDITS - 0 (LTP:2,0,0)

Rationale:

To inculcate the environmental values translating into pro-conservation actions Honorable Supreme Court of India has made it 'mandatory' to introduce a basic course on environment at the undergraduate level.

Course Objectives:

1. **Develop awareness about various environmental pollution effects and control measures.**
2. **Create awareness about environmental ethics.**

Teaching and Assessment Scheme

Teaching Scheme (Hours per week)			Credits	Assessment Scheme				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE	CE	ESE	CE	
2	0	0	0	30	20	00	00	50

Course Content:

Unit No.	Topics	Teaching Hours
1	INTRODUCTION TO ENVIRONMENT **Definition, principles and scope of Environmental Science. Impacts of technology on Environment, Environmental Degradation, Importance for different engineering disciplines**	**02**
2	**ENVIRONMENTAL POLLUTION** **Water Pollution**: Introduction – Water Quality Standards, Sources of Water Pollution, Classification of water pollutants, Effects of water pollutants **Air Pollution:** Composition of air, Structure of atmosphere, Ambient Air Quality Standards, Classification of air pollutants, Sources of common air pollutants like PM, SO_2, NOX, Auto exhaust, Effects of common air pollutants **Noise Pollution:** Introduction, Sound and Noise, Noise measurements, Causes and Effects **Solid Waste:** Generation and management **Bio-medical Waste:** Generation and management **E-waste:** Generation and management	**12**
3	**GLOBAL ENVIRONMENTAL** ISSUES Sustainable Development, Climate Change, Global Warming and Green House Effect, Acid Rain, Depletion of Ozone layer, Carbon Footprint, Cleaner Development Mechanism (CDM), International Steps for Mitigating Global Change	07
4.	SOCIAL ISSUES AND ENVIRONMENT **Role of an individual in prevention of environmental pollution. Environmental ethics: Issues and possible solution. Wasteland reclamation, consumerisms and waste products.**	**05**
5	CONCEPT OF 4R's Principles, Application of 4R's :Reduce, Reuse, Recycle, Recovery	**02**
	Total	28

HS102: ENVIRONMENTAL SCIENCE
CREDITS - 0 (L=2, T=2, P=0)

Rationale: **To inculcate the environmental values translating into pro-conservation actions Honorable Supreme Court of India has made it 'mandatory' to introduce a basic course on environment at the undergraduate level.**

Course Objectives:

1. **Develop awareness about various environmental pollution effects and control measures.**
2. **Create awareness about environmental ethics.**

Teaching and Assessment Scheme

Teaching Scheme			Credits	Assessment Scheme				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE	CE	ESE	CE	
2	2	0	0	35	15	30	20	100

Course Content:

Unit No.	Topics	Teaching Hours
1	INTRODUCTION TO ENVIRONMENT **Definition, principles and scope of Environmental Science. Impacts of technology on Environment, Environmental Degradation, Importance for different engineering disciplines**	**02**
2	**ENVIRONMENTAL POLLUTION** **Water Pollution**: Introduction – Water Quality Standards, Sources of Water Pollution, Classification of water pollutants, Effects of water pollutants **Air Pollution:** Composition of air, Structure of atmosphere, Ambient Air Quality Standards, Classification of air pollutants, Sources of common air pollutants like PM, SO_2, NOX, Auto exhaust, Effects of common air pollutants **Noise Pollution:** Introduction, Sound and Noise, Noise measurements, Causes and Effects **Solid Waste:** Generation and management **Bio-medical Waste:** Generation and management **E-waste:** Generation and management	**12**
3	**GLOBAL ENVIRONMENTAL ISSUES** Sustainable Development, Climate Change, Global Warming and Green House Effect, Acid Rain, Depletion of Ozone layer, Carbon Footprint, Cleaner Development Mechanism (CDM), International Steps for Mitigating Global Change	07
4.	SOCIAL ISSUES AND ENVIRONMENT **Role of an individual in prevention of environmental pollution. Environmental ethics: Issues and possible solution. Wasteland reclamation, consumerisms and waste products.**	**05**

Unit No.	Topics	Teaching Hours
5	CONCEPT OF 4R's Principles, Application of 4R's :Reduce, Reuse, Recycle, Recovery	**02**
	Total	28

BS112: LINEAR ALGEBRA AND FOURIER SERIES
CREDITS - 4 (LTP:3,1,0)

Course Objectives:
The basic necessity for the Foundation of Engineering & Technology being Mathematics, the main aim is, to teach Mathematical concepts, develop Mathematical skills & enhance thinking power of students.

Teaching and Assessment Scheme:

Teaching Scheme (Hours per week)			Credits	Assessment Scheme				
L	T	P	C	Theory Marks		Practical Marks		Total Marks
				ESE	CE	ESE	CE	
3	1	0	4	60	40	20	30	150

Course Contents:

Unit No.	Topics	Teaching Hours
1	Matrices: addition and multiplication by scalar, matrix multiplication; Linear systems of equations (homogeneous and nonhomogeneous), rank of a matrix, determinants, Cramer's Rule, inverse of a matrix, Gauss elimination and Gauss-Jordan elimination.	10
2	Vector Space, linear dependence of vectors, basis, dimension; Linear transformations (maps), range and kernel of a linear map, rank and nullity, Inverse of a linear transformation, rank-nullity theorem, composition of linear maps, Matrix associated with a linear map.	12
3	Eigenvalues, eigenvectors, symmetric, skew-symmetric, and orthogonal Matrices, eigen bases. Diagonalization; Inner product spaces, Gram-Schmidt orthogonalization.	10
4	Periodic function, Fourier series, Functions of any period, Even and odd functions, Half-range Expansion, Parseval's theorem.	10
	Total	**42**

List of References:

1. Howard A. and Chris R., "*Elementary Linear Algebra*", John Wiley & Sons, 2005.
2. Grewal B. S., "*Higher Engineering Mathematics*", Khanna Publisher, New Delhi, (Latest Edition).

3. Bali N. P. and Goyal M., "*Engineering Mathematics*", Laxmi Publication (Latest Edition).

BS102: LINEAR ALGEBRA AND FOURIER SERIES
CREDITS = 5 (L=3, T=2, P=0)

Course Objectives:
The basic necessity for the Foundation of Engineering & Technology being Mathematics, the main aim is, to teach Mathematical concepts, develop Mathematical skills & enhance thinking power of students.

Teaching and Assessment Scheme:

Teaching Scheme (Hours per week)			Credits	Assessment Scheme				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE	CE	ESE	CE	
3	2	0	5	70	30	30	20	150

Course Contents:

Unit No.	Topics	Teaching Hours
1	Matrices: addition and multiplication by scalar, matrix multiplication; Linear systems of equations (homogeneous and nonhomogeneous), rank of a matrix, determinants, Cramer's Rule, inverse of a matrix, Gauss elimination and Gauss-Jordan elimination.	10
2	Vector Space, linear dependence of vectors, basis, dimension; Linear transformations (maps), range and kernel of a linear map, rank and nullity, Inverse of a linear transformation, rank-nullity theorem, composition of linear maps, Matrix associated with a linear map.	12
3	Eigenvalues, eigenvectors, symmetric, skew-symmetric, and orthogonal Matrices, eigen bases. Diagonalization; Inner product spaces, Gram-Schmidt orthogonalization.	10
4	Periodic function, Fourier series, Functions of any period, Even and odd functions, Half-range Expansion, Parseval's theorem.	10
	Total	**42**

List of References:
1. Howard A. and Chris R., *"Elementary Linear Algebra*", John Wiley & Sons, 2005.
2. Grewal B. S., "*Higher Engineering Mathematics*", Khanna Publisher, New Delhi, (Latest Edition).
3. Bali N. P. and Goyal M., "*Engineering Mathematics*", Laxmi Publication (Latest Edition).

BS105: ELECTROMAGNETIC PHYSICS
CREDITS - 4 (LTP:3,0,1)

Teaching and Examination Scheme:

Teaching Scheme (Hours per week)			Credits	Assessment Scheme		Total Marks
L	T	P	C	Theory Marks	Practical Marks	

				ESE	**CE**	**ESE**	**CE**	
3	0	2	4	60	40	20	30	150

Course Contents:

Unit No	Topics	Teaching Hours
1.	**Electrostatics in vacuum** Calculation of electric field and electrostatic potential for a charge distribution; Divergence and curl of electrostatic field; Laplace's and Poisson's equations for electrostatic potential and uniqueness of their solution and connection with steady state diffusion and thermal conduction; Practical examples like Farady's cage and coffee-ring effect; Boundary conditions of electric field and electrostatic potential; method of images; energy of a charge distribution and its expression in terms of electric field.	6
2.	**Electrostatics in a linear dielectric medium** Electrostatic field and potential of a dipole. Bound charges due to electric polarization; Electric displacement; boundary conditions on displacement; Solving simple electrostatics problems in presence of dielectrics – Point charge at the centre of a dielectric sphere, charge in front of a dielectric slab, dielectric slab and dielectric sphere in uniform electric field.	6
3.	**Magnetostatics** Bio-Savart law, Divergence and curl of static magnetic field; vector potential and calculating it for a given magnetic field using Stokes' theorem; the equation for the vector potential and its solution for given current densities.	4
4.	**Magnetostatics in a linear magnetic medium** Magnetization and associated bound currents; auxiliary magnetic field; Boundary conditions on and . Solving for magnetic field due to simple magnets like a bar magnet; magnetic susceptibility and feromagnetic, paramagnetic and diamagnetic materials; Qualitative discussion of magnetic field in presence of magnetic materials.	6
5.	**Faraday's law** Faraday's law in terms of EMF produced by changing magnetic flux; equivalence of Faraday's law and motional EMF; Lenz's law; Electromagnetic breaking and its applications; Differential form of Faraday's law expressing curl of electric field in terms of time-derivative of magnetic field and calculating electric field due to changing magnetic fields in quasi-static approximation; energy stored in a magnetic field.	4
6.	**Displacement current, Magnetic field due to timedependent electric field and Maxwell's equations** Continuity equation for current densities; Modifying equation for the curl of magnetic field to satisfy continuity equation; displace current and magnetic field arising from time-dependent electric field; calculating magnetic field due to changing electric fields in quasi-static approximation. Maxwell's equation in vacuum and non-conducting medium; Energy in an electromagnetic field; Flow of energy and Poynting vector with examples. Qualitative discussion of momentum in electromagnetic fields.	6

Unit No	Topics	Teaching Hours
7.	**Electromagnetic waves** The wave equation; Plane electromagnetic waves in vacuum, their transverse nature and polarization; relation between electric and magnetic fields of an electromagnetic wave; energy carried by electromagnetic waves and examples. Momentum carried by electromagnetic waves and resultant pressure. Reflection and transmission of electromagnetic waves from a nonconducting medium-vacuum interface for normal incidence.	10
	Total	**42**

Text Book:
1. David Griffiths, "*Introduction to Electrodynamics*"

List of References:
1. Halliday and Resnick, "*Physics*"
2. W. Saslow, "*Electricity, Magnetism and Light*"

ES105: PROGRAMMING FOR PROBLEM SOLVING
CREDITS - 4 (LTP:3,0,1)

Course Objectives:
To enhance logical thinking and to impart basic programming skills using C programming language

Teaching and Assessment Scheme:

Teaching Scheme (Hours per week)			Credits	Assessment Scheme				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE	CE	ESE	CE	
3	0	2	4	60	40	20	30	150

Course Contents:

Unit No.	Topics	Teaching Hours
1	**Introduction:** Introduction to components of a computer system (disks, memory, processor, Introduction to components of a computer system (disks, memory, processor, where a program is stored and executed, operating system, compilers etc.), notion of machine level, assembly level and high level languages, Idea of algorithm: steps to solve logical and numerical problems, representation of algorithm: flowchart / pseudo code with examples.	6
2	**Fundamentals:** Features of 'C' language, structure of a 'C' program, basic data types, constants and variables, operators and their hierarchy, arithmetic expressions and precedence, writing simple programs in 'C', concept of header files	7

Unit No.	Topics	Teaching Hours
3	**Control Structure Of 'C':** Conditional branching using *if – else* statement, variations in usage of *if – else* statement, *switch-case*, and *goto* statements; looping using *for*, *while, and do – while,* use of *break* and *continue* statements	6
4	**Arrays and Strings:** 1D and 2D arrays, character arrays and strings, library functions for manipulation of strings	7
5	**Functions and Recursion**: Library and user-defined function, passing parameters to functions, passing array to functions, recursion as different way of solving problems, overview of macros and pre-processors	6
6	**Pointers and Structures:** Idea of pointers, defining pointers, simple programs using pointers in 'C', pointers and arrays, calling function by value and by reference, dynamic memory allocation: *malloc* and *calloc*, structures, defining structures, array of structures, nested structures, structure as an argument to functions, structures and pointers, unions	7
7	**File Handling in C:** Introduction, opening, closing, and input / output operations on files, error handling during I/O operations, random access of files	3
	Total	**42**

List of References:

1. Balagarusamy E, "*Programming in ANCI C",* Sixth edition; Tata McGraw-Hill Publishing Company Limited, 2012
2. Gottfried B S, "*Programming with C*", Second edition; Tata McGraw-Hill Publishing Company Limited, 2006
3. Kernighan B W and Ritchie D M, "*C Programming language*" Second edition; Prentice Hall, 2006
4. Kanetkar Y. P., "*Let us C*" Fifth edition; BPB Publication, 2004

ES112: BASICS OF MANUFACTURING PRACTICES
CREDITS - 1 (LTP:0,0,1)

Course Objectives:

To introduce the concepts of basic manufacturing processes and demonstrate the conversion of raw material into a finished product.

Teaching and Assessment Scheme:

Teaching Scheme (Hours per week)			Credits	Assessment Scheme				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE	CE	ESE	CE	
0	0	2	1	0	0	40	60	100

Course Contents:

Unit No.	Topics	Teaching Hours
1	**Introduction to workshop and safety aspect:** Orientation of the workshop, Introduction to safety aspects to be observed in workshop or industries.	2
2	**Machine Shop:** Introduction and demonstration of various machine tools such as Lathe, Drilling, Shaping, Slotting, Planning, Milling, Grinding.	8
3	**Manufacturing Shops:** Introduction and demonstration to Carpentry, Fitting, Welding, Brazing Soldering ,Casting, Plastic moulding & Glass cutting.	18
	Total	**28**

List of References:

1. Hajra Choudhury S.K., Hajra Choudhury A.K. and Nirjhar Roy S.K., "*Elements of Workshop Technology*", Vol. I 2008 and Vol. II 2010, Media promoters and publishers private limited, Mumbai.
2. Kalpakjian S. And Steven S. Schmid, "*Manufacturing Engineering and Technology*", 4th edition, Pearson Education India Edition, 2002.
3. Gowri P. Hariharan and A. Suresh Babu,"*Manufacturing Technology – I*" Pearson Education, 2008.
4. Roy A. Lindberg, "*Processes and Materials of Manufacture*", 4th edition, Prentice Hall India, 1998.
5. Rao P.N., "*Manufacturing Technology*", Vol. I and Vol. II, Tata McGrawHill House, 2017.
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ES103: BASIC ELECTRICAL ENGINEERING
CREDITS - 4 (LTP:3,0,1)

Course Objectives:

Electricity is the basic requirement for all citizens of a Country. It is also very important for all sectors of Industry, Engineering and Infrastructure. In view of this, it is desirable for all discipline engineering graduates to know the fundamental concepts of electrical engineering. This subject deals with fundamental circuit analysis and solution methods, introduction to electrical machines, power converters and basics of domestic electrical installations.

Teaching and Assessment Scheme:

Teaching Scheme (Hours per week)			Credits	Assessment Scheme				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE	CE	ESE	CE	
3	0	2	4	60	40	20	30	150

Course Contents:

Unit No.	Topics	Teaching Hours
1	**DC Circuits:** Electrical circuit elements (R, L and C), voltage and current sources, Kirchoff current and voltage laws, analysis of simple circuits with dc excitation. Superposition, Thevenin and Norton Theorems. Time-domain analysis of first-order RL and RC circuits.	8
2	**AC Circuits**: Representation of sinusoidal waveforms, peak and rms values, phasor representation, real power, reactive power, apparent power, power factor. Analysis of single-phase ac circuits consisting of R, L, C, RL, RC, RLC combinations (series and parallel), resonance. Three-phase balanced circuits, voltage and current relations in star and delta connections.	8
3	**Transformers:** Magnetic materials, BH characteristics, ideal and practical transformer, equivalent circuit, losses in transformers, regulation and efficiency. Auto-transformer and three-phase transformer connections.	6
4	**Electrical Machines:** Generation of rotating magnetic fields, Construction and working of a three-phase induction motor, Significance of torque-slip characteristic. Loss components and efficiency, starting and speed control of induction motor. Single-phase induction motor. Construction, working, torque-speed characteristic and speed control of separately excited dc motor. Construction and working of synchronous generators.	8
5	**Power Converters:** DC-DC buck and boost converters, duty ratio control. Single-phase and three-phase voltage source inverters; sinusoidal modulation.	6
6	**Electrical Installations** Components of LT Switchgear: Switch Fuse Unit (SFU), MCB, ELCB, MCCB, Types of Wires and Cables, Earthing. Types of Batteries, Important Characteristics for Batteries. Elementary calculations for energy consumption, power factor improvement and battery backup.	6
	Total	**42**

Suggested Text / Reference Books

1. D.P. Kothari and I. J. Nagrath, "*Basic Electrical Engineering*", Tata McGraw Hill,2010.
2. D.C. Kulshreshtha, "*Basic Electrical Engineering*", McGrawHill,2009.
3. Ritu Sahdev, *Basic Electrical Engineering*, (ISBN: 9789386173492), Khanna Book Publishing Co.
4. B. L. Theraja, "*A Textbook of Electrical Technology*" - Volume I and II, S. Chand Publishers, 2012
5. L.S. Bobrow, "*Fundamentals of Electrical Engineering*", Oxford University Press,2011.
6. E. Hughes, "*Electrical and Electronics Technology*", Pearson,2010.
7. V.D. Toro, "*Electrical Engineering Fundamentals*", Prentice Hall India, 1989.

List of experiments/demonstrations:

1. Basic safety precautions. Introduction and use of measuring instruments–voltmeter, ammeter, multi-meter, oscilloscope. Real-life resistors, capacitors and inductors.

2. Measuring the steady-state and transient time-response of R-L, R-C, and R-L-C circuits to a step change in voltage (transient may be observed on a storage oscilloscope). Sinusoidal steady state response of R-L, and R-C circuits – impedance calculation and verification. Observation of phase differences between current and voltage. Resonance in R-L-C circuits.
3. Transformers: Observation of the no-load current waveform on an oscilloscope (non- sinusoidal wave-shape due to B-H curve non-linearity should be shown along with a discussion about harmonics). Loading of a transformer: measurement of primary and secondary voltages and currents, and power.
4. Three-phase transformers: Star and Delta connections. Voltage and Current relationships (line-line voltage, phase-to-neutral voltage, line and phase currents). Phase-shifts between the primary and secondary side. Cumulative three-phase power in balanced three-phase circuits.
5. Demonstration of cut-out sections of machines: dc machine (commutator-brush arrangement), induction machine (squirrel cage rotor), synchronous machine (field winging – slip-ring arrangement) and single-phase induction machine.
6. Torque Speed Characteristic of separately excited dc motor.
7. Synchronous speed of two and four-pole, three-phase induction motors. Direction reversal by change of phase-sequence of connections. Torque-Slip Characteristic of an induction motor. Generator operation of an induction machine driven at super-synchronous speed.
8. Synchronous Machine operating as a generator: stand-alone operation with a load. Control of voltage through field excitation.
9. Demonstration of (a) dc-dc converters (b) dc-ac converters –PWM waveform (c) the use of dc-ac converter for speed control of an induction motor and (d) Components of LT switch-gear.

HS101: ENGLISH
CREDITS - 3 (LTP:2,0,1)

Course Objectives:

To acquaint BE students with the basics of English. The curriculum intends to familiarize students with LSRW Skills and provides exposure and practice in all four aspects to equip them with the useful language competencies and confidence to communicate well. The course accentuates good drilling in practicum in order to enable students to learn, perform and enhance their accuracy and skills in English language to excel in their field of specialization

Teaching and Assessment Scheme:

Teaching Scheme (Hours per week)			Credits	Assessment Scheme				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE	CE	ESE	CE	
2	0	2	3	30	20	20	30	100

Course Contents:

Unit No.	Topics	Teaching Hours
1	**Vocabulary Building** 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. General English words and their technical equivalent words	4
2	**Basic Writing Skills** Sentence Structures. Use of phrases and clauses in sentences, Importance of proper punctuation, Creating coherence and Cohesion, Organizing principles of paragraphs in documents, Techniques for writing precisely	6
3	**Identifying Common Errors in Writing** Subject-verb agreement, Noun-pronoun agreement, Misplaced modifiers, Articles, Prepositions, Redundancies, Clichés, Collocations	6
4	**Nature and Style of sensible Writing** Types of writing- descriptive, narrative, argumentative, Describing, Defining, Classifying, Providing examples or evidence, Writing introduction and conclusion	4
5	**Writing Practices** Paragraph Writing: Topic sentence, supportive sentences and conclusion, Précis Writing, Essay Writing	4
6	**Language Skills** (This unit involves interactive practice sessions In Language Lab) Listening Comprehension, Reading Comprehension, Writing Skills (Permission letter, Invitation letter, Acknowledgement letter, Reporting complaint/grievance), Pronunciation, Intonation, Stress and Rhythm, Common Everyday Situations: Conversations and Dialogues Communication at Workplace, Interviews, Formal Presentations, Public Speeches: Talking about self (Professional Setting, social setting), Introduction of Speakers, Vote of thanks	6
	Total	**30**

Language Lab Activities:

Sr. No.	Language Laboratory Activities	Duration	Nature of Activities
1	Listening Comprehension	1	Individual Task
2	Reading aloud stories - developing dialogues - deciding roles and enactment and performance analysis	2	Group work
3	Dialogue Writing (Cue cards)	1	(Team Work- Teacher Guided)
4	Reading Comprehension	2	Individual Tasks & Group Tasks (Digital Language Lab)
5	Note Taking and Note Making	1	
6	Book/Story Review/Article Review	1	
7	Group Discussion	1	

8	Short Oral Presentations (preferably recorded for self-analysis)	1	
9	Extempore (preferably recorded for self-analysis)	1	Individual Task
10	ICT Based presentations/ Technology based presentation	2	1 in Group & 1 individual
11	Graph/Chart Interpretation	1/2	Individual Task
12	Diagram illustration	1/2	Individual Task

List of References:

1. Michael Swan, "*Practical English Usage*". OUP. 1995.
2. F.T. Wood, "*Remedial English Grammar*". Macmillan.2007
3. William Zinsser, "*On Writing Well"*, Harper Resource Book. 2001
4. Liz Hamp-Lyons and Ben Heasly, *"Study Writing"*. Cambridge University Press. 2006.
5. Sanjay Kumar and PushpLata, "*Communication Skills"* Oxford University Press. 2011.
6. *"Exercises in Spoken English",* Parts. I-III. CIEFL, Hyderabad. Oxford University Press
7. Michael McCarthy& Felicity O' Dell, "*English Vocabulary in Use".* CUP 1994
8. Michael McCarthy& Felicity O' Dell, "*English Collocations in Use"*. CUP 2005
9. "*Writing Skills: Success in 20 Minutes a Day*". .GP Goodwill's 2013
10. Judith F. Olson, "*Write Better; Speak better"*. Reader's Digest.1998
11. *"How to Say It"*, Third Edition: Choice Words, Phrases, Sentences, and Paragraphs for Evry Situation Original Edition, Rosalie Maggio, Prentice Hall Press, 2009

2EE01: ELECTRICAL CIRCUIT ANALYSIS
CREDITS - 4 (LTP:3,0,1)

Course Objectives:

The subject aims to provide the student with:

1. Understanding of concepts and principles of passive circuit analysis and synthesis
2. Ability to solve complex circuits using different theorems and methods.
3. Advanced understanding of electrical networks which will be useful for advance Subjects.

Teaching and Assessment Scheme:

Teaching Scheme (Hours per week)			Credits	Assessment Scheme				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE	CE	ESE	CE	
3	0	2	4	60	40	20	30	150

Course Contents:

Unit No	Topics	Teaching Hours
1	**Networks Theorem** Detail analysis on Source transformation, Node and Mesh Analysis, Thevenin's and Norton's Theorem. Maximum power transfer theorem, Reciprocity theorem, Compensation theorem, Substitution theorem, Millman Theorem, Analysis with dependent current and voltage sources. Concept of duality and dual networks.	10
2	**Solution of First and Second order networks** Detail analysis on Solution of first and second order differential equations for Series and parallel R-L, R-C, R-L-C circuits. Initial and final conditions in network elements, forced and free response, time constants, steady state and transient state response. Mesh Analysis of Circuits with Independent Sources, Mesh Analysis of Circuits Containing Dependent Sources.	08
3	**Sinusoidal steady state analysis** Representation of sine function as rotating phasor, phasor diagrams, impedances and admittances, AC circuit analysis, Discharging of a Capacitor through an inductor, Source free second order linear networks, and second order linear networks with constant inputs. Mutual coupled circuits, Dot Convention in coupled circuits, Ideal Transformer	08
4	**Electrical Circuit Analysis Using Laplace Transforms** Review of Laplace Transform, Analysis of electrical circuits using Laplace Transform for standard inputs, convolution integral, inverse Laplace transform, transformed network with initial conditions. Transfer function representation. Poles and Zeros. Frequency response (magnitude and phase plots), series and parallel resonances	06
5	**Two Port Network, Network Functions and Graph Theory** Two Port Networks, terminal pairs, relationship of two port variables, impedance parameters, admittance parameters, transmission parameters and hybrid parameters, interconnections of two port networks. Networks topology and Graph Theory concepts, Matrix Representation for the network.	08
	Total	**40**

List of references:

1. Franklin S. KUO*, "Network Analysis & Synthesis",* Wiley Publication
2. M.E Van Valkenburg*, "Network Analysis",* PHIPublication
3. K.S. Suresh Kumar*, "Electric Circuits and Networks"* Pearson Education
4. U.A. Patel,*"Circuits and Networks",* Mahajan Publications

Course Outcomes:

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

1. Apply network theorems for the analysis of electrical circuits.
2. Obtain the transient and steady-state response of electrical circuits.
3. Analyse circuits in the sinusoidal steady-state.
4. Analyse two port circuit behaviour of the network.
5. Obtain graph structure of a network and solve the network.

2EE02: ANALOG ELECTRONICS
CREDITS - 3 (LTP:3,0,0)

Course Objectives:

The subject aims to provide the student with:

1. Understanding of concepts and principles of Analog circuits.

2. Ability to solve complex circuits using different applications of op-amp.

3. Advanced understanding of electronics, linear and nonlinear electronic circuits which will be useful for advance Subjects.

Teaching and Assessment Scheme:

Teaching Scheme (Hours per week)			Credits	Assessment Scheme				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE	CE	ESE	CE	
3	0	0	3	60	40	0	0	100

Course Contents:

Unit No.	Topics	Teaching Hours
1	**Diode circuits** P-N junction diode, I-V characteristics of a diode; review of half-wave and full-wave rectifiers, Zener diodes, clamping and clipping circuits	04
2	**BJT circuits** Structure and I-V characteristics of a BJT; BJT as a switch. BJT as an amplifier: small-signal model, biasing circuits, current mirror; common- emitter, common-base and common-collector amplifiers; Small signal equivalent circuits, high-frequency equivalent circuits	07
3	**MOSFET circuits** MOSFET structure and I-Vcharacteristics. MOSFET as a switch. MOSFET as an amplifier: small-signal model and biasing circuits, common-source, common-gate and common-drain amplifiers; small signal equivalent circuits-gain, input and output impedances, trans-conductance, high frequency equivalent circuit.	07
4	**Differential, multi-stage and operational amplifiers** Differential amplifier; power amplifier; direct coupled multi-stage amplifier; internal structure of an operational amplifier, ideal op-amp, non-dualities in an op-amp (Output offset voltage, input bias current, input offset current, slew rate, gain bandwidth product	08
5	**Linear applications of op-amp** Idealized analysis of op-amp circuits. Inverting and non-inverting amplifier, differential amplifier, instrumentation amplifier, integrator, active filter, P,PI and PID controllers and lead/lag compensator using an op-amp, voltage regulator, oscillators (Wein bridge and phase shift).	08
6	**Nonlinear applications of op-amp** Hysteretic Comparator, Zero Crossing Detector, Square-wave and triangular-wave generators. Precision rectifier, peak detector. Monoshot.	06
	Total	**40**

List of References:

1. A.S. Sedra and K.C.Smith,*"Microelectronic Circuits",*New York, Oxford University Press,1998.
2. J.V.Wait, L. P. Huelsman and G.A.Korn, "*Introduction to Operational Amplifier theory and applications"*, McGraw Hill U.S.,1992.
3. J. Millman and A.Grabel, "*Microelectronics"*, McGraw Hill Education,1988.
4. P. Horowitz and W.Hill, "*The Art of Electronics*", Cambridge University Press,1989.
5. P.R.Gray,R.G.Meyerand S.Lewis,"*Analysis and Design of Analog Integrated Circuits"*, John Wiley & Sons, 2001.

Course Outcomes:

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

1. Understand the characteristics of transistors.
2. Design and analyses various rectifier and amplifier circuits.
3. Design sinusoidal and non-sinusoidal oscillators.
4. Understand the functioning of OP-AMP and design OP-AMP based circuits.

2EE03: ANALOG ELECTRONICS LABORATORY
CREDITS - 1 (LTP:0,0,1)

Teaching & Assessment Scheme:

Teaching Scheme (Hours per week)			Credits	Assessment Scheme				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE	CE	ESE	CE	
0	0	2	1	00	00	40	60	100

Unit No	Title
1	Performance of characteristics of diode.
2	Performance of characteristics of Half Wave rectifier
3	Performance of characteristics of Full Half Wave rectifier
4	Performance of characteristics of Op-Amp as a Clipper and Clamper
5	Performance of characteristics of BJT for common base configuration
6	Performance of characteristics of BJT for common emitter configuration
7	Performance of characteristics of BJT for common collector configuration
8	Performance of character of MOSFET
9	Performance of an Op-Amp as a inverting, non-inverting and differential Amplifier
10	Performance of an Op-Amp as a summing and scaling amplifier
11	Performance of an Op-Amp as a clipper and clamper
12	Performance of an Op-Amp as a instrumentation amplifier.
13	Performance of an Op-Amp as a Schmitt trigger
14	Performance of an Op-Amp as a integrator and differentiator

2EE04: ELECTRICAL MACHINES - I
CREDITS - 3 (LTP:3,0,0)

Course Objectives:

The subject aims to provide the student with:

1. Understanding of the basics of electrical machines and their construction
2. Knowledge of testing and performance of electrical machines.
3. Knowledge for learning advanced machines and their control.
4. In-depth understanding of application based knowledge in the field of electrical drives.

Teaching and Assessment Scheme

Teaching Scheme (Hours per week)			Credits	Assessment Scheme				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE	CE	ESE	CE	
3	0	0	3	60	40	00	00	100

Course Contents:

Unit No.	Topics	Teaching Hours
1	**Electromechanical Energy Conversion Principles:** Energy in a magnetic systems, field energy and mechanical force, energy in singly and multiply excited magnetic systems, determination of magnetic force and torque from energy and co energy, Forces and torques in magnetic field systems, dynamic equations of electro-mechanical systems and analytical techniques.	06
2	**DC Generators:** Construction of DC Machine, Working, types, EMF equation, Armature windings, Characteristics and applications, Building of EMF, Armature reaction - Demagnetizing and Cross magnetizing mmf and their estimation; Remedies to overcome the armature reaction; Commutation process, Causes of bad commutation and remedies.	07
3	**D.C. Motors:** Principles of working, Significance of back EMF, Torque Equation, Types, Characteristics and Selection of DC Motors, Starting of DC Motors, Speed Control, Losses and Efficiency, Condition for Maximum Efficiency, Braking of DC Motors, Effect of saturation and armature reaction on losses; Applications, Permanent Magnet DC Motors, Type and Routine tests.	07
4	**Single Phase Transformer:** Transformer construction, Ideal and practical transformer, exact and approximate equivalent circuits, no load and on load operation, phasor diagrams, power and energy efficiency, voltage regulation, parallel operation, effect of load on power factor, Per Unit system, excitation phenomenon in transformers, switching transients, Auto transformers, voltage and current transformers, welding transformers, Pulse transformer and applications.	10
5	**Three Phase Transformers:** Constructional features of three phase transformers, Cooling methodology, Standard and special transformer connections, Phase conversion, Parallel operation of three phase transformers, three winding transformers and its equivalent circuit, On load tap changing of transformers, Modern trends in transformers, Type and routine tests, Standards.	10
	Total	**40**

List of References:

1. D. P. Kothari and I. J. Nagrath, "*Electric Machines*", Tata McGraw HillPublication,4th Edition 2010, Reprint 2012.
2. B.L.Theraja,"*A Textbook of Electrical Technology Volume II (Multicolour Edition)",* S.Chand Publication,
3. J.B.Gupta, "*Theory and Performance of Electrical Machines*" S.K Kataria &Sons Publication,

fifteenth Edition 2015, Reprint 2017
4. M. G.Say,"*Performance and design of AC machines*", CBS Publishers,2002.

E-resource: nptel.ac.in/courses/108105017; NPTEL: Electrical Engineering, Electrical Machines –I.

Course Outcomes

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

1. Analyse and apply the energy conversion principles to rotating machines.
2. Evaluate the steady state parameters, basic operating characteristics and performance of DC Machine and its application.
3. Evaluate the steady state parameters, basic operating characteristics and performance of transformers.

2EE05: ELECTRICAL MACHINES LABORATORY-I
CREDITS - 1 (LTP:0,0,1)

Teaching and Assessment Scheme

Teaching Scheme (Hours per week)			Credits	Assessment Scheme				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE	CE	ESE	CE	
0	0	2	1	00	00	40	60	100

List of practical:

1. O.C.C characteristic of separately excited DC shunt Generator.
2. Load test on separately and self-excited DC shunt Generator.
3. Load test on DC series generator.
4. Load test on DC series and shunt motor.
5. Speed control of DC series and shunt motor.
6. Ward Leonard method for speed control of DC shunt motor.
7. Hopkinson test.
8. Field test on DC series motor.
9. Open circuit and short circuit test on single phase transformer.
10. Sumpner test on single phase transformer.
11. Parallel operation of single phase transformer.
12. Scott connection of three phase transformer.
13. Three phase Transformer connection.
14. Separation of core loss in transformer.
15. Braking of DC motor

2BS01: ORDINARY DIFFERENTIAL EQUATIONS AND STATISTICS
CREDITS - 4 (LTP:3,1,0)
2nd Year, B. Tech. (CP, EL, EE, EC, IT)

Course objective:

To introduce differential equations and statistics techniques used in engineering analysis.

Teaching and Assessment Scheme:

Teaching Scheme (Hours per Week)			Credits	Assessment Scheme				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE	CE	ESE	CE	150
3	1	0	4	60	40	20	30	

Course Contents:

Unit No.	Topics	Teaching Hours
1	**Ordinary differential equations of higher orders** Second order linear differential equations with variable coefficients, method of variation of parameters, Cauchy-Euler equation; Power series solutions; Legendre polynomials, Bessel functions of the first kind and their properties.	8
2	**Transform Calculus -1** Laplace Transform, Properties of Laplace Transform, Laplace transform of periodic functions. Finding inverse Laplace transform by different methods, convolution theorem. Evaluation of integrals by Laplace transform, solving ODEs by Laplace Transform method.	10
3	**Transform Calculus-2** Fourier transforms: properties, methods, inverses and their applications.	4
4	**Basic Statistics:** Measures of Central tendency: Moments, skewness and Kurtosis - Probability distributions: Binomial, Poisson and Normal - evaluation of statistical parameters for these three distributions, Correlation and regression – Rank correlation.	8
5	**Applied Statistics*:*** Curve fitting by the method of least squares- fitting of straight lines, second degree parabolas and more general curves. Test of significance: Large sample test for single proportion, difference of proportions, single mean, difference of means, and difference of standard deviations.	8
6	**Small samples*:*** Test for single mean, difference of means and correlation coefficients, test for ratio of variances - Chi-square test for goodness of fit and independence of attributes.	4
	TOTAL	**42**

List of References:

1. Erwin Kreyszig, "*Advanced Engineering Mathematics"*, 9th Edition, John Wiley & Sons, 2006.
2. Chandrika Prasad and Reena Garg, *"Advanced Engineering Mathematics*", Khanna Book Publishing Co. (P) Ltd., Delhi
3. N.P. Bali and Manish Goyal, "*A text book of Engineering Mathematics"*, Laxmi Publications, Reprint, 2010.
4. B.S. Grewal, "*Higher Engineering Mathematics"*, Khanna Publishers, 35th Edition, 2000.
5. W. E. Boyce and R. C. Di Prima, *"Elementary Differential Equations and Boundary Value Problems*", 9th Edition, Wiley India, 2009.
6. S. C. Gupta, V. K. Kapur, *"Fundamental of Statistics"*, Sultan Chand & Sons, India,
7. S. Ross, "*A first course in Probability"*, Pearson Education India, 2002.
8. Richard A. Johnson, Miller and Freund's – *"Probability and Statistics for Engineers"*, Prentice Hall of India, 2011.

Course Outcome:

At the end of this course students will be able to

1. Understand effective mathematical tools for the solutions of ordinary differential equations.
2. Analyze and solve ordinary differential equations using various techniques including transform techniques.
3. Apply effective mathematical tools of ordinary differential equations, Laplace and Fourier transform.
4. Understand the concepts and tools of Statistics.
5. Analyze and solve various engineering problems through the tools of Statistics.
6. Adapt tools of applied statistics and sampling theory and apply them in engineering problems.

2HS02: ECONOMICS AND MANAGEMENT
CREDITS – 3 (LTP:3,0,0)

Course Objectives:

To provide the basics of economics and management applicable to various branches of engineering. The subject will enable them to connect the concepts of economics to the practical situation and take appropriate decision. It will help select projects and price the products as well as to fix capacity utilization to maximum benefits. The subject provides understanding towards implications of monetary and fiscal policy variables on business organizations. It will prepare students towards entrepreneurship and identify business opportunity, prepare business plans and to judge business feasibility.

Teaching and Assessment Scheme:

Teaching Scheme (Hours per week)			Credits	Assessment Scheme				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE	CE	ESE	CE	100
3	0	0	3	60	40	00	00	

Course Contents:

Unit No.	Topics	Teaching Hours
1	**Economics:** Definitions, Nature, Scope, Difference between Microeconomics & Macroeconomics Theory of Demand and Supply: meaning, determinants, law of demand, law of supply, equilibrium between demand & supply ,elasticity of demand, price elasticity, income elasticity, cross elasticity Cost: Meaning, short run & long run cost, fixed cost, variable cost, total cost, average cost, marginal cost, opportunity cost Break even analysis: Meaning, explanation, numerical **Markets:** Meaning, types of markets & their characteristics Perfect competition, monopoly, monopolistic competition anti-competitive laws and concept of dumping, Inflation, types of inflation, measures to control inflation, Fiscal and monetary policy. National Income, NI current price and NI at market price, GNP,GDP,NNP,NDP and personal and disposable income	20

Unit No.	Topics	Teaching Hours
2	**Introduction to Management**: Definition, nature and scope of management. Functions of Management, Planning, Organizing, Staffing, Directing and Controlling Introduction to Marketing Management: Marketing Mix, Marketing v/s Selling, Market segmentation and Holistic marketing	5
3	**Introduction to Financial Accounting and Costing**: Costing, Concepts of Costing, Balance Sheet, Investment Appraisal-Net present Value (NPV), Payback period, Internal Rate of Return (IRR), Depreciation, Numerical	6
4	**Entrepreneurship:** Concepts, Importance; Characteristics of a Successful Entrepreneur, Problems faced by Entrepreneurs, Types of Entrepreneur, Creativity, Innovation and Entrepreneurship.	6
5	**Formalities For Setting Up of A Small Business Enterprise**: Identifying The Business Opportunity; Growth of a Business Idea; Business Plan Preparation	5
	Total	**42**

List of References:

1. Dewett, K.K. "*Modern Economic Theory",* S. Chand & Company Ltd.
2. Ahuja, H.L. "*Advanced Economic Theory",* S. Chand & Company Ltd.
3. Gail Freeman-Bell and James Balkwill, "*Management in Engineering"*, Prentice Hall of India.
4. James A .F. Stoner, R. Edward Freeman, Daniel R. Gilbert. Jr, "*Management",* Pearson, Lt. Ed.
5. Hishrich Robert, Peters Michael and Sheperd Dean, "*Entrepreneurship",* Tata McGraw-Hill
6. Roy Rajiv, *"Entrepreneurship",* Oxford, Latest Edition.
7. Pednekar Achut, *"Entrepreneurship"* Himalaya Publishing, Latest Edition.

Course Outcomes (COs):

At the end of this course students will be able to …

1. Understand and apply the basics of economics, demand, demand forecasting, elasticity and management to engineering areas.
2. Apply the basics of project planning, project evaluation; break even, depreciation, quality concepts and costing and et al to engineering.
3. Analyze product development, product life cycle and its advantages to the organization.
4. Evaluate the need of human resource development, recruitment and training and its advantages to the organization
5. Develop Motivation towards Entrepreneurship and Innovation and thus design business plan and analyze scope and profitability

2EE06: DIGITAL ELECTRONICS
CREDITS - 3 (LTP:3,0,0)

Teaching and Assessment Scheme

Teaching Scheme (Hours per week)			Credits	Assessment Scheme		Total Marks
L	T	P	C	Theory Marks	Practical Marks	

				ESE	CE	ESE	CE	
3	0	0	3	60	40	00	00	100

Course Contents:

Unit No	Topics	Teaching Hours
1	**Fundamentals of Digital Systems and logic families** Digital signals, digital circuits, AND, OR, NOT, NAND, NOR and Exclusive-OR operations, Boolean algebra, Number systems-binary, signed binary, octal, hexadecimal number, binary arithmetic, one's and two's complements arithmetic, codes, error detecting and correcting codes, characteristics of digital lCs, digital logic families, TTL, Schottky TTL and CMOS logic, interfacing CMOS and TTL, Tri-state logic.	10
2	**Combinational Digital Circuits** Standard representation for logic functions, K-map representation, simplification of logic functions using K-map and Boolean expression, minimization of logical functions. Don't care conditions, Multiplexer, De-Multiplexer/Decoders, Adders, Subtractor, BCD arithmetic, carry look ahead adder, serial adder, ALU, elementary ALU design, popular MSI chips, digital comparator, parity checker/ generator, code converters, priority encoders, decoders/drivers for display devices, Q-M method of function realization.	08
3	**Sequential circuits and systems** A 1-bit memory, the circuit properties of Bistable latch, the clocked SR flip flop, J- K-T and D-types flip-flops, applications of flip-flops, shift registers, applications of shift registers, serial to parallel converter, parallel to serial converter, ring counter, sequence generator, ripple (Asynchronous) counters, synchronous counters, counters design using flip-flops, special counter IC's, asynchronous sequential counters, applications of counters.	08
4	**A/D and D/A Converters** Digital to analog converters: weighted resistor/converter, R-2R Ladder D/A converter, specifications for D/A converters, examples of D/A converter lCs, sample and hold circuit, analog to digital converters: quantization and encoding, parallel comparator A/D converter, successive approximation A/D converter, counting A/D converter, dual slope A/D converter, A/D converter using voltage to frequency and voltage to time conversion, specifications of A/D converters, example of A/D converter ICs	07
5	**Semiconductor memories and Programmable logic devices** Memory organization and operation, expanding memory size, classification and characteristics of memories, sequential memory, read only memory (ROM), read and write memory (RAM), content addressable memory (CAM), charge de-coupled device memory (CCD), commonly used memory chips, ROM as a PLD, Programmable logic array, Programmable array logic, complex Programmable logic devices (CPLDS), Field Programmable Gate Array (FPGA). Classification and characteristics of memories, RAM, ROM, EPROM, EEPROM, NVRAM, SRAM, DRAM.	07
	Total	**40**

List of References:

1. A.Kumar, "*Fundamentals of Digital Circuits"*, Prentice Hall India, 2016.

2. R. P.Jain,"*Modern Digital Electronics"*, McGraw Hill Education,2009
3. M. M. Mano, *"Digital logic and Computer design*", Pearson Education India, 2016.

Course Outcomes

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

1. Understand working of logic families, logic gates and number systems.
2. Design and implement Combinational and Sequential logic circuits.
3. Understand the process of Analog to Digital conversion and Digital to Analog conversion.
4. Use PLDs to implement the given logical problem.
5. Understand concepts on memory classification and its application.

2EE07: DIGITAL ELECTRONICS LABORATORY
CREDITS - 1 (LTP:0,0,1)

Teaching and Assessment Scheme

Teaching Scheme (Hours per week)			Credits	Assessment Scheme				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE	CE	ESE	CE	
0	0	2	1	00	00	40	60	100

List of practical:

1. Hands on calculation on numbering system and Circuit Minimization techniques.
2. Hands on experiments of basic gates
3. Hands on experiments of universal gates
4. Hands on experiments of Adder and Subtractor circuits
5. Hands on experiments of Flip-flop circuits
6. Hands on experiments of Multiplexer and Demultiplexer circuits
7. Hands on experiments of Encoder and Decoder Circuits.
8. Hands on experiments of Register and Counter circuits
9. Hands on experiments of A/D and D/A converter circuits
10. Exposure to Recent technologies in Digital Engineering

2EE08: ELECTRICAL MACHINES –II
CREDITS - 3 (LTP:3,0,0)

Course Objectives:

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

1. Understand the concepts of rotating magnetic fields.
2. Understand the operation of ac machines.
3. Analyse performance characteristics of ac machines.

Teaching and Assessment Scheme

Teaching Scheme (Hours per week)			Credits	Assessment Scheme				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE	CE	ESE	CE	

3	0	0	3	60	40	00	00	100

Course Contents:

Unit No.	Topics	Teaching Hours
1	**Fundamentals of AC Machine Windings:** Physical arrangement of windings in stator and cylindrical rotor; slots for windings; single-turn coil - active portion and overhang; full-pitch coils, concentrated winding, distributed winding, winding axis, Air-gap MMF distribution with fixed current through winding-concentrated and distributed, Sinusoidal distributed winding, winding distribution factor	8
2	**Three phase Induction Machines:** Construction, Types (squirrel cage and slip-ring), Torque Slip Characteristics, Starting and Maximum Torque. Equivalent circuit. Phasor Diagram, Losses and Efficiency. Effect of parameter variation on torque speed characteristics (variation of rotor and stator resistances, stator voltage, frequency). Methods of starting, braking and speed control for induction motors. Generator operation. Self-excitation. Doubly-Fed Induction Machines.	10
3	**Single-phase Induction Motors:** Constructional features, double revolving field theory, equivalent circuit, determination of parameters. Split-phase starting methods and applications	6
4	**Synchronous Machines :** Constructional features, cylindrical rotor synchronous machine - generated EMF, equivalent circuit and phasor diagram, armature reaction, synchronous impedance, voltage regulation. Operating characteristics of synchronous machines, V-curves. Salient pole machine - two reaction theory, analysis of phasor diagram, power angle characteristics. Parallel operation of alternators - synchronization and load division.	8
5	**Special A.C. Machines:** Reluctance motor, hysteresis motor, permanent magnet ac motors, ac servomotors, universal motor, stepper motor, commutator motor	8
	Total	**40**

List of References:

1. D. P. Kothari and I. J. Nagrath, "*Electric Machines*", Tata McGraw Hill Publication,4th Edition 2010, Reprint 2012.
2. B.L. Theraja , "*A Textbook of Electrical Technology Volume II (MulticolourEdition*)", S.Chand Publication,
3. J.B.Gupta, " *Theory and Performance of Electrical Machines*" S.K Kataria& SonsPublication, fifteenth Edition 2015, Reprint 2017
4. N.K.Datta,"*Theory and practice of Electrical Machine Design*" S.KKataria & Sons Publication, first Edition 2016.
5. M. G.Say,"*Performance and design of AC machines*", CBS Publishers,2002.

E-resource:https://nptel.ac.in/courses/108106072; NPTEL: Electrical Engineering, Electrical Machines –II.

Course Outcomes

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

1. Analyse and apply the energy conversion principles to AC rotating machines.
2. Evaluate the steady state parameters, basic operating characteristics and performance of AC Machine and its application.
3. Evaluate the steady state parameters, basic operating characteristics and performance of

Special AC machines.

2EE09: ELECTRICAL MACHINES LABORATORY – II
CREDITS - 1 (LTP:0,0,1)

Teaching and Assessment Scheme:

Teaching Scheme (Hours per week)			Credits	Assessment Scheme				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE	CE	ESE	CE	
0	0	2	1	00	00	40	60	100

List of practical:

1. Load test on three phase induction motor.
2. Circle diagram of three phase induction motor.
3. Unbalance and single phasing of three phase induction motor.
4. Torque- Speed characteristic of three phase induction motor.
5. V- Curve of synchronous motor.
6. OC and SC test on Alternator.
7. ZPF method of A l t e r n a t o r
8. Synchronization of three phase alternator.
9. Design of ac machine windings.
10. Load test on universal motor.
11. Starting method of single phase induction motor.
12. Stepper motor control
13. VFD for three phase induction motor.
14. Load test on three phase commutator motor.

2EE10: POWER ELECTRONICS
CREDITS - 3 (LTP: 3,0,0)

Course Objectives:

The subject aims to provide the student to:

1. Understand the differences between signal level and power level devices.
2. Analyze controlled rectifier circuits.
3. Analyze the operation of chopper circuits.
4. Understand and analyze the operation of voltage source inverters and their applications.

Teaching and Assessment Scheme

Teaching Scheme (Hours per week)			Credits	Assessment Scheme				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE	CE	ESE	CE	
3	0	0	3	60	40	00	00	100

Course Contents:

Unit No	Topics	Teaching Hours
1	**Power switching devices** Diode, Thyristor, MOSFET, IGBT: I-V Characteristics; Firing Circuit for thyristor; Voltage and current commutation of a thyristor; Gate drive circuits for MOSFET and IGBT.	6
2	**Thyristor rectifiers** Single-phase half-wave and full-wave rectifiers, Single-phase full- bridge thyristor rectifier with R- load and highly inductive load; Three-phase full-bridge thyristor rectifier with R-load and highly Inductive load; Input current wave shape and power factor.	6
3	**DC-DC buck converter** Elementary chopper with an active switch and diode, concepts of duty ratio and average voltage, power circuit of a buck converter, analysis and waveforms at steady state, duty ratio control of output voltage.	6
4	**DC-DC boost converter** Power circuit of a boost converter, analysis and waveforms at steady state, relation between duty ratio and average output voltage.	6
5	**Single-phase voltage source inverter** Power circuit of single-phase voltage source inverter, switch states and instantaneous output voltage, square wave operation of the inverter, concept of average voltage over a switching cycle, bipolar sinusoidal modulation and unipolar sinusoidal modulation, modulation index and output voltage	8
6	**Three-phase voltage source inverter** Power circuit of a three-phase voltage source inverter, switch states, instantaneous output voltages, average output voltages over a sub- cycle, three-phase sinusoidal modulation	8
	Total	**40**

List of References:

1. P. S. Bimbhra. *"Power Electronics"*. Khanna Publication.2017.
2. M. H.Rashid,"*Power electronics: circuits, devices, and applications*",Pearson Education India, 2009.
3. R.W.Erickson and D. Maksimovic, "*Fundamentals of Power Electronics*", Springer Science & Business Media, 2007.
4. L. Umanand, "*Power Electronics: Essentials and Applications*", Wiley India,2009.

Course Outcomes:

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

1. Design and analyse power switches devices
2. Understand and analyse controlled rectifier circuits and their applications
3. Understand and analyse chopper circuits and their applications
4. Understand and analyse single phase inverter circuits and their applications.
5. Understand and analyse three phase voltage inverter circuits and their applications.

2EE11: POWER ELECTRONICS LABORATORY
CREDITS - 1 (LTP:0,0,1)

Teaching and Assessment Scheme:

Teaching Scheme (Hours per week)			Credits	Assessment Scheme				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE	CE	ESE	CE	
0	0	2	1	00	00	40	60	100

List of practical:

1. Characteristics of SCR
2. Synchronised UJT firing circuit for SCRs
3. Antiparallel connection of SCRs.
4. Single phase controlled rectifier with resistive load
5. Single phase controlled rectifier with RL load and freewheeling diode
6. Class C Commutation Circuit
7. Class D Commutation Circuit
8. Step-down and step-up Choppers circuit
9. AC power control using TRIAC
10. Performance of DC drives
11. Mini project based on the syllabus

2EE12: ELECTRICAL AND ELECTRONICS MEASUREMENT
CREDITS – 2 (LTP:2,0,0)

Course Objectives:

The subject aims to provide the student with:

1. Understanding of concepts and principles of various measurement devices, their Characteristics, their operation and their limitations
2. Analyse the dynamic response and the calibration of few instruments. Using different Theorems and methods.
3. Advanced instrumentation applications for electrical and electronics devices which will be useful for advance Subjects.

Teaching and Assessment Scheme:

Teaching Scheme (Hours per week)			Credits	Assessment Scheme				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE	CE	ESE	CE	
2	0	0	2	30	20	00	00	50

Course Content

Unit No	Topics	Teaching Hours
1	**Concepts relating to Measurements:** True value, Accuracy, Precision, Resolution, Drift, Hysteresis, Dead-band, Sensitivity.	4
2	**Errors in Measurements**. Basic statistical analysis, Measurements of R, L and C. AC & DC Bridges measurement & applications.	5
3	**Galvanometer :** D'Arsonaval Galvanometer:-Construction, Torque equation, Dynamic behavior, Ballistic Galvanometer:- construction, Theory, calibration	4
4	**Concept of Analog meters** : Analog instruments ; classification of analog instruments; principle of operation, various operating forces, PMMC, Moving Iron, Moving Coil, Dynamometer type, Induction type, Extension of range of instruments, Examples	6
5	**Concept of Wattmeter & Energy meter :** Electrodynamometer Wattmeter: - Construction, Theory, Errors. Low power Factor Wattmeter, Measurement of power in three-phase circuits. Three phase wattmeter, Measurement of Reactive power, Analog and Digital Energy meter.circuits.Calibration and testing of energy meter.	6
6	**Current and Voltage Measurements**. Shunts, Potential Dividers. Basic of Instrument Transformers, Hall Sensors	5
7	**AC. & D.C. potentiometers** DC potentiometer -Basic circuits, standardization, voltage ratio box , application of DC potentiometer, AC potentiometer ,Calibration	4
8	**Measuring Instruments:** Digital Multi-meter, True RMS meters, Clamp-on meters, Meggers Digital Storage Oscilloscope. Special Instruments.	6
	Total	**40**

List of references:

1. W.D. Cooper, Albert D Helfrick, "*Modern Electronic Instrumentation & Measurement Techniques*", PHI Publication.
2. A K Sawhney, "*A course in Electrical & Electronics Measurements & Instrumentation*", Dhanpat Rai&Co.
3. E.W. Golding & Widdies "*Electrical Measurements & Measuring Instruments*", Wheeler Publication
4. J.B Gupta, "*Electrical Measurements & Measuring Instruments*", S K Kataria and Sons.

Course Outcomes:

After learning this course the students will be able to:

1. Assess the knowledge about the instruments for measuring an unknown quantity, calibrate and testing its applications.
2. Basic structure and different characteristics of instruments, calibration and testing.
3. Practice the fundamentals of Measuring & Testing of Electrical instruments.
4. Interpret the working and applications of various types Electrical instruments and its applications.
5. Associate the knowledge about Special Measuring Instruments and its advance operations.

2EE13: ELECTRICAL AND ELECTRONICS MEASUREMENT LABORATORY

CREDITS – 1 (LTP:0,0,1)

Teaching and Assessment Scheme:

Teaching Scheme (Hours per week)			Credits	Assessment Scheme				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE	CE	ESE	CE	
0	0	2	1	00	00	40	60	100

List of Experiments:

1. Measurement of medium resistance using whetstone bridge method.
2. Measurement of Low Resistance using Kelvin's double bridge.
3. Measurement of High resistance and Insulation resistance using Megger.
4. Measurement of L using a bridge technique as well as LCR meter.
5. Measurement of C using a bridge technique as well as LCR meter.
6. Usage of DSO
7. Usage of CT-PT Test Set.
8. Calibration of energy meter
9. Extension of range of instruments
10. Mini Project

2BS04: PROBABILITY AND NUMERICAL ANALYSIS
CREDITS - 4 (LTP:3,1,0)
2nd Year, B. Tech. (Electrical)

Course Objective:
To introduce probability and numerical techniques used in engineering.

Teaching and Assessment Scheme:

Teaching Scheme (Hours per Week)			Credits	Assessment Scheme				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE	CE	ESE	CE	
3	1	0	4	60	40	20	30	150

Course Contents:

Unit No.	Topics	Teaching Hours
1	**Basic Probability:** • Orientation of Probability spaces, conditional probability, independence; Discrete random variables, Independent random variables, the multinomial distribution, Poisson approximation to the binomial distribution, infinite sequences of Bernoulli trials, sums of independent random variables; • Expectation of Discrete Random Variables, Moments, Variance of a sum, Correlation coefficient, Chebyshev's Inequality.	12
2	**Continuous Probability Distributions:** Continuous random variables and their properties, distribution functions and densities, normal, exponential and gamma densities.	4

Unit No.	Topics	Teaching Hours
3	**Bivariate Distributions:** Bivariate distributions and their properties, distribution of sums and quotients, conditional densities, Bayes' rule.	4
4	**Numerical Methods – 1** Solution of polynomial and transcendental equations – Bisection method, Newton-Raphson method and Regula-Falsi method. Finite differences, Relation between operators, Interpolation using Newton's forward and backward difference formulae. Interpolation with unequal intervals: Newton's divided difference and Lagrange's formulae. Numerical Differentiation, Numerical integration: Trapezoidal rule and Simpson's 1/3rd and 3/8 rules.	12
5	**Numerical Methods – 2** Ordinary differential equations: Taylor's series, Euler and modified Euler's methods. Runge-Kutta method of fourth order for solving first and second order equations. Milne's and Adam's predicator-corrector methods.	10
	Total	**42**

List of References:

1. B.S. Grewal, "*Higher Engineering Mathematics"*, Khanna Publishers, 35th Edition, 2000.
2. S. C. Gupta, V. K. Kapur, "*Fundamental of Statistics*", Sultan Chand & Sons, India,
3. S. Ross, "*A first course in Probability"*, Pearson Education India, 2002.
4. Richard A. Johnson, Miller and Freund's - Probability and Statistics for Engineers, Prentice Hall of India, 2011.
5. S. S. Sastry, "Introductory Methods of Numerical Analysis", 4th edition, Prentice Hall India Pvt., Limited, 2005.
6. Chapra S. and Canale R., "*Numerical Methods for Engineers*", 6th edition, Tata McGraw-Hill.
7. Jain M. K., Iyengar SRK and Jain R. K., "*Numerical Methods for Scientific & Engineering Computation*", 6th Edition, New Age International Publishers.

Course outcome:

At the end of this course students will be able to

1. Understand the concepts and tools of Probability theory.
2. Analyze and solve various engineering problems through the probability theory.
3. Adapt tools of probability theory and apply them in engineering problems.
4. Examine, analyze, and compare Probability distributions.
5. Determine numerical solution of algebraic and transcendental equations and discuss different difference operators.
6. Use interpolation techniques for data analysis and numerically solve initial value problems.

2HS01: PROFESSIONAL SOFT SKILLS
CREDITS – 2 (LTP:1,0,1)

Course Objectives:

To equip students with Professional soft skills like communication, interviews, group discussion, presentation etc. The subject also will enable them to learn interpersonal skills, work culture and effective management of time and stress.

Teaching and Assessment Scheme:

Teaching Scheme (Hours per week)			Credits	Assessment Scheme		Total Marks
L	T	P	C	Theory Marks	Practical Marks	

				ESE	CE	ESE	CE	100
1	0	2*	2	30	20	20	30	

***Will be conducted in Class Room**

Course Contents:

Unit No.	Topics	Teaching Hours
1	**Communication skills:** Process of communication, Flows of Communication in organization, Barriers to communication (Formal Flow – Upward, Downward, lateral and diagonal, Strategies to improve Organizational Communication, Effectiveness in Managerial Communication, and importance of technical communication, Non verbal communication	2
2	**Interviews and Meetings**: Types of interview, General preparation for interview, Gathering information about the company, knowing about the role/job position, Types of interviewing questions, Non-verbal communication to win the interview.	2
3	**Meeting and Conferences**: Planning a meeting (Agenda and notice), Conducting a meeting, Post meeting actions (Minutes), Planning & Conducting a Conference (anchoring and Report writing), and Video/web conferences **,**Indentifying Strengths and Weakness	2
4	**Presentation Skills and Letters:** Effective Presentation strategies: Purpose, analyzing the audience and locale, organizing the content Oral presentation, Graphic presentation, Presentation aids, Personality Development. Newsletters, technical article and business letters. Technical Reports, characteristics, Importance, objectives, categories of report, format structure of reports, types of reports	4
5	**Group Discussion**: Qualities needed for effective group discussion. Email etiquettes, Telephone Etiquettes, Role and responsibility of engineer, Work culture in jobs. Work place, rights and responsibilities	3
6	**Time and Stress Management**: Concept & Importance of Time Management, Techniques of Time Management, and Concept & Importance of Stress Management, Techniques of Stress Management, and Overcoming Stage fear and Interpersonal Relationships	2
	Total	**15**

Activities for Practical (Conducted in Class Room)

Sr. No	Activity	Duration (Hours)	Nature of Activity
1	Mock interview	1	Individual
2	Letter Writing	1	Individual

3	Group Discussion	2	Group
4	Group Discussion	2	Group
5	Presentation	2	Individual
6	Presentation	2	Group
7	CV preparation	1	Individual
8	Extempore (over coming stage fear)	1	Individual
9	Aptitude Test	1	Individual
10	Writing skills	1	Individual

List of References:

1. G,S,B,K Babu Rao, "*Business Communication and Soft Skill*", Himalaya Publishing house (1st Edition)
2. Diane Hacker, "*Pocket Style Manual"*, Bedford Publication, New York, 2003. (ISBN 0312406843)
3. Shiv Khera, "*You Can Win"*, Macmillan Books, New York, 2003.
4. Raman Sharma, "*Technical Communications*", Oxford Publication, London, 2004.
5. *"Ethics in Engineering practice and research" (2nd Edition)* by Caroline Whit beck Cambridge
6. Sharma, R. and Mohan, K. "*Business Correspondence and Report Writing*", TMH New Delhi 2002.

Course Outcomes (COs):

At the end of this course students will be able to …

1. Understand the communication process and communicate professionally.
2. Participate in Group Discussion and evaluate the same.
3. Develop Interview skills and Write Reports
4. Make effective Presentations.
5. Conduct meetings and conferences.
6. Effectively manage time and stress.

3EE01: ELECTROMAGNETIC FIELDS
CREDITS - 3 (LTP: 3,0,0)

Course Objective:

1. Revisiting the vector algebra and vector calculus.
2. Solving electromagnetic field problem using vector calculus.
3. Learning applications and understanding about the analysis techniques in electromagnetic field theory.

Teaching and Assessment Scheme:

Teaching Scheme (Hours per Week)			Credits	Assessment Scheme				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE	CE	ESE	CE	
3	0	0	3	60	40	00	00	100

Course Contents:

Unit No.	Topics	Teaching Hours
1	**Review of Vector Calculus** Vector algebra-addition, subtraction, components of vectors, scalar and vector multiplications, triple products, three orthogonal coordinate systems (rectangular, cylindrical and spherical). Vector calculus-differentiation, partial differentiation, integration, vector operator del, gradient, divergence and curl; integral theorems of vectors. Conversion of a vector from one coordinate system to and other.	06
2	**Static Electric Field** Coulomb's law, Electric field intensity, Electrical field due to point charges. Line, Surface and Volume charge distributions. Gauss law and its applications. Absolute Electric potential, Potential difference, Calculation of potential differences for different configurations. Electric dipole, Electrostatic Energy and Energy density	08
3	**Conductors, Dielectrics and Capacitance** Current and current density, Ohms Law in Point form, Continuity of current, Boundary conditions of perfect dielectric materials. Permittivity of dielectric materials, Capacitance, Capacitance of a two wire line, Poisson's equation, Laplace's equation, Solution of Laplace and Poisson's equation, Application of Laplace's and Poisson's equations.	08
4	**Static Magnetic Fields** Biot-Savart Law, Ampere Law, Magnetic flux and magnetic flux density, Scalar and Vector Magnetic potentials. Steady magnetic fields produced by current carrying conductors	06
5	**Magnetic Forces, Materials and Inductance** Force on a moving charge, Force on a differential current element, Force between differential current elements, Nature of magnetic materials, Magnetization and permeability, Magnetic boundary conditions, Magnetic circuits, inductances and mutual inductances.	08
6	**Time Varying Fields and Maxwell's Equations** Faraday's law for Electromagnetic induction, Displacement current, Point form of Maxwell's equation, Integral form of Maxwell's equations, Motional Electromotive forces. Boundary Conditions.	06
	Total	**42**

List of References:

1. W. Hayt, "*Engineering Electromagnetics*", McGraw Hill Education, 2012
2. M. N. O. Sadiku, "*Elements of Electromagnetics*", Oxford University Publication, 2014.
3. A. Pramanik, "*Electromagnetism - Theory and applications*", PHI Learning Pvt. Ltd, New Delhi, 2009.
4. A. Pramanik, "*Electromagnetism-Problems with solution"*, Prentice Hall India, 2012.
5. G. W. Carter, "*The electromagnetic field in its engineering aspects*", Longmans, 1954.
6. W. J. Duffin, "*Electricity and Magnetism*", McGraw Hill Publication, 1980.

Course Outcomes (COs):

1. Comprehend Coulomb's law, Gauss's law and their applications in electromagnetism.
2. Obtain the electric and magnetic fields for simple configurations under static Conditions.
3. Comprehend magnetic forces, materials and inductance and analyse time varying Electric and magnetic fields.

4. Apply Maxwell's equation in point form and integral form.

3EE02: POWER SYSTEMS - I
CREDITS - 3 (LTP: 3,0,0)

Course Objective:

1. To introduce basic concepts of Power Systems and various energy sources.
2. To understand and analyze power system modelling and analysis.

Teaching and Assessment Scheme:

Teaching Scheme (Hours per Week)			Credits	Assessment Scheme				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE	CE	ESE	CE	100
3	0	0	3	60	40	0	0	

Course Contents:

Unit No.	Topics	Teaching Hours
1	**Basic Concepts** Evolution of Power Systems and Present-Day Scenario. Structure of a power system: Bulk Power Grids and Micro-grids. Generation: Conventional and Renewable Energy Sources. Distributed Energy Resources. Energy Storage. Transmission and Distribution Systems: Line diagrams, transmission and distribution voltage levels and topologies (meshed and radial systems). Synchronous Grids and Asynchronous (DC) interconnections. Review of Three-phase systems. Analysis of simple three-phase circuits. Power Transfer in AC circuits and Reactive Power.	06
2	**Performance and Characteristics of Transmission Lines** Overhead Transmission Lines and Cables: Electrical and Magnetic Fields around conductors, Corona. Parameters of lines and cables. Capacitance and Inductance calculations for simple configurations. Travelling-wave Equations. Sinusoidal Steady state representation of Lines: Short, medium and long lines. Power Transfer, Voltage profile and Reactive Power. Characteristics of transmission lines. Surge Impedance Loading. Series and Shunt Compensation of transmission lines.	08
03	**Transformers and Synchronous Machines** Transformers: Three-phase connections and Phase-shifts. Three-winding transformers, auto- transformers, Neutral Grounding transformers. Tap-Changing in transformers. Transformer Parameters. Single phase equivalent of three-phase transformers. Synchronous Machines: Steady-state performance characteristics. Operation when connected to infinite bus. Real and Reactive Power Capability Curve of generators. Typical waveform under balanced terminal short circuit conditions – steady state, transient and sub-transient equivalent circuits. Loads: Types,	08

Unit No.	Topics	Teaching Hours
	Voltage and Frequency Dependence of Loads. Per-unit System and per-unit calculations.	
04	**Fault Analysis** Method of Symmetrical Components (positive, negative and zero sequences). Balanced and Unbalanced Faults. Representation of generators, lines and transformers in sequence networks. Computation of Fault Currents. Neutral Grounding.	10
05	**Introduction to DC Transmission** DC Transmission Systems: Line-Commutated Converters (LCC) and Voltage Source Converters (VSC). LCC and VSC based dc link, Real Power Flow control in a dc link. Comparison of ac and dc transmission.	05
06	**Renewable Energy Systems** Solar PV systems: I-V and P-V characteristics of PV panels, power electronic interface of PV to the grid. Wind Energy Systems: Power curve of wind turbine. Fixed and variable speed turbines. Permanent Magnetic Synchronous Generators and Induction Generators. Power Electronics interfaces of wind generators to the grid.	05
	Total	42

List of References:

1. J. Grainger and W.D. Stevenson, *"Power System Analysis"*, Indian Edition, McGraw Hill Education, 1994.
2. D. P. Kothari and I. J. Nagrath, "*Modern Power System Analysis*", Fourth Edition, McGraw Hill Education, 2011.
3. B.R. Gupta, "*Power System Analysis and Design*", Sixth Edition, S. Chand and Co.
4. Hadi Saadat, "*Power System Analysis*" Fourth Edition, McGraw Hill Education, 2002.
5. Vijay K. Sood, "*HVDC and FACTS Controllers: Applications of Static Converters in Power Systems"*, Springer, First edition, 2013
6. Chetansingh Solanki, *"Renewable Energy Technologies: A Practical Guide for Beginners"* , Prentice hall of India, 2008

Web Resources:

1. NPTEL Video course on Power System Generation Transmission Distribution - Prof. D. P. Kothari, IIT Delhi http://www.nptelvideos.in/2012/11/power-sys-generation-transmission.html
2. NPTEL Video Course on Power System Analysis – Prof. A. K. Sinha, IIT, Kharagpur http://nptel.ac.in/courses/108105067
3. NPTEL Webcourse on Power System Analysis – Prof. Arindam Ghosh, IIT, Kanpur https://nptel.ac.in/courses/108/104/108104051/#
4. NPTEL Video Course on Non-conventional Sources of Energy – Prof. Prathap Haridoss, IIT, Madras https://nptel.ac.in/courses/121106014/#
5. NPTEL Video Course on Energy Resources and Technology - Prof. S. Banerjee, IIT, Kharagpur https://nptel.ac.in/courses/108/105/108105058/

Course Outcomes (COs):

At the end of this course students will be able to …

1. Conceptualize the basics of generation, transmission and distribution and various sources of energy.
2. Analyze the modelling, performance and characteristics of transmission lines.
3. Understand and analyze the modelling of transformers and synchronous machines.
4. Evaluate fault currents for different types of faults for symmetrical and unsymmetrical faults.
5. Apply the concepts of HVDC power transmission for power flow control.
6. Understand the concepts and apply the technologies for renewable energy generation like wind and solar power.

3EE03: POWER SYSTEMS - I LABORATORY
CREDITS - 1 (LTP: 0,0,1)

Course Objective:

1. To understand and analyze the power system networks by conducting various hardware experiments.
2. To study and analyze the performance of power system by carrying out various simulations on to different power system analysis software.

Teaching and Assessment Scheme:

Teaching Scheme (Hours per Week)			Credits	Assessment Scheme				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE	CE	ESE	CE	
0	0	2	1	-	-	40	60	100

List of Experiments:

Sr. No.	Suggested List of Experiments
1.	**Introduction to different types of cables, insulators and substation layout and arrangement in power system.**
2.	**To observe the voltage distribution across an insulator string and evaluate string efficiency**
3.	**Performance and Analysis of Short Transmission line**
4.	**Performance and Analysis of Medium Transmission line**
5.	To validate and compensate Ferranti effect on an unloaded transmission line
6.	Simulation of performance analysis of transmission line for shunt compensation
7.	Simulation of performance analysis of transmission line for series compensation
8.	Simulation and Analysis of Symmetrical Faults
9.	Simulation and Analysis of Symmetrical Components
10.	Simulation and Analysis of Unsymmetrical Faults
11.	To test Polarity, Ratio and magnetization characteristics of CT/PT

Sr. No.	Suggested List of Experiments
12.	Floating Neutral of a unbalanced three-phase distributing systems
13.	Performance of Solar PV modules in series and parallel configurations
14.	Ground Constant of Circuit Breaker
15.	Visit to substation, power station, solar, wind power installations or related firm /industry

List of References:

1. Scilab Textbook Companion for Power System Analysis And Design by B. R. Gupta, Sixth edition, S. Chand & Co., 2011 https://scilab.in/textbook_run/1076
2. Scilab Textbook Companion for Modern Power System Analysis by Nagrath and Kothari, 3rd Edition, Tata McGraw Hill, 2003 https://scilab.in/textbook_run/1076

Course Outcomes (COs):

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

1. Perform hardware based experiments on various power system components including renewable energy sources.
2. Simulate, analyze and evaluate different transmission lines parameters.
3. Simulate, analyze a network under balanced and unbalanced fault conditions and interpret the results.
4. Simulate and analyze the reactive power requirement of lines, voltage profile along the line and VAR compensation.

3EE04: SIGNALS AND SYSTEMS
CREDITS - 3 (LTP: 3,0,0)

Course Objectives:

1. To describe various signals and systems mathematically and understand how to perform mathematical operations on them.
2. Also familiar with commonly used signals such as the unit step, ramp, and impulse function, sinusoidal signals, complex exponentials and their operations.
3. Analysis using Fourier series and Fourier transform for a given signal.

Teaching and Assessment Scheme:

Teaching Scheme (Hours per Week)			Credits	Assessment Scheme				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE	CE	ESE	CE	
3	0	0	3	60	40	00	00	100

Course Contents:

Unit No.	Topics	Teaching Hours
1	**Fundamentals of Signals and Systems:** Classifications of various signals and systems as seen in everyday life, Signal properties: periodicity, absolute integrability, deterministic and stochastic character, Some special signals of importance: the unit step, the unit impulse,	08

Unit No.	Topics	Teaching Hours
	the sinusoid, and the complex exponential, continuous and discrete time signals, Characterization of systems, System's various properties: linearity: additivity and homogeneity, shift-invariance, causality, stability, basic instruments associated with signals and systems study, basic examples of various signals.	
2	**Continuous Time(CT) Signals and Systems:** Classification of CT signals and systems, Impulse response and step response, the Dirac impulse and mathematical difficulties of it, representation of CT LTI system using impulses, Kronecker impulses and representation, convolution, input-output behavior with aperiodic convergent inputs, cascade interconnections. Characterization of causality and stability of LTI systems. System representation through differential equations and difference equations. State-space Representation of systems.	08
3	**Discrete Time(DT) Signals and Systems:** Generation of DT signals and its representation, classification of Discrete time signals, mathematical operations of discrete time signals, mathematical equations of discrete time system, response of LTI discrete time system in time domain, classification of discrete time systems, System representation through differential equations and difference equations. State-space Representation of systems.	06
4	**Sampling and Reconstruction of Signals:** Principle of CT signal Sampling, its objective and its implications, under and over sampling, ideal Sampling and quantization of signals Spectra of sampled signals, reconstruction of original signals, zero-order hold, first-order hold, aliasing and its effects, relation between continuous and discrete time systems, introduction to the applications of signal and system theory for modulation of communication systems, filtering and feedback control systems.	08
5	**Fourier Series(FS) and Fourier Transform(FT) of CT and DT signals:** Fourier series representation of CT and DT signals, Calculation of Fourier Coefficients. Development of FT from FS, properties of FT, Analysis of LTI CT system using FT, FS and FT of DT signals, Discrete-Time Fourier Transform (DTFT) and the Discrete Fourier Transform (DFT) and their properties. Parseval's Theorem. DTFT of periodic DT signals.	06
6	**Z Transform:** Introduction, Region of Convergence(ROC), properties of it, Poles and Zeros of rational function of Z, Inverse Z Transform, Analysis of LTI DT system using Z Transform, relation between Laplace Transform and Z Transform	06
	Total	**42**

List of References:

1. K. Gopalan, *"Signals and Systems*", 3rd Edition, Cengage Learning (India) Ltd., 2011
2. Anand Kumar*,"Signal and Systems*", 3rd Edition, Prentice Hall,2012
3. A Nagoor Kani, "*Signals and Systems*", 22nd reprint, McGraw Hill (India) Ltd., 2019
4. B. P. Lathi, "*Linear Systems and Signals*", Oxford University Press, 2009.

5. A.V. Oppenheim, A.S. Willsky and S. H. Nawab, "*Signals and systems*", Prentice Hall India, 1997.
6. M. J. Robert, "Fundamentals of Signals and Systems", McGraw Hill Education, 2007.

Web Material:

1) **Signals and Systems Web Course by Prof. V M Gadre, IIT Bombay**
https://nptel.ac.in/courses/117/101/117101055/IITB
2) **Signals and Systems Video Lectures by Prof. K S Venkatesh, IIT Kanpur**
https://nptel.ac.in/courses/117/104/117104074/IIT Kanpur

Course Outcomes:

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

1. Understand and analyse the mathematical modelling of various signals and systems.
2. Analyse continuous and discrete time linear time invariant systems
3. Evaluate and analyse various signals in terms of Fourier and Laplace transform.
4. Evaluate and analyse the reconstruction of signals.

3EE05: SIGNALS AND SYSTEMS LABORATORY
CREDITS – 1 (LTP: 0,0,1)

Course Objective:

1. To conduct study and performance of various signals and systems and thereby analyzing for developing understanding for its applications using various hardware experiments.
2. To study and analyze the performance of signals and systems by carrying out various simulations on to different analysis software.

Teaching and Assessment Scheme:

Teaching Scheme (Hours per Week)			Credits	Assessment Scheme				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE	CE	ESE	CE	
0	0	2	1	-	-	40	60	100

List of Experiments:

Sr. No.	Suggested List of Experiments
1.	Demonstration of various instruments used for signal and system laboratory
2.	Demonstration of various instruments used for signals analysis
3.	Generation of sin and cosine signals using OP-AMP oscillator circuit
4.	Performance and analysis of Sampling of continuous time signal
5.	Performance and analysis of amplitude modulation of signals
6.	Realization of oscillator circuit using half and full wave circuits
7.	Performance and analysis of frequency to voltage convertor of a signal

Sr. No.	Suggested List of Experiments
8.	Performance and analysis of voltage to frequency convertor of a signal
9.	Performance and analysis of Active Low pass filter
10.	Performance and analysis of Active High pass filter
11.	Generation of various periodic and aperiodic waveforms using analysis software
12.	FFT analysis of a signal using analysis software
13.	Perform various mathematical operations on signals using analysis software
14.	Fourier analysis of a signal using analysis software
15.	Perform Discrete convolve and auto correlation of two sequences using analysis software

List of References:

1. K. Gopalan, "*Signals and Systems*", 3rd Edition Cengage Learning (India) Ltd., 2011,
2. Tarunkumar Rawat, "*Signals and Systems",* 1st Edition, Oxford University Press, 2010.
3. A Nagoor Kani, "*Signals and Systems*", 22nd reprint, McGraw Hill (India) Ltd., 2019,

Course Outcomes (COs):

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

1. Perform hardware based experiments on various signals and systems.
2. Simulate, analyze and evaluate different signals and its applications
3. Simulate, analyze and evaluate active low pass and active high pass filter design
4. Perform various mathematical analysis of a signals.

3EE06: MICROPROCESSORS AND MICROCONTROLLERS
CREDITS - 3 (LTP: 3,0,0)

Course Objective:

To provide solid foundation on the fundamentals of microprocessors and applications, interfacing the external devices to the processor according to the user requirements thus, enabling to create novel products and solutions for real time problems.

Teaching and Assessment Scheme:

Teaching Scheme (Hours per Week)			Credits	Assessment Scheme				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE	CE	ESE	CE	
3	0	0	3	60	40	00	00	100

Course Contents:

Unit No.	Topics	Teaching Hours
1	**Fundamentals of Microprocessors:** Fundamentals of Microprocessor Architecture. 8-bitMicroprocessor and Microcontroller architecture, Comparison of 8-bit microcontrollers, 16-bit and 32-bit microcontrollers.	06

Unit No.	Topics	Teaching Hours
	Definition of embedded system and its characteristics, Role of microcontrollers in embedded Systems. Overview of the 8051 family.	
2	**Microcontroller Basics:** Difference between microprocessor and microcontroller, CISC vs RISC design philosophy, Von Neumann vs Harvard architecture, Introduction to MCS -51 Family microcontrollers, address bus, data bus, control signals, clock and reset circuits, working registers, special function registers, stack and use of stack pointer, program counter, I/O Ports, power saving modes and its operation, timing diagram for execution cycle.	**04**
3	**8051 Microcontroller Architecture:,** 80C51 Central Processing Unit Diagram, Architectural block diagram, Pin diagram and Pin Functions, memory organization, Internal program and data memory.	**05**
4	**On Chip Peripherals** : Timer/Counters and associated registers, Various modes of timer/counter operations, Concept of Interrupt, Interrupt versus polling, Types of Interrupts in 8051, Interrupt control and associated registers, Interrupt vectors, Interrupt execution, Basics of serial communication, Serial data input/output and associated registers, Various modes of serial data communication.	**08**
5	**Integrated Development Environment (IDE) for Microcontrollers**: Editor, linker, loader, debugger, simulator, emulator. Instruction set, instruction formats, concept of assembler directives and various addressing modes. Basic programming using assembly instructions. Introduction to embedded-C, Integrated Development Environment (IDE), cross compiler, ISP (In-System Programming) and IAP (In-Application Programming)	**05**
6	**External Peripheral Interfaces:** ADC, DAC, LCD, LED & keyboard interfacing, External Memory Interfacing, Stepper motor interfacing, DC Motor interfacing, sensor interfacing, Introduction to CAN Protocol and its interfacing, USB protocol and its interfacing, Blue-tooth, Zig-bee protocol and its interfacing.	**05**
7	**Introduction to Advanced Microcontrollers**: Advanced concepts of 8-bit controllers, study of watchdog timer, study of PCA timer in different modes like capture mode, PWM generation mode, High speed output, toggle mode, migrating from 8- bit to 16- bit and 32 bit ARM Processors**.**	**06**

Unit No.	Topics	Teaching Hours
8	**Application of Microcontrollers**: Application of Microcontroller in day to day life devices, Industrial control devices, Metering & Measurement devices, Energy management and automobiles.	03
	Total	**42**

List of References:

1. Ramesh S. Gaonkar, "Microprocessor Architecture, Programming, and Applications with the 8085", 5th Edition, Penram International, 2009.
2. Douglas Hall , "Microprocessor & Interfacing", 2nd Edition, TMH, 2006.
3. Muhammad A. Mazidi, "The 8051 Microcontroller And Embedded Systems Using Assembly and C", 2nd Edition., PHI, 2012.
4. Kenneth J. Ayala , "The 8051 Microcontroller", 3rd Edition., Cengage Learning Publication, 2007.
5. Ajit Pal, "Microcontrollers: Principals and Applications", 2nd Edition, PHI, 2011.
6. Datasheet of P89V51RD2.

Web Resources:

1. Nptel Web course on Microprocessor by Dr. Pramod Agarwal, IITRoorkee. https://nptel.ac.in/courses/108/107/108107029/
2. Nptel Web course on Microcontrollers and Applications by Dr. S. P. Das, IITKanpur. https://nptel.ac.in/courses/117/104/117104072/

Course Outcomes (COs):

At the end of this course students will be able to:

1. Understand the fundamentals of Microprocessors.
2. Understand the internal design of 8051 microcontroller along with the features and their programming.
3. Competent with the on chip peripherals of microcontrollers.
4. Design different interfacing applications using microcontrollers and peripherals.
5. Demonstrate the limitations and strengths of different types of microcontrollers and their comparison.
6. Build systems using microcontrollers for real time applications.

3EE07: MICROPROCESSORS AND MICROCONTROLLERS LABORATORY
CREDITS -1 (LTP: 0,0,1)

Course Objective:

To facilitate students to be familiar with microprocessor kits and enabling to create novel products and solutions for real time problems using microcontrollers and interfacing devices.

Teaching and Assessment Scheme:

Teaching Scheme (Hours per Week)			Credits	Assessment Scheme				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE	CE	ESE	CE	
0	0	2	1	00	00	40	60	100

List of Experiments:

Sr. No.	Suggested list of Experiments
1	Hands-on-training using 8085 microprocessor kit.
2	Hands-on-training using 8051 microcontroller kit.
3	Introduction to Keil µvision software for assembly and C language programming.
4	To perform programs on data transfer group of instructions.
5	To perform programs on arithmetic group of instructions.
6	To perform programs on logical group of instructions.
7	To perform programs on jumping group of instructions.
8	To perform programming of timer.
9	To perform programming of interrupts.
10	Performance on VPL kit using P89V51RD2 for interfacing with LCD, LED, stepper motor, etc.
11	Programming PCA timer of P89V51RD2 for capture and compare mode.
12	Programming PCA timer of P89V51RD2 as a 16 bit software timer.
13	Programming PCA timer of P89V51RD2 for high speed output to generate a square wave.
14	Program to generate PWM using PCA timer of P89V51RD2.
15	Comprehensive PCA program using all modules in various modes simultaneously.
16	Mini project.

List of References:

1. Ramesh S. Gaonkar, "Microprocessor Architecture, Programming, and Applications with the 8085", 5th Edition, Penram International, 2009.
2. Muhammad A. Mazidi, "The 8051 Microcontroller And Embedded Systems Using Assembly and C", 2nd Edition, PHI, 2012.
3. Kenneth J. Ayala, "The 8051 Microcontroller", 3rd Edition, Cengage Learning Publication, 2007.
4. Datasheet of P89V51RD2.

Course Outcomes (COs):

At the end of this course students will be able to:

1. Understand the interfacing of microcontrollers with various peripherals.

2. Determine the strengths of different types of microcontrollers and develop systems using microcontrollers for real time applications.

3EE08: HIGH VOLTAGE ENGINEERING
CREDITS - 4 (LTP: 3,0,1)

Course Objective:
The subject aims to provide the student of electrical disciplines to understand the basic physics related to various breakdown processes in solid, liquid and gaseous insulating materials. Also the Knowledge of generation and measurement of high voltage D. C., A.C., & Impulse voltages, tests on H. V. equipments and on insulating materials, as per the standards and how over-voltages arise in a power system, and protection against the over- voltages.

Teaching and Assessment Scheme:

Teaching Scheme (Hours per Week)			Credits	Assessment Scheme				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE	CE	ESE	CE	
3	0	2	4	60	40	20	30	150

Course Contents:

Unit No.	Topics	Teaching Hours
1.	**Electrical breakdown in gases**: Mechanisms of breakdown in gases, various related ionization processes. Townsends and Streamer theories. Paschen's law, Breakdown in Non-uniform fields. Effect of wave shape of impressed voltage on the breakdown strength. Breakdown of sphere gap and rod gap. Practical gaseous dielectrics: SF_6, SF_6 mixtures, vacuum, Introduction to Gas insulated substations.	06
2.	**Breakdown in liquid and solid dielectrics**: Liquid as insulators, breakdown in liquids - electronic breakdown, suspended solid particle mechanism, cavity breakdown, electro-convection and electro-hydrodynamic model of dielectric breakdown, examples. Transformer oil filtration, transformer oil test. Breakdown in solids, intrinsic breakdown, streamer breakdown, electromechanical breakdown, edge breakdown and treeing, thermal breakdown, erosion breakdown, tracking - breakdown of solid dielectrics in practice, solid dielectrics used in practice.	06
3.	**Generation of high voltages**: Generation of high direct voltages, half and full wave rectifier circuits, voltage multiplier circuits, Van de Graff generators, electrostatic generators, examples. Generation of high alternating voltages, high voltage testing transformers, cascaded transformers, resonant transformers, examples. Impulse voltages, impulse voltage generator circuits, Marx circuit, operation, design and construction of impulse generators, examples - impulse current generator - control systems.	10
4.	**Measurement of high voltages**: High direct current voltage measurement, peak voltage measurements by spark gaps, sphere gaps, reference measuring systems, uniform field gaps, rod gaps, factors affecting sphere gap measurements, examples , electrostatic voltmeters - ammeter in series with high ohmic resistors and high ohmic resistor voltage	08

Unit No.	Topics	Teaching Hours
	dividers - generating voltmeters and field sensors – the measurement of peak voltages, high-voltage capacitors for measuring circuits - voltage dividing systems and impulse voltage measurements, generalized voltage generation and measuring circuit, voltage dividers, interaction between voltage divider and its lead, the divider's low-voltage arm - digital recorders, errors inherent in digital recorders.	
5.	**Over Voltage and Insulation Coordination** Lighting, Switching and temporary over voltages, BIL, SIL, methods of insulation coordination, Voltages produced by traveling surges, Bewley lattice Diagrams.	06
6.	**High Voltage Testing** Measurement of insulation resistance of cables. Wet and dry flashover test of insulators. Testing of insulators in simulated polluted conditions. Testing of transformers and rotating machines. Basic techniques of non-destructive testing of insulators; measurement of loss angle, High Voltage Schering bridge, and partial discharge measurement techniques. Introduction of Sweep Frequency Response Test.	04
7.	**Introduction to software.** Software applications to high voltage Engineering field.	02
	Total	42

List of References:

1. Kuffel, E., Zaengl W.S., Kuffel J., "*High Voltage Engineering: Fundamentals*", 2nd Edition, Butterworth- Heinmann , 2000.
2. Naidu M. S. and Kamaraju V., "*High Voltage Engineering"*, fourth Edition, Tata McGraw- Hill Publishing Company Limited, New Delhi, 2009.
3. Wadhwa C.L., *"High Voltage Engineering*", third edition, New Age publishers, New Delhi, 2010.
4. Rakosh Das Begamudre, *"High Voltage Engineering, Problems and Solutions",* New Age International Publishers, New Delhi, 2010.
5. Dieter Kind, Kurt Feser, *"High Voltage Test Techniques",* Reed educational and professional publishing Ltd. (Indian edition), New Delhi-2001.
6. Muhammad H. Rashid, *"Introduction to Pspice Using OrCAD for circuits and electronics"*, Third Edition, Pearson Education.

Web Resources:

1. NPTEL Web course - High Voltage Engineering – Prof. Ravindra Arora, IIT Kanpur
   https://nptel.ac.in/courses/108/104/108104048/

Course Outcomes (COs):

At the end of this course students will be able to:

1. Understand how to formulate basic problems and model the associated configurations, circuits and systems related to high voltage components and systems.
2. Deal with high voltage systems and networks and solve basic problems related to generation, measurement and testing.
3. Understand properties of various insulating materials.
4. Discuss overvoltage phenomenon and insulation coordination in electric power systems.

3HS01: ETHICS AND CONSTITUTION OF INDIA#
CREDITS – 0 (LTP: 2,0,0)

Course Objective:
To create awareness of Engineering Ethics and human values, instill moral social values, loyalty and ethical issues. It will allow the students to assimilate with basic information about Indian Constitution, know its salient features and thus functioning of Democracy in India

Teaching and Assessment Scheme:

Teaching Scheme (Hours per Week)			Credits	Assessment Scheme				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE	CE	ESE	CE	
2	0	0	0	30	20	00	00	50

Course Contents:

Unit No.	Topics	Teaching Hours
1	**Professional Ethics:** Definition of Ethics, Professional Ethics, Business Ethics, Corporate Ethics, Engineering Ethics, Personal Ethics; Profession, Professionalism, Professional Responsibility, Professional Ethics; Conflict of Interest, Gift v/s Bribery, Environmental breaches, Negligence, Deficiencies in state-of-the-art; Vigil Mechanism, Whistle blowing, protected disclosures.	7
2	**Engineering ethics:** Definition-Approach-Senses of Engineering Ethics-variety of moral issues– Definition–Ethical theories-Theories about right action Personality– Self-control- Self-interest –Self-respect.	7
3	**Constitution and Constitutionalism**: Historic perspective of constitution of India, Salient features and Characteristics of constitution of India, Scheme of fundamental rights, Scheme of fundamental duties and its legal status, The directive principles of State policy-its importance and implementation	7
4	**Federal Structure:** Distribution of legislative and financial powers between the union and states, Parliamentary form of government in India, The constitution powers and status of the President of India, Amendment of Constitution powers and procedure. Functions of state legislature, Structure of state executive-Powers and positions of Governor, Speaker, Deputy Speaker, Chief Minister and council of minister.	7
	Total	**28**

List of References:

1. Govindrajan.M, Natrajan S, Senthilkumar V.S, "*Engineering Ethics(Including Human Values)",* PHI publication, latest edition.
2. Reddy.N H, Ajmera, Santosh, "*Ethics, Integrity and Aptitude*", Tata McGraw Hill.
3. Durga Das Basu (DD Basu): *"Introduction to the Constitution on India*", (Students Edition.) Prentice –Hall EEE, 19th / 20th Ed., (Latest Edition) or 2008.

4. Shubham Singles, Charles E. Haries, and Et al: "*Constitution of India and Professional Ethics*" by Cengage Learning India Private Limited, Latest Edition – 2018.
5. M.V.Pylee, "*An Introduction to Constitution of India*", Vikas Publishing, 2002.

Course Outcomes (COs):

At the end of this course students will be able to …

1. Practice the moral values that ought to guide the engineering profession.
2. Discover the set of justified moral principles and apply them to concrete situation.
3. Appreciate the ethical issues and know the code of ethics in different professional bodies.
4. Discover the Federal structure and Constitution of India.
5. Know the successful functioning of democracy in India.
6. Apply the statutes available in the Constitution to the field of engineering.

3CE81: ENVIRONMENT AND HEALTH
CREDITS – 3 (LTP: 3,0,0)

Objective of the Course:

1. To make the students conversant with sources of various pollution.
2. Impart knowledge of health effects of various pollutants.

Teaching and Assessment Scheme:

Teaching Scheme (Hours per week)			Credits	Assessment Scheme				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE	CE	ESE	CE	100
3	0	0	3	60	40	00	00	

Course Content:

Unit No.	Topics	Teaching Hours
1	**Introduction** Scope and importance of Environmental Health, Introduction to Environmental pollution, its impact on human health, epidemiology, agents of diseases and their pathways, chronic and communicable diseases.	07
2	**Air Pollution and Health** Sources of air pollution, Types of air pollutants, impacts on human health, air quality guidelines in protecting public health, global climatic changes and its impact, Indoor air quality, case studies.	11
3	**Water Pollution and Health** Drinking water quality criteria, water borne diseases, aspects of water and wastewater treatment, Fluoride and Arsenic in drinking water in India, case studies.	10
4	**Solid Waste and Hazardous Waste and Health** Sources, classification and composition of MSW, Introduction to MSW management. Definition and classification of hazardous waste, hazard and risk, Health effects of hazardous waste, Resource Conservation and Recovery Act (RCRA) and The Health and Safety at Work Act 1974 (HSWA), case studies.	12

5	**Noise Pollution and Health** Introduction, Sources of Noise, permission noise level and standards, Effects of noise, noise control, case studies.	05
	Total	**45**

List of References:

1. H.S. Peavy, D.R. Rowe and G. Tchbanoglous, "*Environmental Engineering*", McGraw Hill International Edition.
2. G. Tchabanoglous, "*Solid Waste Treatment and Disposal*", McGraw Hill Pub.
3. J.A. Salvato, "Environmental Sanitation", Wiley Interscience.
4. M.L. Davis and D.A. Cornwell, "Introduction to Environmental Engineering", McGraw Hill International edition.
5. Metcalf and Eddy, (Revised by G. Tchobanoglous, Wastewater Engineering: Treatment, disposal and Reuse, Tata-McGraw Hill, New Delhi.
6. J. E. Park, "*Preventive and Social Medicine*", Banarasidas Bhanot Publishers, Jabalpur, 1995.
7. Rao M.N., "*Air Pollution*", Tata McGraw- Hill Publising Company Ltd.,

Course Outcomes (CO_s):

At the end of this course students will be able to

1. Understand assessment procedure of various pollutants of air water and land.
2. Appreciate the effects of various types of pollution on human health

3CE83: EARTH SYSTEM AND GEO-ENVIRONMENT
CREDITS – 3 (LTP: 3,0,0)

Course Objective:

1. Understand and articulate the ways Earth's interior and surface operates, the interconnection of spheres to earth system and linking biogeochemical processes
2. Acknowledge earth resource and cycles of material and energy exchange, dynamic nature of earth and surficial and sub surficial morphological changes on and within the earth
3. Develop understanding of geo-environment, geo-environment divides, Resilience of environmental systems to the global climate and environmental changes and extreme events.
4. Comprehend the advance tool, techniques to monitor, mitigate and manage the geo-environmental challenges
5. Apply the course acquaintance in the respective field of interest.

Teaching and Assessment Scheme:

Teaching Scheme (Hours per Week)			Credits	Assessment Scheme				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE	CE	ESE	CE	
3	0	0	3	60	40	00	00	100

Course Contents:

Unit No.	Topics	Teaching Hours
1	**Earth System:** Earth system Spheres and interaction: Introduction, Scope and fundamentals of Earth System, Understanding Lithosphere (Geosphere), Hydrosphere, Atmosphere, Cryosphere, Biosphere, and dynamics, Anthroposphere influence and impact on earth system. Physical Earth science and Morphology: Natural agencies and Geological work on land surface, Weathering, erosion, surficial and sub surficial water action and associated morphological changes. Earth's Material and Resources: The Rock cycle and rock formation, Various rock types and mineral as resource and soil types and genesis of soil Earth's dynamics: Earthquakes, Seismic activities and plate tectonics, Volcanic bustle and Morphological changes of earth, Relevant case studies	**20**
2	**Geo environment:** Overview of Geo-environment, Geo-environmental divide: Physiographical, geological, hydrological divides and geo-climate. Geo-environmental disasters: Landslides and Mass movement, Tsunami, Desertification, and hydro-meteorological disasters. Anthropogenic influenced Geo environmental problems. Relevant examples and case studies.	**10**
3	**Global geo-environmental Problems and Challenges:** Environmental changes, Global warming, climate changes and pollution related complexities wicked and super wicked problems, understanding geo-environmental impact and challenges in general, Learning through case studies, trending research work and projects at global scale.	**7**
4	**Tool, Techniques and mitigation for disasters and Geo-environmental Problems:** Basic principles and applications of Remote sensing, GIS and GPS, Gadgets and devices for monitoring, predicting time series geo environmental changes; Disasters warning systems for cyclone, Tsunami etc, Disaster management and Mitigation: Software and Modelling approach. Demonstration of working of tools and techniques (Virtual mode).	**8**
	Total	**45**

List of References:

7. Edward A Keller, "*Environmental Geology*", 9th Edition, Pearson, ISBN-13: 978-0321643759, ISBN-10: 0321643755, 2010
8. Edward A Keller, "*Introduction to Environmental Geology*", 5th edition, Pearson, ISBN-10: 9789352864324, ISBN-13: 978-9352864324, 2011
9. Valdiya K S, "*Environmental Geology*", 2nd edition, McGraw Hill, ISBN: 9781259058479, 2013
10. W G Ernst (Editor), "*Earth System: Processes and Issues*", Cambridge University Press, ISBN-10: 0521473233, ISBN-13: 978-0521473231, 2000
11. Steffen, W., Sanderson, R.A., Tyson, P.D., Jäger, J., Matson, P.A., Moore III, B., Oldfield, F., Richardson, K., Schellnhuber, H.J., Turner, B.L., Wasson, R.J, "*Global change and the Earth system: A planet under pressure*", Springer, 2005
12. Andrew DeWet, Kirsten Menking, "*Environmental geology: An Earth system Approach*", 2d edition, W H Freeman, ISBN-10: 1429237430, ISBN-13: 978-1429237437, 2014

13. Sinha, Rajiv, Ravindra, Rasik (Editors), "*Earth system Processes and Disaster management"*, Springer, ISBN 978-3-642-28845-6, 2013
14. Jensen, "*Remote sensing of the environment: An earth resource Perspective*", 2nd edition, Pearson India, ISBN: 9789332518940, 2013
15. Study Report, "*Thriving on our changing Planet",* The National Academic press, ISBN 978-0-309-46757-5, 2018
16. Basudev Bhatta, "*Remote sensing*", Oxford, ISBN: 9780198072393, 2011
17. Prabin Singh, "*Engineering & General Geology*" 8th edition, S K Kataria & sons ,2013

Course Outcomes (COs):

At the end of this course students will be able to …

1. Acquire knowledge of earth system, natural resources, material and energy exchange, dynamics of earth system, linkage of earth system and geo-environmental issues
2. Think critically and discriminate the natural and anthropogenic causatives of geo-environmental disaster, wicked, super-wicked problems and future challenges
3. Associate developed cognizance and perception to accomplish project and research work in a prolific way
4. Employ tool, techniques and software in the respective field to enlarge the future scope and for the career enrichment

3SE81: DISASTER MANAGEMENT AND MITIGATION
CREDITS – 3 (LTP: 3,0,0)

Course Objectives:

1. To impart knowledge of causes of various disaster and its impact
2. To understand the concept of Disaster Management Cycle and Framework
3. To explain the Applications of Science and Technology for Disaster Management & Mitigation

Teaching and Assessment Scheme:

Teaching Scheme (Hours per Week)			Credits	Assessment Scheme				
				Theory Marks		Practical Marks		Total Marks
L	T	P	C	ESE	CE	ESE	CE	
3	0	0	3	60	40	00	00	100

Course Contents:

Sr. No.	Topics	Teaching Hrs.
1	**Introduction** Understanding the Concepts and definitions of Disaster and its types, Hazard, Vulnerability, Risk, Capacity, Disaster and Development, and disaster management	4
2	**Consequences and Control of Disasters** Geological, Hydro-Meteorological, Biological, Technological and Man- made Disasters, Global Disaster Trends, Emerging Risks of Disasters, Climate Change and Urban Disasters	8

3	**Disaster Management Cycle and Framework** Disaster Management Cycle, Paradigm Shift in Disaster Management Pre-Disaster Risk Assessment and Analysis, Risk Mapping, zonation and Micro zonation, Prevention and Mitigation of Disasters, Early Warning System; Preparedness, Capacity Development, Awareness During Disaster Evacuation, Disaster Communication, Search and Rescue, Emergency Operation Centre, Incident Command System, Relief and Rehabilitation, Damage and Needs Assessment, Restoration of Critical Infrastructure, Early Recovery, Reconstruction and Redevelopment, IDNDR, Yokohama Strategy, Hyogo Framework of Action	12
4	**Disaster Management in India** Disaster Profile of India, Mega Disasters of India and Lessons Learnt, Disaster Management Act 2005, Institutional and Financial Mechanism, National Policy on Disaster Management, National Guidelines and Plans on Disaster Management, Role of Government, Non-Government and Inter-Governmental Agencies	11
5	**Applications of Science and Technology for Disaster Management & Mitigation** Geo-informatics in Disaster Management, Disaster Communication System, Land Use Planning and Development Regulations, Structural and Non Structural Mitigation of Disasters, S&T Institutions for Disaster Management in India	10
	Total	**45**

List of References:

1. Coppola D P, 2007. Introduction to International Disaster Management, Elsevier Science (B/H), London.
2. Manual on natural disaster management in India, M C Gupta, NIDM, New Delhi
3. An overview on natural & man-made disasters and their reduction, R K Bhandani, CSIR, New Delhi
4. Disaster Management Act, Publisher by Govt. of India
5. Publications of National Disaster Management Authority (NDMA) on Various Templates and Guidelines for Disaster Management
6. NIDM Publications, GoI
7. National Disaster Management Policy, GoI
8. Roy, P.S. (2000): Space Technology for Disaster management: A Remote Sensing & GIS Perspective, Indian Institute of Remote Sensing (NRSA) Dehradun.

Course Outcomes:

After learning the course the students should be able to:

1. Understand disasters, disaster preparedness and apply the mitigation measures
2. Understand role of IT, remote sensing, GIS and GPS in risk reduction
3. Apply knowledge of disaster management acts and guidelines.

List of Open Source Software/learning website:

www.GIS. Development.net
www.iirs.nrsa.org
http://quake.usgs.gov
www.nidmindia.nic.in

ACTIVE LEARNING ASSIGNMENTS: Preparation of power-point slides, which include videos, animations, pictures, graphics for better understanding theory and practical work – The faculty will allocate chapters/ parts of chapters to groups of students so that the entire syllabus to be covered. The power-point slides should be put up on the web-site of

the College/ Institute, along with the names of the students of the group, the name of the faculty, Department and College on the first slide.

3CP81: FUNDAMENTALS OF COMPUTER NETWORKS AND SECURITY
CREDITS- 3 (LTP: 3,0,0)

Course Objective:
To learn the fundamentals of computer networks and network security concepts.

Teaching and Assessment Scheme:

Teaching Scheme (Hours per Week)			Credits	Assessment Scheme				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE	CE	ESE	CE	
3	0	0	3	60	40	-	-	100

Course Contents:

Unit No.	Topics	Teaching Hours
1	**Introduction** Components, Direction of Data flow, networks, Components and Categories, types of Connections, Topologies, Protocols and Standards, ISO / OSI model, Transmission Media, Coaxial Cable, Fiber Optics, Line Coding Modems	8
2.	**Networks basic** Error, detection and correction, Parity, LRC, CRC, Network Layer, Internetworks, Packet Switching and Datagram approach, IP addressing methods, Subnetting, Routing, Distance Vector Routing, Link State Routing, Routers.	8
3.	**Networking protocols** Functions of transport layer, Multiplexing, De-multiplexing, Sockets, User Datagram Protocol (UDP), Transmission Control Protocol (TCP), Congestion Control, Quality of services (QOS), Integrated Services, Domain Name Space (DNS), SMTP, FTP, HTTP, WWW, Security, Cryptography**.**	10
4	**Security at the application layer** Email architecture, Email Security, PGP-Pretty Good Privacy, PGP Certificates, Trust model in PGP, Key rings, S/MIME-simple multipurpose Internet Mail Extension	7
5	**Security at the transport Layer** SSL Architecture, Key Exchange algorithms, Encryption/ Decryption algorithms, Hash Algorithms, Protocols related to SSL, TLS- Transport layer security, version, cipher suite	6
6	**Security at network layer:** Transport mode, Tunnel mode, comparison, Security protocols, services provide by IPSec, Security Association, Security Policy, Internet Key	6

Unit No.	Topics	Teaching Hours
	Exchange	
	Total	**45**

List of References:

1. Behrouz A forouzan, "*Data Communication and networking*", Mc-Graw hill.
2. Behrouz A forouzan, "*Cryptography and Network Security*".
3. William Stallings, "*Network Security Essentials: Applications and Standards*"

Course Outcomes (COs):

At the end of this course students will be able to…

1. Understand the concepts of Data Communication, Networking and Reference models
2. Understand the concepts of Internetworking Devices and Routing techniques
3. Understand the Application layer protocols like DNS, SMTP, SNMP, FTP, HTTP etc.
4. Understand the concepts of Security at Application layer.
5. Understand the concepts of Security at the Transport Layer.
6. Understand the concepts Security at Network layer.

3CP82: FUNDAMENTALS OF OPERATING SYSTEMS
CREDITS - 3 (LTP: 3,0,0)

Course Objective:

To learn the fundamentals and various functions of operating systems.

Teaching and Assessment Scheme:

Teaching Scheme (Hours per Week)			Credits	Assessment Scheme				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE	CE	ESE	CE	
3	0	0	3	60	40	00	00	100

Course Contents:

Unit No.	Topics	Teaching Hours
1	**Introduction** Functions of operating systems, processes, files, command interpreter, Different types of operating systems, operating system interface. Operating system structure: Monolithic, Layered, Hexokernels, Virtual Machines and Client-Server.	05
2	**Processes and their implementation** Process states and state transition diagram, Inter process communication: shared memory and message passing, Race condition, critical sections, mutual exclusion, semaphores and monitors. Threads and thread implementation. Process scheduling: Objectives, First come first serve, shortest job first, Round-robin, Priority-based scheduling and Multilevel	12

Unit No.	Topics	Teaching Hours
	feedback queue Scheduling algorithms. Scheduling algorithms of Real Time Operating system.	
3	**Deadlocks** Definition and simple examples, deadlock detection, recovery, avoidance and Prevention.	**04**
4	**Memory management** Fixed and variable size partitions, protection of user address space, Swapping, virtual memory systems, demand paging, working set, page replacement strategies, Segmentation.	**09**
5	**File system** Files, Directories and Special files, access methods, Implementing Files and Shared Files, Disk space management and file space allocation methods, file system security, reliability and performance, File-System Backups, File-System Consistency, Reliability and Performance.	**09**
6	**Input and output** Basic concepts, I/O software layers: interrupt handlers, device drivers, and device-independent I/O software. Disk arm scheduling algorithms, clocks, power management.	**06**
	Total	**45**

List of References:

1. Andrew S. Tanenbaum, "*Modern Operating Systems*", Prentice Hall International
2. Silberschatz and Galvin, "*Operating System Concepts*", John Willey and Sons
3. William Stallings,"*Operating Systems*" Prentice Hall of India
4. D.M.Dhamdhere, "*Operating Systems*", Tata McGraw Hill

Course Outcomes (COs):

At the end of this course students will be able to…

1. Understand basic functions of operating system, system call and design structures
2. Explore the process management policies, process synchronization, Dead lock detection and prevention mechanisms used in different operating systems
3. Analyze scheduling algorithms used in general purpose and real time operating systems
4. Compare different memory management schemes and page replacement algorithms.
5. Understand file systems from user and design perspective.
6. Understand role of device driver in I/O management.

3IT81: CYBER SECURITY
CREDITS –3(LTP: 3,0,0)

Course Objective:

To learn importance of securing applications and to make aware about Cyber Security Cyber law, Cyber Crime.

Teaching and Assessment Scheme:

Teaching Scheme (Hours per Week)			Credits	Assessment Scheme				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE	CE	ESE	CE	
3	0	0	3	60	40	-	-	100

Course Contents:

Unit No.	Topics	Teaching Hours
1	**Introduction:** A brief history of the internet,Application security, Data security, Security technology-Firewall and VPNs, Access control, Security threats, Malicious software, Network and denial of services attack, Electronic payment system, E- Cash, Credit/Debit cards, Digital signature.	5
2	**Cyber Security And Cyber Crime Investigation:** Introduction to cyber security, Introduction to cyberspace, Survey of malware and its existence, Definition of security hole, Security patch, Viruses, Worms, Trojan horses, Social engineering, Avoiding Malwares, Spyware, Keyboard loggers, Ransomware, E-Mail and SPAM, Spoofing, Spammer's tools.	7
3	**Vulnerability Scanning:** Introduction to vulnerability, Vulnerability scanning, Different web vulnerabilities, Open Port and Service Id, Banner disclosure, Traffic probe, Web application testing, Penetration testing.	7
4	**Port Scanning:** Understanding port and services tools, Port scanning tool- Nmap, Netcat, Network sniffers and injection tools, Wireshark.	5
5	**Network Defense Tools:** Firewall basics, Packet filter Vs firewall, How a firewall protects a network, Packet characteristic to filter, Stateless Vs Stateful firewalls, Network address translation (NAT) and port forwarding, The basic of virtual private networks.	6
6	**Web Application Tools:** Scanning for web vulnerabilities tools: Nikto and W3af, Web application testing using DVWA, Manual SQL injection scanning using DVWA, Password Cracking and Brute-Force tools, Wi-Fi passwords cracking WEP & WAP/WAP2 with Aircrack-ng.	8
7	**Introduction to Cyber Crime:** Cyber Crimes, Types of cybercrime, Hacking, Attack vectors, Cyberspace, Traditional problems Associated with Computer Crime, Introduction to incident response, Cybercrime against individual, Cybercrime against property Cybercrime against organization, Cybercrimes against society, Cybercriminals.	7
	Total	**45**

List of References:

1. Mike Shema, *"Anti-Hacker Tool Kit (Indian Edition)"*, Mc Graw Hill.
2. Nina Godbole and Sunit Belpure, *"Cyber Security Understanding Cyber Crimes, Computer Forensics and Legal Perspectives",*Wiley Publication
3. Dafydd Stuttard and Marcus Pinto, *"The Web Application Hacker's Handbook: Finding and Exploiting Security Flaws"*, WileyPublication

Course Outcomes (COs):

At the end of this course students will be able to …

1. Learn the concepts of confidentiality, availability and integrity in Information Security.
2. Explain the concepts cyber-attack, cybercrimes, cyber laws and also how to protect themselves and ultimately society from such attacks.
3. Develop Secure Web Application through vulnerability scanning and understanding the importance of data privacy and protecting data.
4. Distinguish and classify the forms of cybercriminal activity and the technological methods used to undertake such crimes.
5. Investigate assumptions about the behavior and role of victims in cyberspace, and use basic web-tools to explore behavior on-line.
6. Analyze and assess the impact of cybercrime on government, businesses, individuals and society.

3IT82: INTERNET TECHNOLOGY
CREDITS -3 (LTP: 3,0,0)

Course Objective:

To provide knowledge regarding working of Internet, implementation of network with different topologies and server configuration.

Teaching and Assessment Scheme:

Teaching Scheme (Hours per Week)			Credits	Assessment Scheme				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE	CE	ESE	CE	
3	0	0	3	60	40	-	-	100

Course Contents:

Unit No.	Topics	Teaching Hours
1	**Introduction To Internet:** Internet, Growth of internet, Owners of the internet, Anatomy of internet, ARPANET and internet, History of WWW, HTTP protocol, Request and response messages, Methods of HTTP, HTTPS, SMTP, IMAP, POP3 and DNS, Internet applications, Impact of internet on society, Transmission infrastructure, Internet Standards: Standards bodies and the standards process, IETF, ITU, IEEE, ATM forum.	8
2	**Internet Technology, Protocols And Addressing:** Packet switching technology, Internet protocols: TCP/IP, Router, Internet addressing scheme: Machine addressing (IP address), E-mail addresses and Resources addresses.	6

Unit No.	Topics	Teaching Hours
3	**Internet Network:** Network definition, Common terminologies: LAN, WAN, Node, Host, Workstation, Bandwidth, Interoperability, Network administrator, Network security, Network components: Severs, Clients, Communication media, Types of network: Peer to Peer, Clients server, Addressing in internet: DNS, Domain Name and their organization, understanding the internet protocol address, Network topologies: Bust, Star and ring, Ethernet, FDDI, ATM and intranet.	8
4	**Networking Hardware And Software Components:** Network interface cards, Network cables, Network connecting devices, Core Components:Hardware platforms, Internet server components, Web servers, E-mail servers, FTP servers, Proxy servers, News servers, Directory servers, Mirrored servers.	6
5	**Access Methods and Internet Working:** Access Network Architectures: Access Network characteristics. Differences between Access Networks, Local Area Networks and WideArea Networks. Access Technologies: Why there is an upper limit on modem speeds.Voice grade modems, ADSL, Cable Modems, Frame Relay.	5
6	**Internet Application:** FTP, Telnet, Email, Chat. World Wide Web: HTTP protocol.Search Engines. E-Commerce and security issues including symmetric and asymmetrickey, encryption and digital signature, and authentication. Emerging trends, Internettelephony, virtual reality over the web, etc.	6
7	**Internet Security Management Concepts, Information Privacy And Copyright Issues:** Overview of internet security, Firewalls, Internet security, Management concepts and information privacy and copyright issues, Basics of asymmetric cryptosystems.	6
	Total	**45**

List of References:

1. Greenlaw R and Hepp E*, "Fundamentals of Internet and www"*, 2nd EL, Tata McGraw-Hill, 2007.
2. D. Comer, *"The Internet Book",* Pearson Education, 2009.
3. P. J. Deitel, H. M. Deitel, *"Internet and World Wide Web: How to program",* Pearson publication.
4. M. L. Young, *"The Complete reference to Internet",* Tata McGraw Hill, 2007.
5. Douglas E Comer, *"Computer Networks and Internets With Internet Applications",* Pearson.
6. Douglas E Comer, *"Internetworking with TCP / IP, Principles, Protocols & Architecture",*6th Edition, PHI.
7. William Stallings "*Data & Computer Communications*" 8th Edition.
8. A.Farrel IElseviers, "*The Internet and its protocols – A Comparative Approach*" , Morgan Kaufmann Publishers.

Course Outcomes (COs):

At the end of this course students will be able to …

1. Understand the current topics in Web & Internet technologies.
2. Describe the basic concepts for network implementation.
3. Learn the basic working scheme of the Internet and its working.
4. Understand fundamental working of networking hardware and software technology.
5. Understand various internet application and its importance.

6. Identify the various security hazards on the Internet and need of security measures.

3IT83: SOFTWARE PROJECT MANAGEMENT
CREDITS – 3 (LTP: 3,0,0)

Course Objective:
To provide understanding of various stages of software development and quality management process.

Teaching and Assessment Scheme:

Teaching Scheme (Hours per Week)			Credits	Assessment Scheme				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE	CE	ESE	CE	
3	0	0	3	60	40	-	-	150

Course Contents:

Unit No.	Topics	Teaching Hours
1	**Project Management:** The management spectrum, The people, The product, The process, The project, Software development life cycle, Typical software roles and responsibilities, Components, Review of models for software development, The W5HH principle.	4
2	**Project Life Cycle And Effort Estimation** Software process and process models, Choice of process models, Rapid application development, Agile methods, Extreme Programming, SCRUM, Managing interactive processes, Basics of software estimation, Effort and Cost estimation techniques, COCOMO II A Parametric productivity model - Staffing Pattern.	8
3	**Activity Planning And Risk Management** Objectives of activity planning, Project schedules, Activities, Sequencing and scheduling, Network planning models, Forward pass & backward pass techniques, Critical path (CRM) method, Risk identification, Assessment monitoring, PERT technique, Monte carlo simulation, Resource allocation, Creation of critical patterns, Cost schedules.	8
4	**Quality Planning:** Quality concepts, Procedural approach to quality Management, Quantitative approaches to quality management, Quantitative quality management planning, Setting the quality goal, Estimating defects for other stages, Quality process planning, Defect prevention planning.	4
5	**Quality Management:** Quality concepts, Software quality assurances, software reviews,formal technical reviews, Formal approaches to SQA, Statistical software qualityassurances, Change Management: software Configuration management, The SCMrepository, SCM Process, Configuration management for web engineering.	4

Unit No.	Topics	Teaching Hours
6	**Project Management in Maintenance of Projects:** Introduction, Software project maintenance life cycle, Process, estimation, Configuration management, Metrics, Defect prevention.	8
7	**Project Execution And Closure:** The review process, Planning, Overview and preparation, Group review meeting, Rework and follow-up, one-person review, Guidelines for reviews in projects, Data collection, Analysis and control guidelines, Introduction of reviews and the NAH syndrome.	6
8	**Software Testing Tools:** Test case generation Methodology, Study of various testing tools.	3
	Total	**45**

List of References:

1. R. S. Pressman, "*Software Engineering*", 7th ed ,Tata McGraw Hills.
2. Pankaj Jalote, "*Software project management in practice*", Addison-Wesley.
3. B. Hughes & M. Cotterell, "*Software Project Management*", Tata McGraw Hills.
4. Mantel et al., "*Project Management* – Core text Book", Wiley .
5. Roger S. Pressman, "*Software Engineering*: *A practical Approach*", McGraw-Hill.

Course Outcomes (COs):

At the end of this course students will be able to …

1. Understand significance of Software development life cycle.
2. Understand steps of software estimation.
3. Analysis of various risk management technique.
4. Reconstruct software using quality management technique.
5. Calculate overall time of software using project execution cycle.
6. Apply software testing tool on real time software.

3IT84: ENTERPRISE RESOURCE PLANNING
CREDITS - 3 (LTP: 3,0,0)

Course Objective:

To understand the business process, project management life cycle and emerging trends of ERP.

Teaching and Assessment Scheme:

Teaching Scheme (Hours per Week)			Credits	Assessment Scheme				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE	CE	ESE	CE	
3	0	0	3	60	40	-	-	100

Course Contents:

Unit No.	Topics	Teaching Hours
1	**ERP and Related Technologies:** Introduction, Related Technologies, Business Intelligence, E-Commerce and E-Business, Business Process Reengineering, Data Warehousing, Data Mining, OLAP, Product life Cycle management, Supply chain management, Customer relationship management, Management information system, Decision support system, Executive information system.	8
2	**ERP Manufacturing Perspective :** MRP - Material Requirement Planning, BOM - Bill Of Material, MRP - Manufacturing Resource Planning, DRP - Distributed Requirement Planning, PDM - Product Data Management.	5
3	**ERP Implementation:** Implementation Challenges, Strategies, Life Cycle, Pre-implementation Tasks, Requirements Definition, Methodologies, Package selection, Project Teams, Process Definitions, Vendors and Consultants, Data Migration, Project management, Post Implementation Activities.	10
4	**ERP in Action and Business Modules:** Operation and Maintenance, Performance, Maximizing the ERP System. **Business Modules:** Finance, Manufacturing, Human Resources, Plant maintenance, Materials Management, Quality management, Marketing, Sales, Distribution and service.	10
5	**ERP Case studies and ERP Tools:** E-Commerce to E-business, E-Business structural transformation, Flexible Business Design, Customer Experience, Create the new techno enterprise, New generation e-business leaders, memo to CEO, Empower your customer, Integrate Sales and Service, Integrated Enterprise applications. **Introduction to ERP Tools:** JD Edwards-Enterprise One, Microsoft Dynamics-CRM Module.	8
6	**Emerging Trends of ERP:** Extended ERP systems and ERP add-ons, Business analytics, Enterprise architecture planning, ERP usage in Real world, ERP implementation, Future of ERP applications. **Trends in ERP Systems:** Web enabled, wireless technologies, cloud computing.	4
	Total	**45**

List of References:

1. Alexis Leon, *"ERP demystified"*, Third Edition,Tata McGraw-Hill, 2014
2. Alexis Leon, *"Enterprise Resource Planning",* Third Edition,Tata McGraw Hill,2012
3. Ravi Shankar & S. Jaiswal, *"Enterprise Resource Planning"*, Galgotia.
4. Annetta Clewwto and Dane Franklin, *"Guide to Planning ERP Application"*, McGRaw-Hill

Course Outcomes (COs):

At the end of this course students will be able to …

1. Analyze the life cycle of ERP and its related technologies.
2. Identify implementation strategy used for ERP.
3. Explain the performance and maintenance operations of ERP.
4. Examine the working and design principles of various business modules of ERP.

5. Understand the basic tools of ERP.
6. Apply different emerging technologies for implementation of ERP.

3EE81: ENERGY AUDIT & CONSERVATION (O. E.-I)
CREDITS - 3 (LTP: 3,0,0)

Course Objective:
To enhance practical exposure in energy management of industrial utilities such as electrical as well as thermal.

Teaching and Assessment Scheme:

Teaching Scheme (Hours per Week)			Credits	Assessment Scheme				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE	CE	ESE	CE	
3	0	0	3	60	40	00	00	100

Course Contents:

Unit No.	Topics	Teaching Hours
01	**General Aspects**: Basics of electrical & thermal energy, energy units and conversion. Energy Scenario: Primary & Secondary energy, Commercial & Non-Commercial energy, Nonrenewable & renewable energy, Globally energy reserves and production, Energy conservation and its importance. Energy Conservation Acts: 2001, 2010, Electricity act 2003, National action plan on climate changes, Integrated energy policy, Schemes under EC act 2001. Perform Achieve and Trade (PAT) by BEE in 2008.	05
02	**Energy Management & Audit:** Definition as per EC act-2001, Objective, Need, Types, Benchmarking. Management : Top management commitment & support, Energy policy & planning, Evaluating Energy Performance, Management Tools for Effective Implementation- 5S, KAIZEN, TPM, TQM, ISO 50001, Financial analysis: techniques, Role of ESCOs, project management technique- critical path method, pert analysis. Energy Monitoring & Targeting: Definition, Key elements, CUSUM analysis, Industry 4.0.	07
03	**Renewable Energy Sources:** Concept & Fundamental, Applications: solar-thermal, solar –electrical, wind energy, biomass energy, hydro energy, fuel cell, energy from waste, wave energy, tidal energy, geothermal energy. Global energy Issues: Acid rain, Ozone layer, depletion, global warming & climate change, loss of biodiversity.	05
04	**Energy Efficiency And Performance Of Electrical Utilities:** Electric motor, Air compressed system, HVAC and refrigeration system, Fans & Blowers, Pumps & Pumping System, Cooling towers , Lighting system, DG, ECBC codes. Case study.	10
05	**Energy Efficiency & Performance Of Thermal Utilities:** Boiler, furnace, Insulation & Refractories, Heat exchangers. Case study.	10

Unit No.	Topics	Teaching Hours
06	**Energy Audit Case Study:** Thermal Power Plant, Textile Industry, Ceramic Industry And Cement Industry.	05
	Total	**42**

List of References:

1. General aspects of energy management and energy audit, Guide book EA-EM, BEE, India.
2. Energy efficiency in electrical utilities, Guide book EA-EM, BEE, India.
3. Energy efficiency in thermal utilities, Guide book EA-EM, BEE, India.
4. Energy performance assessment for equipment and utility systems, Guide book EA-EM, BEE, India.
5. Doty, Steven; Turner, Wayne C, Energy Management Handbook (8th Edition), Fairmont Press, Inc., 978-0-88173-707-3
6. Amlan Chakrabarti, Energy Engineering and management, PHI Publication

Course Outcomes (COs):

After learning this course the students will be able to:

1. Understand the recent energy management scenario and nee schemes.
2. Operate and control the industrial process.
3: Identify the utility problems for energy management in different sectors.
4. Solve the industrial energy management and control issues.
5. Solve the problems in different utilities individually.

3EE83: INSTALLATION AND COMMISSIONING OF ELECTRICAL EQUIPMENT CREDITS - 3 (LTP:3,0,0)

Course Objective:

It is required to carry out/supervise installation, commissioning and maintenance of various electrical equipment in power stations, substations and industry. This course will enable the students to understand the concepts, principles and acquire basic skills of installation, commissioning and maintenance of electrical equipment in power stations, substations and industry.

Teaching and Assessment Scheme:

Teaching Scheme (Hours per Week)			Credits	Assessment Scheme				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE	CE	ESE	CE	
3	0	0	3	60	40	--	---	100

Course Contents:

Unit No.	Topics	Teaching Hours
1	**Installation of Electrical Equipment:** Introduction unloading of electrical equipment at site, inspection storage foundation alignment of electrical machines, Tools/Instruments necessary for installation inspection, storage and handling of transformer, switchgear and induction motor preparation of technical report.	04
2	**Commissioning and Testing:** Tests before commissioning of electrical equipment; Electrical and Mechanical test, specific tests on – transformer, induction motor, alternator, need of gradually loading of various machines, tests to be performed after commissioning and before starting the machine, various instruments required for testing, commissioning of switchgear, test report on commissioning and test certificate of electrical equipment, preparations before commissioning of power transformer, commissioning-power transformer, three phase induction motor, transformer insulation oil: properties as per IS, sampling, testing and filtering/purifying, standard tests as per IS, measurement of insulation resistance of different equipment's/machines, methods of Drying the winding of electrical equipment's and its record, classification and measurement of insulation resistance, Polarization Index, appropriate insulation test for specific purpose	08
3	**Maintenance of Electrical Equipments:** General aspect of maintenance, classification, preventive maintenance-concept, classification, advantages, activities, functions of the maintenance department, breakdown maintenance-concept, advantages, activities reasons of failure of electrical equipment due to poor maintenance, factors for preparing maintenance schedule, frequency of maintenance, maintenance schedule of transformer below and above 1000kVA, maintenance schedule - induction motor, circuit breaker, overhead line, storage Battery, probable faults due to poor maintenance in transformer, induction motor, circuit breaker, overhead lines and battery	08
4	**Trouble Shooting:** Causes of fault in electrical equipment's, Internal and external Instruments and tools for trouble shooting, common troubles in electrical equipment – DC Machines, AC Machines, Transformers, Circuit-breaker, underground cable, electrical installation, need of trouble shooting chart, advantages, trouble shooting chart – DC Motor, DC Generator, Transformer, Synchronous Motor, Induction Motor, Circuit-breaker, troubleshooting chart for Domestic appliances- electrical iron, ceiling fan, Washing machine, Air cooler, Vacuum cleaner Fluorescent tube light: Construction, working and troubleshooting chart.	06
5	**Earthing:** Necessity of earthing, system earthing; advantage of neutral earthing of generator in power station, equipment earthing: Objective Types of earth electrodes, Methods of earthing; plate earthing, pipe earthing and coil earthing, Earthing in extra high voltage and underground cable Earthing resistance, factor affecting Determination of maximum permissible resistance of the earthing system, measurement of earth resistance: voltmeter-ammeter method, earth tester method, ohm meter method and earth loop tester method Earthing, grounding and bonding, Comparison between equipment earthing and system grounding Earthing procedure – Building installation, Domestic appliances, Industrial premises Earthing in substation, generating station and overhead line	06

Unit No.	Topics	Teaching Hours
6	**Electrical Accidents and Safety:** Causes of electrical accidents, Factors affecting the severity of electrical shock, Actions to be taken when a person gets attached to live part, Safety regulations and safety measures, Indian electricity supply act 1948- 1956, Factory act 1948, Procedure of shut down for substation and power lines, Permit to work : certificate of (i)requisition for shut down(ii) Permit to work and (iii) Line clear certificate Instruction for the safety of persons working on a job with a permit to work, Fire extinguishers- For fixed installation and portable devices	04
	Total	**36**

List of References:

1. Rao, S., "Testing, commissioning, operation and maintenance of electrical equipment", 6/E., Khanna Publishers, New Delhi
2. Ramesh. L, Chakrasali, "Testing & Commissioning of Electrical Equipment", Prism Books Pvt. Ltd., 2014.
3. Paul Gill, "Electrical power equipment maintenance and testing", CRC Press, 2008.
4. Singh Tarlok,"Installation, commissioning and maintenance of Electrical Equipment's. K. Kataria and Sons, New Delhi,
5. Philip Kismet, "Electrical Equipment Handbook: Troubleshooting and Maintenance", McGraw- Hill, 2003.
6. Relevant Indian Standards (IS Code) and IEEE Standards for-Installation, maintenance and commissioning of electrical equipment/machines.

Course Outcomes (COs):

After learning the course, the students will be able to

1. Installation of Electrical Equipment's
2. Perform commissioning and testing of electrical equipment's
3. Preparation of maintenance schedule of different equipment and machines
4. Trouble shooting chart for various electrical equipment, machines and domestic appliances
5. Procedure of different types of earthling for different types of electrical installations
6. To become familiar about electrical safety regulations and rules during maintenance.

3EL81: ELECTRONICS COMMUNICATION SYSTEM
CREDITS - 3 (LTP: 3,0,0)

Course Objective:

1. To introduce the basic principles and techniques used in Electronic Communications, Digital modulation techniques, Cellular Technology.

2. To introduce fundamental of networking, LAN, Wireless technologies and advance Communication systems.

Teaching and Assessment Scheme:

Teaching Scheme (Hours per Week)			Credits	Assessment Scheme				
L	T	P	C	Theory Marks		Practical Marks		Total Marks
				ESE	CE	ESE	CE	
3	0	0	3	60	40	00	00	100

Course Contents:

Unit No.	Topics	Teaching Hours
1.	**Introduction to Electronic Communication:** The Significance of Human Communication, Communication Systems, Types of Electronic Communication, Modulation and Multiplexing, The Electromagnetic Spectrum, Bandwidth.	06
2.	**Digital Communication Techniques:** Digital Transmission of Data, Parallel and Serial Transmission, Data Conversion, Pulse Modulation, Digital Signal Processing.	07
3.	**Fundamentals of Networking and LAN and Ethernet:** Network Fundamentals, LAN Hardware, Ethernet LANs, Advanced Ethernet.	06
4.	**Cell Phone Technologies:** Cellular Telephone Systems, A Cellular Industry Overview, 2G and 3G Digital Cell Phone Systems, Long Term Evolution and 4G Cellular Systems , Base Stations and Small Cells.	08
5.	**Wireless Technologies :** Wireless LAN, PANs and Bluetooth, Zigbee, WiMAX and Wireless MetropolitanArea Networks, Infrared Wireless, Ultra wideband, Additional wireless application.	08
6.	**Satellite and Optical Communications:** Satellite orbits, Satellite Communication Systems, Satellite Subsystems, Satellite Applications, Global Navigations Satellite Systems (GNSS), Optical Principals, Optical Communication System, Fiber Optic Cables, and Wave Division Multiplexing Technique.	10
	Total	**45**

List of References:

1. Louis E. Frenzel Jr.,"*Principles of Electronic Communication Systems*", Tata Mc-Graw Hill.
2. Frenzel., "*Communication electronics, principles and applications*", Tata Mc-Graw Hill.
3. George Kennedy, Bernard Davis, SRM Prasanna, "*Electronic Communication Systems*", Tata McGraw-Hill .
4. Behrouz A Forouzan, "*Data Communications and Networking*", Tata Mc-Graw Hill.

Course Outcomes (COs):

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

1. Understand the basic concept Communication system.
2. Apply network fundamentals for LAN and Ethernet.

3. Analyze Cellular Technologies.

4. Analyze advance communication systems.

3EC81: INTRODUCTION TO CELLULAR COMMUNICATION
CREDITS - 3 (LTP: 3,0,0)

Course Objective:
To understand the concept of mobile communication, frequency reuse, wireless model, GSM & CDMA network, various wireless protocols & its applications related to mobile communication.

Teaching and Assessment Scheme:

Teaching Scheme (Hours per Week)			Credits	Assessment Scheme				
L	T	P	C	Theory Marks		Practical Marks		Total Marks
				ESE	CE	ESE	CE	
3	0	0	3	60	40	00	00	100

Course Contents:

Unit No.	Topics	Teaching Hours
1.	**Evolution of Mobile Communication Systems :** Introduction-base station, mobile station, MSC, forward and reverse channel, control channel, Paging system, Cordless telephone system, Cellular telephone system, Advantages and disadvantages of mobile communications, Comparison of wireless systems, applications of wireless communications.	04
2.	**Cellular Concept – System Design Fundamentals :** Introduction, frequency reuse, channel assignment strategies, handoff strategies, umbrella cell concept, interference and system capacity, co-channel and adjacent channel interference, cell splitting, sectoring, microcell zone concept.	06
3.	**Mobile Communication Engineering :** Introduction, Radio paths, Propagation attenuation, Basic propagation mechanisms, mobile radio channel, simulation of wireless fading channels, free space propagation model, outdoor propagation model.	08
4.	**GSM & CDMA Systems :** GSM network architecture, GSM signaling protocol architecture, Identifier used in GSM systems, GSM speech coding, authentication and security in GSM, GSM call procedures, GSM handoff procedures, GSM services and features, Concept of spread spectrum, CDMA architecture.	12
5.	**3G and 4G Digital Mobile Technology :** 2.5G TDMA evolution path, GPRS technology, EDGE technology, 2.5G CDMA technology, Need of 3G and 4G mobile networks, IMT-2000 Global standards, UMTS technology, W-CDMA air interface, TD-SCDMA technology, CDMA 2000 technology. 4G-LTE.	09

Unit No.	Topics	Teaching Hours
6.	**Emerging Wireless Network Technologies :** IEEE 802.11 WLAN technology, IEEE 802.15 WPAN technology, IEEE 802.16 WMAN technology, Mobile adhoc networks (MANETs), Wireless sensor networks, RFID technology, IEEE 802.21 standards overview, Case studies of latest wireless technologies.	06
	Total	**45**

List of References:

1. T. L. Singal, *"Wireless Communications"*, Tata McGraw Hill , 2nd Edition, 2011.
2. T. S. Rappaport, *"Wireless Communications: Principles and practice"*, Pearson, 2nd Edition, 2010.
3. A. Goldsmith, "*Wireless Communications*", Cambridge university press, 1st Edition, 2005.
4. B. Razavi, "*RF Microelectronics",* Prentice Hall, 1st Edition, 1998.
5. W.C.Y. Lee, *"Mobile Communications Engineering"*, McGraw Hill Telecomm., 2nd Edition, 1998.

Course Outcomes (COs) :

By learning this course students will be able to …

1. Understand the basics of mobile communication systems.
2. Design the cellular system and improve the coverage and capacity of system.
3. Analyze and design the various mobile propagation model.
4. Design GSM and CDMA wireless networks.
5. Study the 3G and 4G digital mobile technology.
6. Compare the recent emerging protocol of wireless communication system.

3EC82: APPLIED ELECTRONICS
CREDITS - 3 (LTP: 3,0,0)

Course Objective:

The basics of applications based electronics fundamentals are covered for the students of different braches other than electronics and communication.

Teaching and Assessment Scheme:

Teaching Scheme (Hours per Week)			Credits	Assessment Scheme				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE	CE	ESE	CE	
3	0	0	3	60	40	00	00	100

Course Content:

Unit No.	Topics	Teaching Hours
1.	**Operational Amplifiers :** Ideal operational amplifier, Operational amplifier Stages, Operational amplifier parameters, Equivalent circuit of op-amp, Ideal Voltage transfer Curve, Open-Loop Op-amp configurations, Closed-Loop op-amp configurations	06
2.	**555 Timer Circuits** : Block diagram, Use as Astable multivibrator and monostable multivibrator	04
3.	**Transducers :** Capacitive Transducer, Inductive Transducer, Linear Variable Differential Transformer, Oscillation Transducer, Potentiometric transducer, Electrical strain gauges, Resistance thermometer, Thermistor, Thermocouple, Piezoelectric Transducer, Photoelectric transducer	07
4.	**Introduction to Electronics Communication :** The significance of Human Communication, Communication systems, Types of Electronics Communication, Modulation and Multiplexing, The electromagnetic Spectrum, Bandwidth	06
5.	**Optoelectronic Devices :** Photoconductive sensors, Photovoltaic sensors, Photo emissive sensors, Light emitters, Liquid Crystal Display, Opto-coupler	07
6.	**Memories and Microcontroller :** Introduction to semiconductor memories, The AVR microcontrollers' history and features, AVR architecture ,AVR programming in C.	07
7.	**Consumer Electronics :** Washing machines (Electronic Controller, Fuzzy logic machines and automatic washing Machines), Audio systems, I-pods, RFID, Barcode Scanner and decoder, Photocopier machines, Introduction to organic electronics and internet of things (Industry 4.0)	08
	Total	**45**

List of References:

1. S Salivahanans, N Kumar, A Vallavaraj, "*Electronic devices and circuits*",2nd Edition, McGraw Hill,2008
2. Santiram KAL, "*Basic Electronics Devices, Circuits and its Fundamentals*",5th Edition, PHI Publication,2006
3. M.A. Mazidi,Sarmad Naimi,Sepehr Naimi, "*The AVR Microcontroller & Embedded Systems using Assembly and C*",1st Edition, Pearson Education,2011.
4. Louis E. Frenzel, "*Principles of Electonic Communication Systems*",3rd Edition, McGraw Hill Publication,2014
5. Alasdair Gilchrist, " *Industry 4.0* ", Apress, 2016

Course Outcomes (COs):

1. Understand the fundamental s of Operational amplifier and its applications.
2. Analyze and able to design sensor based applications.
3. Understand the Principles of Electronics Communication.
4. Understand and able to analyze Modern Communication systems and its applications.
5. Able to use of the CAD tools and programming of AVR on C platform.
6. Design and understands the various modern electronics based real time industrial applications.

3ME81: INDUSTRIAL ENGINEERING AND QUALITY ASSURANCE
CREDITS - 3 (LTP: 3,0,0)

Course Objective:

1. To select appropriate plant location and layout.
2. To apply the concept of productivity and work-study.
3. To understand different aspects of quality assurance and their applications.

Teaching and Assessment Scheme:

Teaching Scheme (Hours Per Week)			Credits	Assessment Scheme				
				Theory Marks		Practical Marks		Total Marks
L	T	P	C	ESE	CE	ESE	CE	
3	0	0	3	60	40	00	00	100

Course Content:

Unit No.	Topics	Teaching Hours
1	**Plant Location Selection and Layout:** Nature of location decision, Importance of plant location, Dynamic nature of plant location, Choice of site for selection, Comparison of location, types of plant layout and selection of layout, Quantitative methods of plant layout: CRAFT and CORELAP, Relationship diagrams, Principles factors governing flow pattern, travel chart.	08
2	**Productivity and Work Study:** Definition of productivity, application and advantages of productivity improvement tools, reasons for increase and decreases in productivity. Areas of application of work study in industry, Reaction of management and labor to work study. *Method Study:* Objectives and procedure for methods analysis, Recording techniques: String Diagram, Operations Process Chart, Flow Process Chart, Flow diagram, Man-Machine, Multiple Activity Chart, Travel Chart, and Two Handed process chart, Therbligs, Micro-motion and macro-motion study: Principles of motion economy, SIMO chart, Normal work areas and work place design. *Work Measurement:* Objectives, Work measurement techniques – time study, work sampling, pre-determined motion time standards (PMTS) Determination of time standards	12
3	**Job Evaluation and Wage Plan:** Objective, Methods of job evaluation, job evaluation procedure, merit rating (Performance appraisal), method of merit rating, wage and wage incentive plans, Non monitory incentives.	05
4	**Inspection and Statistical Quality Control:** Inspection – functions, types, objectives and benefits, quality control principles, Concepts of quality circles, Total quality management, PDCA cycle, concept of Zero Defect, Basic Concept ISO 9000, ISO 14000 and QS 9000, Six sigma: Concept, Principle, Methodology, Scope, Advantage and limitations. SQC Concept, variable and attributes, normal distribution curves and its property	10

	charts for variable and attributes and their applications and interpretation (analysis) process capability. Acceptance sampling, sampling plans, OC curves and AOQ curves Quality assurance, Quality audit.	
5	**Industrial Legislation:** Need for Industrial legislation, Factories act 1948, Industrial dispute act 1947, The Indian trade unions act 1926, Industrial employment act 1946, Payment of wage act 1936, Workmen compensation act 1923, Payment of bonus act 1965, Employees provident fund scheme 1952.	03
6	**Ergonomics:** Scope and objectives of ergonomics, Man-machine interface, anthropometry, Application of human factors in engineering, Work place design.	04
	Total	**42**

List of Reference:

1. Banga and Sharma, "*Industrial Engineering and Production Management"*, Khanna Publishers
2. Barnes, R.L., "*Motion and Time Study, Design & Measurement of Work"*, 7th edition, John Wiley & Sons, New York, 1980
3. Currie R.M, "*Work Study"*, 4th edition, ELBS & Pitman, London, 1977
4. M. Mahajan, "*Industrial Engineering and Production Management"*, 2nd edition, Dhanpat Rai & CO. (P) LTD, 2002.
5. M. Mahajan, "*Statistical Quality Control*", 3rd edition, Dhanpat Rai & CO. (P) LTD, 2002.
6. Martand Telsang, "*Industrial Engineering and Production Management"*, 2nd edition, S Chand & company, 2002.
7. International Labour Organisation (ILO), *"Introduction to Work study"*, Oxford and IBH Publishing.

Course Outcomes (COs):

At the end of this course students will be able to …

1. Select an appropriate plant location and develop optimized plant layout.
2. Apply the concepts of productivity and work-study.
3. Evaluate job and wage plans using different methods.
4. Analyze the concept of inspection and quality assurance to enhance productivity.
5. Understand industrial legislation.
6. Explain the concepts of ergonomics in designing of various products

3ME82: PROJECT MANAGEMENT
CREDITS - 3 (LTP: 3,0,0)

Course Objective:

To illustrate Project management practices

Teaching and Assessment Scheme:

Teaching Scheme (Hours per Week)			Credits	Assessment Scheme				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE	CE	ESE	CE	
3	0	0	3	60	40	0	0	100

Course Contents:

Unit No.	Topics	Teaching Hours
1	**Introduction to project management:** Project management vs general management, life cycle of projects, selection of projects to meet organizational goals. Types of Projects, Government Regulatory Framework, Market Analysis, Technical Analysis. **Management of the organization & the team**: the project manager's role, responsibilities; selection of a project manager, projects & organization.	08
2	**Planning the project:** The planning process, work break down structure, multidisciplinary teams. **Budgeting the project**: methods of budgeting, cost estimating & its improvement, budget uncertainty & risk management. Brief idea on Project Financing. Project cash flow, Financial estimates and Projections, cost of capital.	08
3	**Scheduling the project:** CPM & PERT networks, project uncertainty & risk management, Gantt chart, Use of computer aided tools for the analysis.	08
4	**Allocating resources to the project:** Expediting a project, resource loading & levelling, allocating resources to projects, Goldratt's critical chain.	08
5	**Monitoring & controlling the project:** The plan-monitor-control cycle, data collecting and reporting, earned value, project control, designing the control system, scope creep & change control.	05
6	**Project Execution**. Various phases of project execution, Timely execution of project, various statutory approvals, OH & S (Occupational Health and Safety) aspects during project execution, Case Study **Evaluating & terminating the project:** Evaluation, project auditing, and project termination. Project quality assurance.	05
	Total	**42**

List of References:

5. Samuel J Mantel Jr., Jack R Meredith, Scott M Shafer, Margaret M Sutton, M R Gopalan, "*Project Management*", Wiley India Pvt. Ltd.
6. Eliyahu M. Goldratt, "*Critical Chain: A Business Novel*", North River Press 1997.
7. Dr. B. C. Punmia, K. K. Khandelwal "*Project Planning and Control with PERT and CPM*", Laxmi Publication (P) Ltd.
8. Chandra Prasanaa, "*Projects-Planning analysis, Selection, Implementation and Review"* –Tata Mcgrow-Hill-

Course Outcomes (COs):

At the end of this course students will be able to …

1. Appraise project manager's role
2. Apply the concepts of project planning and budgeting
3. Apply the concepts of scheduling of projects
4. Apply the concepts of allocation of resources to projects
5. Apply methods of monitoring of projects
6. Appraise how to evaluate and terminate projects

3PE81: PRINCIPLES OF SUPPLY CHAIN MANGEMENT
CREDITS – 3 (LTP: 3,0,0)

Course Objective:

To develpoe skills to set analyze an individual corporation's current supply chain practices, to compare those with best industry practices and provide a road-map for improvement.

Teaching and Assessment Scheme:

Teaching Scheme (Hours per Week)			Credits	Assessment Scheme				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE	CE	ESE	CE	
3	0	0	3	60	40	00	00	100

Course Contents:

Unit No.	Topics	Teaching Hours
1	**Introduction to Supply Chain Management:** Definition of Supply Chain, Objectives of Supply Chain, Supply Chain principles, building blocks of a supply chain network, Types of supply chains, Supply Chain as a source of competitive advantage, business processes in supply chains. Strategic, tactical, and operational decisions in supply chains, supply chain design issues, role and importance of Supply Chain Management, Supply Chain Management methodology. Functional view of Supply Chain Management.	07
2	**Supply Chain Drivers and Metrics:** Drivers of Supply Chain Performance, Framework for Structuring Drivers, Facilities, Inventory, Transportation, Information, Sourcing, Pricing, Obstacles to Achieving Fit	04
3	**Designing Distribution Networks & Network Design in the Supply Chain:** The Role of Distribution in the Supply Chain, Factors Influencing Distribution Network Design, Design Options for a Distribution Network. The Role of Network Design in the Supply Chain, Factors Influencing Network Design Decisions, Framework for Network Design Decisions, Models for Facility Location and Capacity Allocation	09
4	**Coordination in Supply Chain:** Role and importance of Supply Chain Coordination, Coordinating procurement, Coordinating pricing decision, coordinating process and product design, coordination for reduced sourcing, vendor development and supplier partnership, Business cycle ownership with Supply Chain Management, Supply Chain integration through push-pull mechanism, Bullwhip Effect. Lack of Supply Chain Coordination ,The Effect on Performance of Lack of Coordination, Obstacles to Coordination in a Supply Chain, Managerial Levers to Achieve Coordination, Building Strategic Partnerships and Trust Within a Supply Chain, Continuous Replenishment and Vendor-Managed Inventories, Collaborative Planning,	09

Unit No.	Topics	Teaching Hours
5	**Supply Chain Globalization & IT Enablement of Supply Chains** The impact of Globalization, enterprise globalization strategies, the global integrated enterprise, requirements and challenges, operational differences, potential hidden costs and total cost strategy. Role of ICT in Supply chains, ICT tools: Information Technology in a supply chain, Upcoming use of Cloud computing, RFID, Use of Telecommunication,e-Procurement,B2B & B2C end of supply chains,Impact of Lead time,Concpet of Block chain.	09
6	**Supply Chain Management Performance Measures:** Performance Measurement of Supply Chain Management, Traditional and Contemporary approaches (Supply Chain Operation Reference Model (SCOR), Performance Benchmarking, Balance Score Card**)**	04
	Total	**42**

List of References:

1. Ronald Ballou, "*Supply Chain Management*", Pearson Education.
2. Sunil Sharma, "*Supply Chain Management – Concepts, Practice & Implementation*", Oxford University Press.
3. N. Chandrasekaran, "*Supply Chain Management – Process, Systems and Practice*", Oxford University Press.
4. David Simchi Levi, Philip Kaminsky, Edith Simchi Levi, "*Designing and Managing the Supply Chain*", Tata McGraw Hill.
5. Blanchard, B.S., "*Logistics Engineering & Management",* Prentice Hall, New Jersey, 1997
6. Sunil Chopra and Peter Menidl, "*Supply Chain Management- Strategy Planning and Operations"*, Prentice Hall, 2001.
7. Manish Govil and Jean Marie Prop, "*Supply Chain Design and Management: Statistical and Tactical Perspectives*", Academic Press, San Diego.
8. Sridhar Tayur, Ram Ganeshan and Micheal Magazine, "*Quantitative Models for Supply Chain Management",* Kluwer Academic Publishers, 2002.
9. R.P. Mohanty and S. G. Deshmukh, "*Supply Chain Management Theories and Practices (Set)",* Biztantra Publication.
10. Janat Shah, "*Supply Chain Management",* Pearson Education.
11. Joel Wisner, G. Keong, "*Principles of Supply Chain Management*", Cengage Learning.

Course Outcomes (COs):

At the end of this course students will be able to …

1. Understand the effect of supply chain on business operations
2. Apply theory and practices to the design and management of supply chains
3. Able to create basic supply network distribution models.
4. Know the world class best practices being carried out in supply chain management.
5. Apply concepts and activities of the supply chain to actual organizations.

3PE82: INDUSTRIAL INTERNET OF THINGS
CREDITS – 3 (LTP: 3,0,0)

Course Objective:

1. To familiarize with Industrial Internet of things for planning to embark in the industrial sector.
2. Introduce the tools and techniques that enable IoT solution and Security aspects

Teaching and Assessment Scheme:

Teaching Scheme (Hours per Week)			Credits	Assessment Scheme				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE	CE	ESE	CE	
3	0	0	3	60	40	00	00	100

Course Contents:

Unit No.	Topics	Teaching Hours
1	**Introduction to Industrial Internet of Things (IIoT):** Introduction to IOT and IIOT, History of IIOT, Components of IIOT - IOT Market, Trends& future Real life examples, Key terms – IOT Platform, Role of IIOT in Manufacturing Processes Use of IIOT in plant maintenance practices, Sustainability through Business excellence tools Challenges & Benefits in implementing IIOT, Scope, History, Vertical and Business Process areas, Importance of building Ecosystems, IIoT Value Chain – who does what? Industry 4.0: Globalization and Emerging Issues, The Fourth Revolution, LEAN Production Systems, Smart and Connected Business Perspective, Smart Factories.	10
2	**Introduction: Sensing & actuation, Communication and Networking Sensor and Interfacing** Introduction to Sensors, Transducers, Classification, Roles of sensors in IIOT, Various types of Sensors, Design of sensors, Sensor architecture, special requirements for IIOT sensors, Role of actuators, types of actuators, Interface, Networks, People &Process, Hype cycle, API, clouds, Data Management Analytics, Mining & Manipulation. Hardwire the sensors with different protocols such as HART, MODBUS-Serial & Parallel, Ethernet, BACNet , Current, M2M etc.	12
3	**Basics of Industrial IoT: Industrial Processes, Industrial Internet Systems** Internet of Things Applications: Smart Metering, e-Health Body Area Networks, City Automation, Automotive Applications, Home Automation, Smart Cards, Plant Automation, Real life examples of IIOT in Manufacturing Sector, Industrial IoT- Application Domains: Factories and Assembly Line, Food Industry, Power Plants, Inventory Management & Quality Control	10
4	**Industrial IoT: Data Analytics and Networking :** IOT Analytics: Role of Analytics in IOT, Data visualization Techniques, Machine Learning and Data Science – data management, Programming, Introduction to R Programming, Statistical Methods., Plant Safety and Security (Including AR and VR safety applications), Facility Management, Case studies, Privacy, Security and Governance. Advances in IoT.	10
	Total	**42**

List of References:

1. Daniel Minoli, *"Building the Internet of Things with IPv6 and MIPv6: The Evolving World of M2M Communications"*, ISBN: 978-1-118-47347-4, Willy Publications.
2. Michahelles, "*Architecting the Internet of Things",* ISBN 978-3- 642-19156-5 e-ISBN 978-3-642-19157-2, Springer.

3. Hakima Chaouchi, "The Internet of Things Connecting Objects to the Web" ISBN : 978-1-84821-140-7, Willy Publications.
4. Olivier Hersent, David Boswarthick, Omar Elloumi, "*The Internet of Things: Key Applications and Protocols",* ISBN: 978-1-119-99435-0, 2nd Edition, Willy Publications
5. Ovidiu & Peter; "*Internet of Things- From Research and Innovation to Market Deployment",* River Publishers Series

Course Outcomes (COs):

At the end of this course students will be able to …

1. Describe IOT, IIOT, Understand, design and develop the real life IoT applications.
2. Understand need of various hardware and software, IoT Layers and their relative importance
3. Study various IoT platforms and Security and Realize the importance of Data Analytics in IoT
4. Understand the concepts of Design Thinking.

3EE09: CONTROL SYSTEMS
CREDITS - 3 (LTP: 3,0,0)

Course Objectives:

1. The course objective is to help learn the students about the knowledge of **f**undamentals of classical and advanced control techniques.
2. To learn the mathematical modelling of real time physical systems and also do analysis and behaviour of system in time and frequency domain.

Teaching and Assessment Scheme:

Teaching Scheme (Hours per Week)			Credits	Assessment Scheme				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE	CE	ESE	CE	
3	0	0	3	60	40	00	00	100

Course Content:

Unit No.	Topics	Teaching Hours
1	**Introduction to Control Systems and its Importance:** Basic concepts of a control system, open loop, close loop, Classification of control systems, Types of control system, Feedback control systems, Effect of feedback on control system performance, Examples of control systems applications, Industrial Control examples	06
2	**Mathematical Modeling of Physical Systems:** Differential equations of physical systems, Transfer function models of linear time-invariant systems, Mechanical systems modeling, Fluid and thermal systems, Analogous systems(F-V & F-I), Block diagram reduction technique, Mason's gain formula, Modelling of DC motors, AC and DC servo motors.	08
3	**Time Response Analysis:** Standard test signals, time response of first and second order systems for standard test inputs, steady state error and static error constants, application of initial and final value theorem, design specifications for second-order systems based on the time-response, effect of adding poles and zeros on	08

Unit No.	Topics	Teaching Hours
	control system performance, concept of stability, necessary condition for stability, Absolute and relative stability, Routh Hurwitz stability criteria, Root Locus: basic properties of root locus, Construction of root locus, Understanding the usefulness of root locus.	
4	**Frequency-Response Analysis:** Relationship between time and frequency response, Polar plots, Bode plots, Nyquist stability criterion, Relative stability using Nyquist criterion – gain and phase margin, closed-loop frequency response	08
5	**Introduction to Controller Design:** Concepts and application of Proportional, Integral and Derivative Controllers, Tuning of PID controllers, Lead and Lag compensation in designs. Stability, steady-state accuracy, transient accuracy, disturbance rejection, insensitivity and robustness of control systems, Analog and Digital implementation of controllers	06
6	**State variable Analysis:** Concepts of state variables. State space model. Diagonalization of State Matrix. Solution of state equations. Eigenvalues and Stability Analysis. Concept of controllability and observability, Pole-placement by state feedback.	06
	Total	**42**

List of References:

1. M. Gopal, "*Control Systems: Principles and Design*", 4th Edition, McGraw Hill Education, 2014.
2. Norman Nise. "*Control System Engineering*", 6th Edition, John Wiley and Sons, 2011.
3. I. J. Nagrath and M. Gopal, "*Control Systems Engineering*", 4th Edition, New Age International, 2009
4. B. C. Kuo, "*Automatic Control System*", 3rd Edition, Prentice Hall, 1995.
5. K. Ogata, "*Modern Control Engineering*, 3rd Edition Prentice Hall, 1997.
6. A. K. Tripathi, Dinesh Chandra, "*Control System Analysis and Design*", 1st Edition, New Age International, 2009

Web Resources:

1. NPTEL Video Course on PROF. C.S. SHANKAR RAM, IIT, Madras
   https://nptel.ac.in/courses/107106081/

Course Outcomes:

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

1. Analyse open loop and closed loop control systems.
2. Formulate and design mathematical model for physical systems
3. Apply standard test signals to investigate stability analysis of the systems.
4. Analyse performance characteristics of system using Frequency response methods.

3EE10: CONTROL SYSTEMS LABORATORY
CREDITS - 1 (LTP: 0,0,1)

Course Objective:

1. To help the students to understand and analyze the control system designs by conducting various hardware experiments.
2. To do simulation of various physical systems and its analysis and their by obtain the performance evaluation using various analysis software.

Teaching and Assessment Scheme:

Teaching Scheme (Hours per Week)			Credits	Assessment Scheme				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE	CE	ESE	CE	
0	0	2	1	-	-	40	60	100

List of Experiments:

Sr. No.	Suggested List of Experiments
1.	To perform and analyze control of torque speed characteristics of DC motor.
2.	To perform and analyze control of angular position of shaft of DC motor
3.	To perform and analyze speed control characteristics of DC motor
4.	To study configuration and evaluate the performance characteristics of feedback light intensity control
5.	To perform and analyze temperature control system of an oven
6.	To conduct the performance of small AC servomotor and determining transfer function
7.	To obtain the performance characteristics of synchro transmitter receiver pair
8.	To perform and analyze the ON/OFF controller
9.	Performance and analysis of open loop and closed loop systems with 1^{st} and 2^{nd} order
10.	Performance and evaluation of closed loop system with disturbance
11.	Performance and analysis of steady state error of a system
12.	Performance and analysis of Proportional(P), Integral(I) and Derivative(D) controllers
13.	Performance and analysis of performance of Proportional - Integral (PI) controller
14.	Performance and analysis of performance of Proportional-Derivative(PD) controller
15.	Performance and analysis of performance of PID controller
16.	Design, implementation of different cascade compensation networks to analyze the effects for a given system
17.	Modelling and analysis of mechanical systems in analysis software
18.	Comparison and analysis of response of electrical circuit and its equivalent transfer function with different standard inputs
19.	Analysis of Root locus technique using programing in analysis software
20.	Analysis of Bode plot technique using programing in analysis software

Sr. No.	Suggested List of Experiments
21.	Modelling and analysis of stability of linear feedback system

List of References:

1. Norman Nise. *"Control System Engineering",* 6th Edition, John Wiley and Sons, 2011.
2. J. Nagrath and M. Gopal, *"Control Systems Engineering",* 4th Edition, New Age International, 2009
3. S. Hasan Saeed, *"Automatic Control Systems with MATLAB Programs",* 9th Edition, S. K. Kataria and Sons, 2018.
4. Introduction to Control systems in scilab from Scilab-Xcos

Course Outcomes (COs):

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

1. To perform hardware based experiments on control system of various physical systems
2. Simulate, analyze and evaluate various physical systems and its controller in software
3. Design control system for given electrical and other engineering systems.
4. Simulate and analyze the performance of various electrical systems in time and frequency domain.

3EE11: POWER SYSTEMS - II
CREDITS - 3 (LTP: 3,0,0)

Course Objective:

To introduce the concept of power system analysis, stability, operation, and control. To introduce the concepts of power system restructuring and economics.

Teaching and Assessment Scheme:

Teaching Scheme (Hours per Week)			Credits	Assessment Scheme				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE	CE	ESE	CE	
3	0	0	3	60	40	00	00	100

Course Contents:

Unit No.	Topics	Teaching Hours
1	**Power Flow Analysis** Review of the structure of a Power System and its components. Analysis of Power Flows: Formation of Bus Admittance Matrix. Real and reactive power balance equations at a node. Load and Generator Specifications. Application of numerical methods for solution of non-linear algebraic equations – Gauss Seidel and Newton-Raphson methods for the solution of the power flow equations. Computational Issues in Large-scale Power Systems.	10

Unit No.	Topics	Teaching Hours
2	**Stability Constraints in synchronous grids** Swing Equations of a synchronous machine connected to an infinite bus. Power angle curve. Description of the phenomena of loss of synchronism in a single-machine infinite bus system following a disturbance like a three phase fault. Analysis using numerical integration of swing equations (using methods like Forward Euler, Runge- Kutta 4^{th} order methods), as well as the Equal Area Criterion. Impact of stability constraints on Power System Operation. Effect of generation rescheduling and series compensation of transmission lines on stability.	08
3	**Control of Frequency and Voltage** Turbines and Speed-Governors, Frequency dependence of loads, Droop Control and Power Sharing. Automatic Generation Control. Generation and absorption of reactive power by various components of a Power System. Excitation System Control in synchronous generators, Automatic Voltage Regulators. Shunt Compensators, Static VAR compensators and STATCOMs. Tap Changing Transformers. Power flow control using embedded dc links, phase shifters.	08
4	**Monitoring and Control** Overview of Energy Control Centre Functions: SCADA systems. Introduction to State-estimation. System Security Assessment. Normal, Alert, Emergency, Extremis states of a Power System. Contingency Analysis. Preventive Control and Emergency Control.	08
5	**Power System Economics and Management** Basic Pricing Principles: Generator Cost Curves, Economic Load Dispatch, Utility Functions, Power Exchanges, Spot Pricing. Electricity Market Models (Vertically Integrated, Purchasing Agency, Whole-sale competition, Retail Competition), Demand Side-management, Transmission and Distributions charges, Ancillary Services. Regulatory framework.	08
	Total	**42**

List of References:

1. D. P. Kothari and I. J. Nagrath, "*Modern Power System Analysis*", Fourth Edition, McGraw Hill Education, 2011.
2. B.R. Gupta, "*Power System Analysis and Design*", 6th Edition, S. Chand and Co., 2011
3. Hadi Saadat, "*Power System Analysis*" Fourth Edition, McGraw Hill Education, 2002.
4. P. Kundur, "*Power System Stability and Control*", Indian Edition, McGraw Hill Education, 1994.
5. Dr. K. Uma Rao, "*Power System Operation and Control*", Wiley India, 2013.
6. M. M. Tripathy, *"Restructured Power Systems and Electricity Market Forecasting*", Create space Independent Pub, 2015

Web Resources:

1. NPTEL Video course on Power System Generation Transmission Distribution - Prof. D. P. Kothari, IIT Delhi
   http://www.nptelvideos.in/2012/11/power-sys-generation-transmission.html
2. NPTEL Video Course on Power System Analysis – Prof. A. K. Sinha, IIT, Kharagpur
   http://nptel.ac.in/courses/108105067
3. NPTEL Webcourse on Power System Analysis – Prof. Arindam Ghosh, IIT, Kanpur
   https://nptel.ac.in/courses/108/104/108104051/#

4. NPTEL Webcourse on Restructured Power Systems – Dr. A. R. Abhyankar, IIT Delhi and Prof. S. A. Khaparde, IIT, Bombay
   https://nptel.ac.in/courses/108/101/108101005/
5. NPTEL Webcourse on Power System Operation and Control – Prof. A. M. Kulkarni, IIT, Bombay
   https://nptel.ac.in/courses/108/101/108101040/

Course Outcomes (COs):

At the end of this course students will be able to …

1. Apply the numerical methods like Gauss-Siedel and Newton Raphson to determine the power flow and bus parameters of a power system in steady-state.
2. Analyze the impact of stability constraints in a synchronous grid using Numerical
3. Integration methods and Equal-area criterion.
4. Understand the various methods of controlling the voltage, frequency and power flow in a power system.
5. Apply the concepts of monitoring and control of a power system through the hierarchical structure of Energy Control Centers.
6. Understand the basic pricing principles for economic load dispatch, power exchanges, and electricity market models.

3EE12: POWER SYSTEMS-II LABORATORY
CREDITS - 1 (LTP: 0,0,1)

Course Objective:

To study and analyze the performance of power system by carrying out various simulations using different power system analysis software. To identify & formulate solutions to problems relevant to power system using software tools.

Teaching and Assessment Scheme:

Teaching Scheme (Hours per Week)			Credits	Assessment Scheme				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE	CE	ESE	CE	
0	0	2	1	-	-	40	60	100

Experiment List:

Sr. No.	Suggested List of Experiments
1.	Algorithm Design and its Implementation for Bus Admittance Matrix
2.	Algorithm Design and its Implementation for Bus Impedance Matrix

Sr. No.	Suggested List of Experiments
3.	Study and Implementation of Gauss Seidel Method and Newton Raphson method for the solution of equations using MATLAB
4.	Load flow analysis using Gauss Seidel Method
5.	Load flow analysis using Newton Raphson Method
6.	Economic dispatch neglecting transmission line losses and no generator limits
7.	Economic dispatch neglecting transmission line losses and including generator limits
8.	Economic dispatch including transmission line losses and generator limits
9.	Transient stability analysis of a Single Machine Infinite Bus (SMIB) System and Multi machine power system
10.	Power system stability analysis using equal area criteria
11.	Simulation and Stability Analysis of Load Frequency Control (LFC) for given Power System
12.	Simulation and Stability Analysis of Automatic Generation Control (AGC) by modifying the Load Frequency Control (LFC) Transfer Function
13.	Technical visit to Load Dispatch Center.

List of References:

1. Scilab Textbook Companion for Power System Analysis And Design by B. R. Gupta, Sixth edition, S. Chand & Co., 2011 https://scilab.in/textbook_run/1076
2. Scilab Textbook Companion for Modern Power System Analysis by Nagrath and Kothari, 3rd Edition, Tata McGraw Hill, 2003 **https://scilab.in/textbook_run/1076**

Course Outcomes (COs):

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

1. Apply load flow analysis to an electrical power network and interpret the results of the analysis
2. Apply concept of economic load dispatch in a case-study of power system operation.
3. Simulate and analyze the transient and steady state stability of a single machine/infinite bus system using analytical and time simulation methods.

3EE13: INDUSTRIAL AUTOMATION AND CONTROL
CREDITS - 3 (LTP: 3,0,0)

Course Objectives:

1. Understand automation technologies and identify advantages, limitations and applications of the same.
2. Develop ability to recognize, articulate and solve industrial problems using automation technologies.

Teaching and Assessment Scheme:

Teaching Scheme (Hours per Week)	Credits	Assessment Scheme	Total Marks

L	T	P	C	Theory Marks		Practical Marks		
				ESE	CE	ESE	CE	
3	0	0	3	60	40	00	00	**100**

Course Contents:

Unit No.	Topics	Teaching Hours
1	**Programmable Logic Controller (PLC)** : An overview of PLC, Introduction, definitions and history of PLC, manufacturing and assembly processes, PLC advantages and disadvantages, overall PLC system, CPU, PLC, input and output modules, program recording devices, General programming procedure, Input and Output module interfacing, Relation of digital gate logic to contact / coil logic	6
2	**PLC Programming:** Creating ladder diagrams from process control descriptions, Basics of register.	7
3	**PLC Functions:** Timer function, Counter function, Arithmetic function, Number comparison functions, Numbering systems and number conversion function, Skip and Master control relay functions, Jump functions, PLC data move systems, Digital bit functions and applications, Sequencer function.	9
4	**Analog PLC operations:** Different PLC operations ,Applications of PLCs:Stepper motor control, Speed control of D.C. motor & Induction motor, Lift/Elevator control, Water level control, Traffic control, Temperature control.	6
5	**HMI:** Architecture, types and specifications, Interfacing and Networking With PLC. SCADA: Introduction, Features and Applications.	5
6	**Introduction to Distributed Control System:** DCS architecture, Communication Protocol.	4
7	**Introduction to Industry 4.0** History of industrial revolutions, Concept of IR4.0, Typical architecture of IR4.0, Design principles and major role players in IR4.0, Advantages and Challenges.	5
	Total	**42**

List of References:

1. John W. Webb, Ronald A. Reis, “Programmable Logic Controllers”, 5th Ed., PHI, 2012.
2. John R. Hackworth, Fredrick D. Hackworth Jr., “Programmable Logic Controllers:

Programming Methods and Applications", Pearson,
3. William Bolton, "Programmable Logic Controllers", 4th Edition, Elsevier.
4. L.A. Bryan and E. A. Bryan, "Programmable Controllers – Theory and implementation," Second edition, An Industrial text company publication, USA, 1997.
5. Richard L. Shell and Ernest L. Hall, "Handbook of industrial automation," CRC press 2000.

Web Resource:

Video Course on

"Industrial Automation & Control" by Prof Siddhartha Mukhopadhyay (IIT, KHARAGPUR) : https://nptel.ac.in/courses/108/105/108105088/

Course Outcomes (COs):

At the end of this course students will be able to:

1. Understand the basics of PLC programming.
2. Understand the different parameters of PLC.
3. Design different process control applications through ladder logic.
4. Analyze & Explain different functions of PLC.
5. **Build and experiment with PLC based SCADA systems for various industrial applications.**
6. **Implement HMI, Distributed Control System and Industry standard 4.0**

3EE14: INDUSTRIAL AUTOMATION AND CONTROL LABORATORY
CREDITS - 1 (LTP: 0,0,1)

Course Objective:

To facilitate students to be familiar with program logic and enabling to understand and develop solutions related to industrial problem for real time applications using automation software and hardware.

Teaching and Assessment Scheme:

Teaching Scheme (Hours per Week)			Credits	Assessment Scheme				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE	CE	ESE	CE	
0	0	2	1	00	00	40	60	100

List of Experiments:

Sr. No.	Suggested List of Experiments
1	Introduction to different PLC programming languages.
2	To develop digital circuits using ladder logic and Codesys software.
3	To demonstrate and control electrical machine parameters using Codesys software.
4	Introduction to Dynalog test bench.
5	To demonstrate set and Reset using Push Buttons.
6	To develop NOT, AND & OR logic using switches and indicators.

Sr. No.	Suggested List of Experiments
7	To develop NAND & NOR logic using switches and indicators.
8	To demonstrate use of PWM.
9	To develop traffic controller logic using ST 2401.
10	To develop water level controller logic using ST 2401.
11	To develop elevator controller logic using ST 2401.
12	To develop industrial control systems.
13	Industry Visit : Process Industry , Automation Industry

List of References:

1. John W. Webb, Ronald A. Reis, "Programmable Logic Controllers", 5th Ed., PHI, 2012.
2. John R. Hackworth, Fredrick D. Hackworth Jr., "Programmable Logic Controllers: Programming Methods and Applications", Pearson,
3. William Bolton, "Programmable Logic Controllers", 4th Edition, Elsevier.

Web Resources:

https://www.sanfoundry.com/100-plc-programming-examples/

Course Outcomes (COs):

At the end of this course students will be able to:

1. **Justify the need of automation softwares.**
2. Design and develop automation solutions for industrial applications.

3EE15: ELECTRICAL POWER UTILIZATION AND TRACTION
CREDITS - 3 (LTP: 3,0,0)

Course Objective:

The subject aims to provide the student of electrical engineering to understand of selection of drives for industrial application, the heating and welding methods for industrial application, concepts of electrolysis processes, illumination engineering and electric traction system.

Teaching and Assessment Scheme:

Teaching Scheme (Hours per Week)			Credits	Assessment Scheme				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE	CE	ESE	CE	
3	0	0	3	60	40	00	00	100

Course Contents:

Unit No.	Topics	Teaching Hours
1	**Electric Drives:** Introduction concept of electric drives, Classification of electric drives, Nature of load, Factors effecting selection of drive. Characteristics of different motors. Mechanical features of electric drive, Load equalization, Flywheel calculations, examples. Temperatures rise of electric drives, heating and cooling curves,	10

Unit No.	Topics	Teaching Hours
	Standard ratings of motors, Examples Applications of electric drives and selection of drives for particular service, Conservation approach to be considered. Energy efficient drives.	
2	**Electrical Heating:** Advantages of electric heating, Modes of transfer of heat, Classification of electric heating methods, Resistances heating methods, Requirements of heating elements, Design of heating elements, Methods of temperature control, Problems, Induction heating: principle, types of induction furnaces, Direct core type, Vertical core type, Indirect core type, Core less type, Advantages and disadvantages, eddy current heating, Applications examples., Arc-furnace: principle, Types, direct and indirect arc furnaces, Power supply and control, Condition for maximum output, Examples., Dielectric heating: principles, advantages and disadvantages, Applications, Choice of frequency, Examples.	08
3	**Electric Welding:** Different types of resistance and arc welding. Electric welding equipment, Comparison between AC and DC Welding.	02
4	**Electrolytic Process:** Principle, Faraday's laws of electrolysis, Current efficiency, Energy efficiency etc., Rating of metals, Production of chemicals, Electro-deposition, Electroplating, Power supply for electrolytic processes.	04
5	**Illumination:** Nature of light, Definitions, Laws of illumination, Design of lighting scheme, methods of lighting, Calculations, examples., Flood lighting, Factory lighting and street lighting, Examples. Advanced Light Sources: LEDs, electrical and optical properties, energy saving potential, LED drivers, intensity control technique, LEDs in communications, remote control Utility services for large building/office complex. Selection of cable/wire sizes; wiring, switching and control circuits. Conservation approach to be considered.	06
6	**Electrical Traction**: Introductions, Different traction systems, Various systems of electric traction. Locomotives, Tramways, trolleys, Track electrification, Comparison between A.C and D.C systems of railway electrification, Types of speed and speed-time curves, Examples. Mechanics of train movement, Tractive effort, power, Output, examples., Energy output from driving axles, Energy output using simplified speed-time curves, Examples, Factors affecting energy consumption, dead weight, accelerating weight, Adhesion weight, examples., Traction motors and their characteristics, Starting and speed control of D.C series and shunt motors, Examples, Starting and speed control of A.C. series and 3-phase induction motors, Braking of traction motors and mechanical considerations, Conservation approach to be considered. Modern three phase electric locomotive, Block Diagram, advantages.	12
	Total	**42**

List of References:

1. J. B. Gupta, "Utilization of Electrical Power and Electric Traction", S. K. Kataria & Sons, 2002.
2. H. Partab, "Art And Science of Utilization of Electrical Energy" , Dhanpat Rai & Co, 2017.

3. G. C .Garg, “Utilization of Electrical Power and Electric Traction”, Khanna Publishers.
4. Soni, Gupta, Bhatnagar, “A course in Electrical Power”, Dhanpat Rai & Sons.
5. S. L. Uppal, “Electrical Power”, Khanna Publishers.
6. Wadhwa. C.L. “Generation, Distribution and Utilization of Electrical Energy”, Third Edition, New Age International Pvt Ltd.

Web Resources:

1. The National Academy of Indian Railways/Study Materials
www.nair.indianrailways.gov.in
2. Indian Railways Service of Electrical Engineers (IRSEE)/Lecture Note
http://www.irieen.indianrailways.gov.in

Course Outcomes (COs):

At the end of this course students will be able:

1. To interpret the working and applications of various devices used by industry for effective utilization of electrical power.
2. To acquire the knowledge regarding the fundamentals and elementary design aspects of illumination, heating and welding.
3. To practice the fundamentals of electrolytic processes and illumination engineering.
4. To address the underlying concepts of electrical traction drives.

3EE31: ELECTRONICS DESIGN LABORATORY (MINI PROJECT)
CREDITS - 2 (LTP: 0,0,2)

Course Objective:

To make familiar with practical aspects of the electrical and electronics components and instruments. Theoretical and practical hands-on training to design and develop the electrical circuits, power electronic components, embedded systems and control strategies for future projects.

Teaching and Assessment Scheme:

Teaching Scheme (Hours per Week)			Credits	Assessment Scheme				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE	CE	ESE	CE	
0	0	4	2	-	-	40	60	100

Course Content:

Unit No.	Topics	Teaching Hours.
1	**PCB Design Basics:** Introduction of e-Sim software, Different electronic circuits simulation in Proteus: AC voltage regulator, Cyclo-converter, Triggering circuits for Different semiconductor switches (Thyristor, Triac, IGBT, MOSFET) etc.	5
2	**Hardware Design Basics:** Hardware of Triggering circuit for thyristor or Triac with and without isolation. Output waveform analysis on Oscilloscope or DSO, Knowledge of isolation and its requirement.	2

Unit No.	Topics	Teaching Hours.
3	**Introduction and application of Arduino Kit:** Basic Programming of Arduino in IDE, Voltage measurement and current measurement using sensors, Hall effect sensor and connection with Arduino (RPM measurement), Interfacing of Arduino with MATLAB software, PWM pulse generation in Arduino using MATLAB interface.	3
4	**Control Techniques and Tools:** STM 32 studio and ARM controller basics and applications, Demonstration of inverter circuit on IGBT Learning Module. Introduction to Raspberry Pi and IOT (Internet of Things)	5
5	**Guidelines for Project**	1
	Total	**14**

List of References:

1. Shibu K. V., "*Introduction to Embedded Systems*" , Tata McGraw-Hill Education,
2. John Markus, "*Electronic Circuit Manual*", McGraw Hill Education.
3. B. Venkatramani, "*Digital Signal Processors, Architecture, programming and applications*", Tata McGraw Hill Education
4. Paul B. Zbar, "*Industrial Electronics: A Text book Manual*", Second Edition, Tata McGraw-Hill Education
5. M. Ramamoorty, "*An Introduction to Thyristors and Their Applications*", Second Edition, Affiliated East-West Press

Web Resources:

1. Free/Libre and Open Source Software for Education Project
   https://fossee.in/
2. Scilab-Arduino Project (FOSSEE)
   https://scilab-arduino.fossee.in/
3. eSim Textbook Companion Project
   https://esim.fossee.in/completed_books
4. eSim Spoken Tutorials Project
   https://spoken-tutorial.org/tutorial-search/?search_foss=eSim&search_language=English

Course Outcomes (COs):

At the end of this course students will demonstrate the ability

1. To design and develop the printed circuit boards using simulation tools.
2. To understand the hardware connections and control techniques for different power electronic circuits
3. To understand the hardware and programming for Arduino kits for Embedded Systems.
4. To integrate various hardware design tools to develop a mini-project.

3CE82: GEOINFORMATICS
CREDITS - 4 (LTP: 3,0,1)

Course Objective:

1. Learn basics of optical remote sensing for mapping the earth surface.
2. Understand thematic mapping using GIS.
3. Study to map location of various objects on the surface of earth.

Teaching and Assessment Scheme:

Teaching Scheme (Hours per Week)			Credits	Assessment Scheme				
L	T	P	C	Theory Marks		Practical Marks		Total Marks
				ESE	CE	ESE	CE	
3	0	2	4	60	40	20	30	150

Course Contents:

Unit No.	Topics	Teaching Hours
1	**Introduction:** Remote sensing systems, multi concept of remote sensing, Remote sensing in India, GIS: Basic Concepts, Basic concept of Positioning and Mapping, Positioning Using Satellites, Concept of Regional and Global Navigation Satellite System.	05
2	**Electromagnetic radiation:** Introduction: EM radiation, EM Spectrum and Wavelength useful for remote sensing, Energy interaction in the atmosphere, Energy interaction with earth surface feature, Resolution: Spatial, Spectral, Radiometric and Temporal.	05
3	**Sensors and platforms:** Classification: Land observation satellites, high resolution sensors, and Satellite data products: Introduction, data reception, transmission and processing of Remote sensing data products and Digital data products.	05
4	**Image interpretation & Digital image processing:** Procedure and elements of visual interpretation, interpretation keys. Overview of digital analysis steps, Image atmospheric correction, Image geo-referencing and resampling. Image contrast enhancement, Image filtering: Low-pass and High-pass filters, Image transformation: PCT, Supervised Classification, Unsupervised Classification and Accuracy Assessment.	10
5	**Geographical Information System (GIS):** Definitions, Key Components and Functions of GIS, Spatial data and its structures, Attribute data for GIS, Geospatial Analysis: Spatial interpolation, Surface analysis, Network analysis and Integration of Remote Sensing and GIS.	10
6	**Global Navigation Satellite System (GNSS):** Global Positioning System (GPS-United States): Introduction and Three Segments of GPS, GPS Positioning Techniques, Surveying Using GPS and Mapping Using GPS. Introduction to GLONASS (Russia), Galelio (European Union), BeiDuo (China) and IRNSS (India).	05
7	**Applications of Geoinformatics in Utility Management** Applications in Utility management of Electricity, Gas sector, Telecommunication, Water supply and waste water collection utility sector.	05
	Total	**45**

List of References:

1. Bhatta B., "*Remote Sensing and GIS*", Oxford University Press, New Delhi. ISBN: 9780198085423, 2011.
2. Chandra A.M. and Ghosh S.K., "*Remote Sensing and Geographical Information System*", Narosa Publishing House, New Delhi. ISBN: 978-1842652788, 2006.

3. Joseph G. and C. Jeganathan, "*Fundamentals of Remote Sensing",* University Press, Hyderabad. ISBN: 9788173715358, 2018.
4. Kang-tsung Chang, "*Introduction to Geographic Information Systems*", McGraw-Hill Education, 4th edition, ISBN: 9780070658981, 2017.
5. Lillesand T.M., Kiefer R.W. and Chipman J.W., "*Remote Sensing and Image Interpretation*", 5th edition, John Wiley and Sons, India, ISBN: 978-8126513352, 2011.
6. Richards J.A. and Xiuping Jia, "*Remote sensing digital image analysis: An Introduction*" 4th edition, Springer, 1999, ISBN: 9788181288660.
7. Rao G.S., "*Global Navigation Satellite System*", Tata McGraw-Hill Education Pvt. Ltd., New Delhi, ISBN: 978-0070700291, 2010.

Course Outcomes (COs):

At the end of this course students will be able to …

1. Apply up-to-date information of optical remote sensing to map surface of earth.
2. Ability to develop various thematic maps.
3. Use Geoinformatics for location based mapping and monitoring.
4. Understand to apply Geoinfromatics to solve problems related with utility sector.

3SE82: ADVANCED STRENGTH OF MATERIALS
CREDITS – 4 (LTP: 3,0,1)

Course Objectives:

1. To impart knowledge of analysis for structural elements.
2. To explain various theories of failure.

Teaching and Assessment Scheme:

Teaching Scheme (Hours per Week)			Credits	Assessment Scheme				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE	CE	ESE	CE	150
03	00	02	04	60	40	20	30	

Course Contents:

Unit No.	Topics	Teaching Hours
1	**Strain energy:** Resilience, Proof resilience, modulus of resilience,Gradual, sudden and Impact loads, Energy of dilation and distortion, Castigliano's theorem, Maxwell's theorem of reciprocal deflection	9
2	**Stresses in Springs:** Leaf spring, deflection and bending stresses; open coiled helical springs; derivation of formula and application for deflection and rotation of free end under the action of axial load and/or axial couple; flat spiral springs – derivation of formula for strain energy, maximum stress and rotation	7

Unit No.	Topics	Teaching Hours
3	**Theories of Failure:** Maximum principal stress theory, maximum shear stress theory, Total strain energy theory, shear strain energy theory, graphical representation and derivation of equation for each and their applications.	7
4	**Bending of curved elements:** Calculation of stresses in crane or chain hooks, rings of circular section and trapezoidal section and chain links with straight sided	5
5	**Shear flow in elements:** Shear stress distribution in rectangular, circular,I,T and channel section and the compression with bending stresses, Shear flow in thin walled open sections, Determination of Shear centre, Derivation of equation of torsion, Assumptions, application of theory of torsion equation to solid & hollow circular shaft, torsional rigidity.	6
6	**Thick Cylinders:** Derivation of Lame's equations, calculation of radial longitudinal and hoop stresses and strains due to internal pressure in thick cylinders, compound cylinders, hub shrunk on solid shafts	5
7	**Rotational stresses:** Rotational stresses in discs and rims of uniform thickness; discs of uniform strength	6
	Total	**45**

List of References:

1. S. P. Timoshenko and D. H. Young, "*Elements of Strength of Materials*" East West Press.
2. GH Ryder, "Strength of Materials", MacMillan and Co.
3. R.S. Lehri and A.S. Lehri, "*Strength of Materials*", S.K Kataria and Sons
4. Advanced Soild Mechanics by LS Srinath, McGraw-Hill.
5. Introduction to Mechanics of Solids by Crandell, Dahl and Lardner, McGraw Hill
6. Advanced Mechanics of Materials by Fred B. Seely and James O. Smith
7. Fundamentals of Solid Mechanics (A Treatise on Strength of Materials) by M. L. Gambhir, PHI Learning pvt. Ltd.
8. Strength of Materials by R. K. Rajput, S. Chand Publisher.
9. Mechanics of Materials by Dr.Kirpal Singh, Standard Publishers & Distributors.

Course Outcomes (COs):

1. Apply the strain energy concept to structural elements.
2. Apply theories of failure in structural elements.
3. Analyze curved elements.
4. Analyze different stresses in thin walled sections, thick shells and rotating elements.

3SE83: BASIC CONCEPTS OF STRUCTURAL BEHAVIOUR
CREDITS – 4 (LTP: 3,0,1)

Course Objectives:

1. To impart the basic concepts of behaviour of different structures.
2. Introduction to Structural Analysis and Design criteria of structural elements.

Teaching and Assessment Scheme:

Teaching Scheme (Hours per Week)			Credits	Assessment Scheme				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE	CE	ESE	CE	
3	0	2	4	60	40	20	30	150

Course Contents:

Unit No.	Topics	Teaching Hours
1	**Structures and Overview:** Classification, Basic issues in analysis and design of structures. Types and selection of suitable structural system.	12
2	**Principles of Mechanics:** Internal forces and moments. Mechanical properties of building materials.	10
3	**Analysis and Design criteria:** Introduction to Structural Analysis and Design criteria of structural Elements like truss, Cable, arch, Beam, Column and Shell.	15
4	**Plate and Grid structures:** Introduction to plate and grid structures	08
	Total	**45**

List of References:

1. Daniel L.Schodek, "Structures", Prentice Hall
2. S. B. Junnarkar and H. J. Shah, "Applied Mechanics", Charotar Publishing House Pvt. Ltd.
3. S. B. Junnarkar and H. J. Shah, "Mechanics of Structure Vol. I", Charotar Publishing House Pvt. Ltd.
4. Popov E.V., "Engineering Mechanics of Solids" Prentice Hall of India, New Delhi.
5. Hibbler R. C., "Structural Analysis" Pearson Education.
6. Patil H.S., Patil Y.D. and Patel Jignesh, "Structural Analysis-I", Synergy Knowledgeware.
7. Charles E. Reynolds, James C. Steedman (Author), Anthony J. Threlfall, "Reinforced Concrete Designer's Handbook"; CRC press-Taylor and Francis.

Course Outcomes (COs):

At the end of this course students will be able to …

1. Understand different structural systems and their behaviour.
2. Compute internal forces and moments induced in structural systems due to different types of loading and apply the knowledge of building materials to structural engineering problems.
3. Analyze different structural systems and apply design concepts to them.
4. Understand plate and grid structures and their behaviour.

3CP83: PROGRAMMING WITH PYTHON
CREDITS - 4 (LTP: 3,0,1)

Course Objective:

To impart programming skills of python programming language.

Teaching and Assessment Scheme:

Teaching Scheme (Hours per Week)			Credits	Assessment Scheme				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE	CE	ESE	CE	
3	0	2	4	60	40	20	30	150

Course Contents:

Unit No.	Topics	Teaching Hours
1	**Introduction** Basic elements of python; Control Structures; Strings and Inputs.	04
2	**Functions, Scoping and Abstraction** Functions and scoping; Specifications; Recursion; Global variables; Modules; Files; System Functions and Parameters.	06
3	**Structured Types, Mutability and Higher-Order Functions** Tuples; Lists and Dictionaries; Lists and Mutability; Functions as Objects.	04
4	**Testing, Debugging, Exceptions and Assertions** Types of testing; Black-box and Glass-box; Debugging; Handling Exceptions; Assertions.	04
5	**Classes and Object-Oriented Programming** Abstract Data Types and Classes; Inheritance; Encapsulation and Information Hiding.	05
6	**Advanced Topics** Plotting using PyLab; Network Programming – Sockets; Graphics and GUI Programming; Drawing using Turtle, Tkinter and Python; Other GUIs; Database Access.	15
7	**Hardware Interfacing** Introduction; Arduino IOP, Programming PYNQ-Z1's onboard peripherals - LEDs, switches and buttons; Peripheral Example; Controlling a single LED; Controlling all the LEDs, switches and buttons	07
	Total	**45**

List of References:

1. John V Guttag. "*Introduction to Computation and Programming Using Python*", Prentice Hall of India
2. R. Nageswara Rao, "*Core Python Programming*", dreamtech
3. Wesley J. Chun. "*Core Python Programming - Second Edition*", Prentice Hall
4. Michael T. Goodrich, Roberto Tamassia, Michael H. Goldwasser, "*Data Structures and Algorithms in Pyhon*", Wiley
5. Kenneth A. Lambert, "*Fundamentals of Python – First Programs*", CENGAGE Publication
6. Luke Sneeringer, "*Professional Python*", Wrox

Course Outcomes (COs):

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

1. Develop proficiency in creating applications using the Python Programming Language.

2. Describe various data structures available in Python programming language and apply them in solving computational problems.
3. Test the code written in Python.
4. Draw various kinds of graphs using PyLab.
5. Perform interfacing with different hardware.
6. Create applications with graphical user interfaces.

3CP84: INFORMATION TECHNOLOGY ESSENTIALS
CREDITS - 4 (LTP: 3,0,1)

Course Objective:

To provide basic knowledge of the technologies needed for application development.

Teaching and Assessment Scheme:

Teaching Scheme (Hours per Week)			Credits	Assessment Scheme				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE	CE	ESE	CE	
3	0	2	4	60	40	20	30	150

Course Contents:

Unit No.	Topics	Teaching Hours
1	**Networking Essentials** Fundamental computer network concepts, Types of computer networks,, Network layers, TCP/IP model, Wireless Local Area Network, Ethernet, WiFi, Network Routing, Switching, Network components, web server	04
2	**Web Essentials** Creating a Website, Working principle of a Website, Browser fundamentals, Authoring tools, Types of servers: Application Server, Web Server, Database Server, HTML basics, HTML tags and their use, CSS	07
3	**Scripting Essentials** Need for Scripting languages, Types of scripting languages **Client side scripting** Client side scripting with JavaScript, variables, functions, conditions, loops and repetition, Pop up boxes, Advance JavaScript: JavaScript and objects, JavaScript own objects, the DOM and web browser environments, Manipulation using DOM, forms and validations, **Server side scripting** PHP, Working principle of PHP, PHP Variables, Constants, Operators, Flow Control and Looping, Arrays, Strings, Functions, Cookies, Sessions, database connectivity	20
4	**Database Essentials** Database management, Database terms, MySQL, commands, Data types, DDL and DML Queries, Accessing MySQL using PHP.	10

Unit No.	Topics	Teaching Hours
5	**Application Essentials** Design and development of real time information systems using database connectivity, networking and scripting languages.	05
	Total	**45**

List of References:

1. Ralph Moseley and M.T. Savaliya, *"Developing Web Applications*", Wiley-India.
2. Harwani, "*Developing Web Applications in PHP and AJAX*", McGrawHill
3. A Silberschatz, H F Korth and S Sudarshan, "*Database System Concepts*", McGraw Hill. (E-book available on the BVM intranet).
4. Behrouz A Forouzan, "*Data Communication and Networking*", 5th Edition, McGraw Hill, 2013 (E-Book available on the BVM intranet)
5. W3Schools is a web developers site, with tutorials and references on web development languages such as HTML, CSS, JavaScript and PHP. URL: https://www.w3schools.com/
6. MDN Web docs. URL: https://developer.mozilla.org/en-US/

Course Outcomes (COs):

At the end of this course students will be able to…

1. Understand the basics of networking.
2. Design and deploy website using HTML and CSS.
3. Design and develop simple web application using client side and server side scripting.
4. Understand database management system.
5. Formulate basic SQL queries.
6. Develop applications using information technologies.

3CP85: OBJECT ORIENTED CONCEPTS AND PROGRAMMING
CREDITS - 4 (LTP: 3,0,1)

Course Objective:

To impart knowledge about the principles of object-oriented programming paradigm using C++.

Teaching and Assessment Scheme:

Teaching Scheme (Hours per Week)			Credits	Assessment Scheme				Total Marks
				Theory Marks		Practical marks		
L	T	P	C	ESE	CE	ESE	CE	
3	0	2	4	60	40	20	30	150

Course Contents:

Unit No.	Topics	Teaching Hours
1	**Overview and Concepts of C++** Review of fundamental concepts of Object-oriented programming, Procedural Vs. Object Oriented Programming, Principles of OOP , Benefits and applications of OOP, Introduction to C++, Program structure, namespace, identifiers, variables, constants, enum, operators, typecasting, control structures	**05**
2	**Objects and Classes** Basics of object and class; Private and public members; static data and function members; constructors and their types; destructors; type conversion; new and delete operators. Arrays of objects; Reference variables.	**10**
3	**Functions and Inheritance** Simple functions; Call and Return by reference; Inline functions; Macro Vs. Inline functions; Operator overloading; Overloading of functions; default arguments; friend functions; Concept of Inheritance; types of inheritance: single; multiple; multilevel; hierarchical; hybrid; protected members; overriding; virtual base class.	**10**
4	**Dynamic Polymorphism** Pointers and Objects; this pointer; virtual and pure virtual functions; Implementing dynamic polymorphism.	**05**
5	**I/O and File Management** Concept of streams; cin and cout; Overloading of inserter and extractor operators; C++ stream classes; Unformatted and formatted I/O; manipulators; File stream and C++ classes; File management functions; File modes; Binary and random Files.	**05**
6	**Exception Handling** Review of traditional error handling; basics of exception handling; exception handling mechanism; throwing mechanism; catching mechanism; rethrowing an exception; specifying exceptions, Introduction of Advanced topics.	**06**
7	**Introduction to Java** Introduction, OOP basics, Packages, Interface.	**04**
	Total	**45**

List of References:

1. E Balagurusamy, "*Object Oriented Programming with C++",* McGraw-Hill (E-book available on the BVM intranet)
2. Herbert Schildt, "*The Compete Reference C++",* McGraw-Hill
3. Deitel, "*C++: How to Program*", PHI
4. Jana Debasish, "*C++ and Object Oriented Programming Paradigm*", PHI
5. Saurav Sahay, "*Object Oriented Programming with C++",* Oxford
6. Herbert Schildt, "*The Complete Reference, Java*", McGraw-Hill.

Course Outcomes (COs):

At the end of this course students will be able to…

1. Differentiate between object-oriented programming and procedural programming paradigms
2. Understand features of object-oriented programming like encapsulation, inheritance, polymorphism, etc. using C++
3. Design a solution to a given problem using object-oriented programming concepts
4. Prepare an application in C++ using I/O, File management and exception handling concepts.

5. Understand concepts of OOP with Java.
6. Enhance logical reasoning and programming skills.

3IT85: WEB APPLICATION AND DEVELOPMENT
CREDITS – 4 (LTP: 3,0,1)

Course Objective:
To learn the concepts of web designing to design and implement web application.

Teaching and Assessment Scheme:

Teaching Scheme (Hours per Week)			Credits	Assessment Scheme				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE	CE	ESE	CE	
3	0	2	4	60	40	20	30	150

Course Contents:

Unit No.	Topics	Teaching Hours
1	**Web server, Access and security, Web Protocol(HTTP/1.1):** Overview of HTTP, HTTP language elements, HTTP extensibility, SSL and security, Evolution of HTTP/1.1 protocol 2.8 methods-headers and response codes in 1.0 /1.1, Cloud Web hosting, Web Server Basics.	3
2	**Web Design:** Concepts of effective web design, Web design issues including browser, Bandwidth and cache, Display resolution, Look and feel of the website, Page layout and linking, Sitemap, Planning and publishing website.	4
3	**HTML:** Basics of HTML, Formatting and fonts, Commenting code, Color, Hyperlink, Lists, Tables, Images, Forms, Frames, Browser architecture and web site structure.	6
4	**HTML5:** HTML5 New Element, HTML5 Canvas, HTML5 Drag/Drop, HTML5 Video, HTML5 Audio, HTML5 Input type, HTML5 Form Element, HTML5 Form Attribute, Features of HTML5.	5
5	**Style sheets:** Need for CSS, Introduction to CSS, Basic syntax and structure, Background images, Colors and properties, Manipulating texts, Using fonts, Borders and boxes, Margins, Padding , lists, Positioning using CSS, CSS2, Overview and features of CSS3.	7
6	**JavaScript:** Client side scripting with JavaScript, Variables, Functions, Pop up boxes, The DOM and web browser environments, Manipulation using DOM, Forms and validations. **DHTML:** Combining HTML, CSS and JavaScript, Events and buttons.	8
7	**PHP:** Introduction and basic syntax of PHP, PHP and HTML, Arrays, Functions, String, Form processing, Files, Advance Features: cookies and sessions.	6
8	**PHP and MySQL:** Introduction to MySQL, Connection to server, Creating database, Selecting a	6

database, Creating a table, Inserting data, Altering tables, Queries, Deleting database, Deleting data and tables.

	Total	**45**

List of References:

1. Ralph Moseley and M. T. Savaliya, *"Developing Web Applications"*, Wiley-India.
2. Black Book, *"Web Technologies"*, dreamtech Press.
3. Black Book,*"HTML 5"*, Dreamtech Pr.
4. Joel Sklar, *"Web Design"*, Cengage Learning.
5. Harwani, *"Developing Web Applications in PHP and AJAX"*, McGrawHill.
6. P.J. Deitel & H.M. Deitel, *"Internet and World Wide Web How to program"*, Pearson.

Course Outcomes (COs):

At the end of this course students will be able to …

1. Able to understand internet concepts that are vital in understanding web development.
2. Understand the role of computer languages and protocols in the workings of the web and able to explain the roles of web development.
3. Describe the strengths and weaknesses of the client-server internet approaches to web design and implementation.
4. Design and apply markup languages for processing, identifying, and presenting of information in web pages.
5. Design and implement an interactive web site(s) with regard to issues of usability, accessibility and internationalization.
6. Design and implement a client-server internet application that accommodates specific requirements and constraints, based on analysis, modeling or requirements specification.

3IT86: JAVA PROGRAMING
CREDITS – 4(LTP: 3,0,1)

Course Objective:

To be familiar with different object oriented concepts which are commonly applied in implementation of various java applications using business logic.

Teaching and Assessment Scheme:

Teaching Scheme (Hours per Week)			Credits	Assessment Scheme				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE	CE	ESE	CE	150
3	0	2	4	60	40	20	30	

Course Contents:

Unit No.	Topics	Teaching Hours
1	**Introduction to JAVA:** Object-oriented programming paradigms & principles, Key features of JAVA, Byte code and Java development Kit, Lexical issues, Data types, Variables, Control statements, Loop.	4
2	**Arrays and Operators:** One-dimensional arrays, Multi-dimensional arrays, Arithmetic operators, The bitwise operators, Shift operators, Relational operators, Short-circuit logical operators, The? operator, Operator precedence.	4
3	**Introduction to Classes and Methods:**	6

Unit No.	Topics	Teaching Hours
	Class Fundamentals, Declaring objects, Assigning object reference variables, Introducing methods, Constructors, Overloading methods, Overloading constructors, Using objects as parameters, Recursion, Passing and returning object form method, Introducing nested and inner classes, Command-line arguments, Understanding keywords: this, final & static.	
4	**Inheritance and String Handling:** Inheritance basics, Super keyword, Multilevel hierarchy, Method overriding, Dynamic method dispatch, Using abstract classes, The object class, Special string operations, Character extraction, String comparison, Searching strings, Modifying a string, Data conversion using valueOf( ), String Buffer class & its methods.	4
5	**Packages and Interfaces:** Defining a package, Finding packages and CLASSPATH, Access protection, Importing packages, Defining an interface, Implementing interfaces, Applying interfaces, Variables in interfaces.	4
6	**Exception Handling:** Exception-handling fundamentals, Exception types, Use of try and catch, Multiple catch clauses, Nested try statements, Throw, Throws, Finally keywords, Java's built-in exceptions, Custom exception, Chained exceptions.	6
7	**Multithreaded Programming:** The java thread model, Creating a thread using implementing runnable & extending thread, Creating multiple threads, isAlive( ) and join( ), Thread priorities, Synchronization, Deadlock.	4
8	**Input/Output and File Operation:** Streams, Byte streams and character streams, The predefined streams, Reading console input, Writing console output, The PrintWriter class, Reading and writing files.	4
9	**The Applet Class:** Applet basics, Applet architecture, An applet skeleton, Simple applet display methods, Repainting, Using the status window, The HTML APPLET tag, Passing parameters to applets.	4
10	**Introducing the AWT and Graphics:** AWT classes, Window fundamentals, Working with frame windows, Creating a frame window in an applet, Working with graphics: Drawing lines, Rectangles, Ellipses, Circles, Arcs and polygons, Sizing graphics, Working with color, Working with fonts.	5
	Total	**45**

List of References:

1. Herbert Schildt, *"The Complete Reference, Java 2",* Ninth Edition, Tata McGraw Hill .
2. Herbert Schildt & Dale Skrien, *"Java Fundamentals A comprehensive introduction",* Tata McGraw Hill .
3. E.Balaguruswamy, *"Programming with Java A Primer",* Tata McGraw Hill.
4. Horstmann & Cornell, *"Core Java Volume-I Fundamentals",* Eight Edition, Pearson Education.

Course Outcomes (COs):

At the end of this course students will be able to …

1. Create java program for simple business logic.
2. Understand the concept of OOP as well as the purpose and usage principles of inheritance, polymorphism, encapsulation and method overloading.

3. Identify classes, objects, members of a class and the relationships among them needed for a specific problem.
4. Demonstrate programs on exceptions, multithreading, various collection classes and applets.
5. Understand the concept of file handling.
6. Identify various event classes and methods which are needed for event based applications.

3IT87: OBJECT ORIENTED PROGRAMMING WITH C++
CREDITS – 4(LTP: 3,0,1)

Course Objective:
Analyzing and solving the real-world problems using various concepts of object oriented programming.

Teaching and Assessment Scheme:

Teaching Scheme (Hours per Week)			Credits	Assessment Scheme				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE	CE	ESE	CE	
3	0	2	4	60	40	20	30	150

Course Contents:

Unit No.	Topics	Teaching Hours
1	**Introduction to C++:** Introduction OOP, Procedural VS. Object oriented Programming, Basic concept of OOP, Principals of OOP, Benefits and applications of OOP, Programming in C++.	3
2	**Data types, operators and Control Structures:** Data Types, Keyword, Tokens, identifiers, variables, constants, enum, operators, typecasting, control structures.	4
3	**C++ Functions:** Function Prototyping, Call by value and reference, Return by reference, Inline function and macro function, Default Arguments, Function Overloading.	5
4	**Class and objects:** Structure vs Class, Member function Declaration, Access Specified for member function, Static data Member and Member Function, Friend Function, Object as Argument, Constructor, Types of Constructor, Destructor.	6
5	**Operator Overloading and Type Conversion:** Unary and Binary Operator Overloading, Types of Type Conversion.	5
6	**Inheritance:** Inheritance, Types of Inheritance, Virtual Base Classes, Abstract Class, Constructor in Derived Class.	5
7	**Virtual Function and Polymorphism:** Polymorphism, Types of Polymorphism, this Pointer, Virtual Function, Pure Virtual Function.	5
8	**I/O functions:** Formatted and Unformatted I/O Operations, Manipulators.	4

Unit No.	Topics	Teaching Hours
9	**File Management:** Classes for File Operations, Basic File Operations, File Functions, Error Handling Operations, Command Line Arguments.	4
10	**Exception Handling:** Try, Catch and Throw, Multiple Catch, Re-throw Exception.	4
	Total	**45**

List of References:

1. E Balagurusamy, *"Object Oriented Programming with C++",* Second Edition,Tata McGraw Hill.
2. Herbert Schlitz, *"The Compete Reference C++",* Second Edition, Tata McGraw Hill.
3. Ashok Kamthane, *"Object Oriented Programming with ANSI and Turbo C++",* Pearson.

Course Outcomes (COs):

At the end of this course students will be able to …

1. Design and analyze real world problem effectively.
2. Understand functions and parameter passing.
3. Differentiate the use of class and structure to develop a program.
4. Develop a program show usage of abstraction.
5. Design effective program using various IOS functions.
6. Create a file to manage data using object oriented programming.

3IT88: MOBILE APPLICATION DEVELOPMENT
CREDITS - 4 (LTP: 3,0,1)

Course Objective:

Design and develop useful Android applications with compelling user interfaces by using, extending, and creating your own layouts and Views and using Menus.

Teaching and Assessment Scheme:

Teaching Scheme (Hours per Week)			Credits	Assessment Scheme				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE	CE	ESE	CE	
3	0	2	4	60	40	20	30	150

Course Contents:

Unit No.	Topics	Teaching Hours
1	**Basics of Android Programming:** Introduction, History, Features and android architecture, Introduction to java and android, Introducing development framework, Dalvik virtual machine – DVM, Installation of Android Studio, Android virtual device (AVD) and SDK manager, Android manifest file,	8

Unit No.	Topics	Teaching Hours
2	**Android Building Blocks:** Types of android applications, Activity lifecycle, Intents, services, Content provider, broadcast receivers, Activity classes, Component lifecycle,Layouts,Views and Resources, Activity with Implicit Intents.	7
3	**Android User Interface :** Buttons,RadioButtons,checkboxes,Pickers,Spinners,Menus:Optionsmenu,contextual menu, Popup menu, Adding menu items, Navigation: Screen Navigation, navigation drawer, Theme and Styles: uses of drawable in android	7
4	**Multimedia in Android:** Introduction to audio and video in Android, Android persistence, Android preferences, Using file system, Accessing SD cards, Location and maps, Using GEOCoder, Android text to speech, Paranoid android, Internet services, Broadcast receivers, Sensor manager, different Parsing techniques like JSON Parsing and SAX Parsing.	10
5	**Database Connectivity**: SQLite database, SQLite data types, Cursors and content values, SQLite open helper, Adding, Updating and deleting content, Firebasedatabase, connection of firebase database with android app.	7
6	**Test and Debug Android Application :** Basics of testing, testing and commercializing applications, Activity testing, service testing, Content provider testing, Test classes, Debugging using DDMS, Configuration changes, Security and permissions, Web services integration, Deployment.	6
	Total	**45**

List of References:

1. Mike Wolfson, *"Android Developer Tools Essentials"*, O'Reilly Media Publications.
2. Jeff Friesen, *"Learn Java for Android Development"*, A press Publications, 2nd Edition.
3. Kevin Brothaler, *"OpenGL ES 2 for Android -The Pragmatic Programmers".*
4. Wei-MengLee, John Wileyand sons, *"Android Application Development Cookbook"*,2013

Course Outcomes (COs):

At the end of this course students will be able to …

1. Design and develop user Interfaces for the Android platform.
2. Gain knowledge to create and publish their own Apps for Android devices
3. Understand the limitations and features of developing application for mobile devices
4. Learn database connectivity using real time database.
5. Analyze different parsing techniques.
6. Apply different Testing techniques on android applications.

3EL82: BASICS OF EMBEDDED AND IOT SYSTEMS
CREDITS –4 (LTP: 3,0,1)

Course Objective:

1. To provide students with good depth of knowledge of Designing Embedded and IOT Systems for various application.

2. Knowledge for the design and analysis of Embedded and IOT Systems for Electronics Engineering students.

Teaching and Assessment Scheme:

Teaching Scheme (Hours per Week)			Credits	Assessment Scheme				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE	CE	ESE	CE	
3	0	2	4	60	40	30	20	150

Course Contents:

Unit No.	Topics	Teaching Hours
1	**Introduction to Embedded and IoT Systems:** Introduction Embedded and IoT systems, Definition, Examples and components of embedded and IoT Systems, Embedded and IoT Systems Design Process, Various Embedded and IoT cores controllers.	5
2	**Hardware/Software Co-design for Embedded and IoT Systems:** Microcontrollers for embedded systems, Arduino embedded platform, Peripheral interfacing and programming with Arduino platform, Sensors and Actuator interfacing, Cloud support with Arduino platform.	10
3	**Protocols for Embedded and IoT systems:** Serial protocols, UART, I2C, and SPI. NFC, Wireless protocols like, RFID, Zig-bee, IEEE 802.15.4e, Thread, 6LoWPAN, Constrained Application Protocol (CoAP), Extensible Messaging Protocol (XMPP) , WebSocket , Advanced Message Queueing Protocol (AMQP) , Message Queue Telemetry Transport (MQTT), Web Real Time Communications (WebRTC), LoRa, SIGFOX, Z Wave.	10
4	**OS based Software development:** Programming in higher level languages on embedded OS platform, Python and C programming, Various aspects of the OS designed for the IoT environment, open source OS for IoT such as Contiki OS, TinyOS etc.	05
5	**IoT based Embedded Systems:** Basic architecture of an IoT based Embedded Systems., Embedded Hardware for IoT applications, like Raspberry Pi, Arduino, and Raspberry Pi based development board, IoT Cloud Platform and IoT client applications on mobile phones.	05
6	**Case Studies of Embedded and IoT Systems:** Embedded application development through Arduino and Raspberry Pi based development boards, Development of mini Project on new version of Operating systems and development board. That project should also address to the current societal needs.	05
	Total	**45**

List of References:

1. Muhammad Ali Mazidi Shujen Chen, Sepehr Naimi Sarmad Naimi "*Embedded Programming Using C Language",* 1st Edition, Freescale ARM Cortex-M.
2. Steve Ferbur, "*ARM System on Chip*".
3. Rajkamal, "*Embedded System: Architecture, Programming and Design*", TMH3.
4. Dr. OvidiuVermesan, Dr. Peter Friess, "*Internet of Things: Converging Technologies for Smart Environments and Integrated Ecosystems*", River Publisher

Course Outcome:

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

1. Knowledge of theory and practice related to Embedded and IOT System.
2. Ability to identify, formulate and solve engineering problems by using Embedded Systems with IoT.
3. Ability to implement real field problem by gained knowledge of Embedded Systems with IoT capability.

Sr. No.	Suggested List of Experiments
1.	Study of Open source operating system used in Embedded Design.
2.	Introduction to Arduino based Embedded System Programming.
3.	LED Interfacing program for Arduino based Embedded System
4.	Interfacing Push button Switch interfacing with Arduino based Embedded System
5.	External Peripheral Interfacing with Arduino based Embedded System.
6.	On Chip peripheral programming with Arduino/Raspberry Pi based Embedded System
7.	Serial Communication Protocol programming with Arduino/Raspberry Pi based Embedded Systems.
8.	Wireless communications with Arduino/Raspberry Pi Embedded IOT Platform.
9.	Bluetooth communication interfacing with Arduino/Raspberry PiEmbedded IOT Board.
10.	WiFi module interfacing with Arduino/Raspberry Pi Embedded IOT Board.
11.	Embedded Systems design with IOT capability.
12.	IOT based Temperature monitoring embedded system with open source cloud tools.
13.	Introduction to RTOS
14.	RTOS based task performances

3EL83: SENSORS TECHNOLOGY
CREDITS-3(LTP:3,0,1)

Course Objective:

1. Introduce students to the principle of various Transducers, their construction, applications and principles of operation, standards and units of measurements.
2. Provide students with opportunities to develop basic skills in the understanding the operation of electronic sensors based technology.

Teaching and Assessment Scheme:

Teaching Scheme (Hours Per Week)			Credits	Assessment Scheme				
				Theory Marks		Practical Marks		Total Marks
L	T	P	C	ESE	CE	ESE	CE	
3	0	2	4	60	40	20	30	150

Course Contents:

Unit No.	Topics	Teaching Hours
1	**Introduction to Electronics Measurement and Instrumentation:** Transducers and sensors- Accuracy and precisions, types of errors, statistical analysis, probability of errors, limiting errors, sensitivity, linearity, hysteresis, resolution, reproducibility, transfer function.	6
2	**Analog Signal Conditioning:** Signal conditioning, Loading effects, Bridges for measurement techniques, Attenuators and Amplifiers, Passive filters, Op-amp based signal conditioning circuits, Inverting and Non-Inverting Amplifiers, Linearization, Differential amplifiers and Instrumentation amplifiers.	6
3	**Digital Signal Conditioning:** Digital measuring techniques, Sample and Hold Circuits, Comparator, Buffers, D/A Conversion and A/D Conversion, Single channel and multi-channel Data Acquisition System (DAS).	6
4	**Temperature Sensors:** Resistance Vs Temperature characteristics for different materials, Thermistors, Thermocouples - thermoelectric effects for thermocouples, thermocouple tables, RTD, Other Thermal Sensors.	6
5	**Pressure, force, displacement and weight measurement:** 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.	6
6	**Flow measurement:** Basic principle of flow meter, Differential pressure flow meters, Variable area flow meter, Volumetric flow meter, Hotwire anemometer, Magnetic and ultrasonic flow meter, Rota meter, Hall effect transducer working and measurement techniques.	6
7	**RF sensing:** Basic principle of EM fields, Antenna, RFID, Near Field and Far Field Sensing, Radar and Navigation, EMI & EMC sensing	9
	Total	**45**

List of References:

1. Curtis D. Johnson, *"Process Control Instrumentation Technology"*, Prentice Hall India.
2. D.V.S. Murty, "*Transducers and Instrumentation"*, Prentice Hall India.
3. Helfrick Albert D. and Cooper W. D., "*Modern Electronic Instrumentation and Measurement Techniques"*, Prentice Hall India.

4. Kalsi H. S. *"Electronic Instrumentation"*, Tata McGraw-Hill Education.
5. Shawhney A. K. "*A Course In Electrical and Electronics Measurements and Instrumentation",*DhanpatRai& Sons, 11th Ed., 1999.
6. Bell David A. "*Electronic Instrumentation and Measurements"*, PHI / Pearson Education.
7. Mathew Sadiku, "Elements of Electromagnetics", PHI

Course Outcomes (COs):

At the end of this course students will be able to:

1. Apply scientific principles for sensing various physical quantities.
2. Understand the operational details of sensors for measurements.
3. Apply measurements techniques for instrumentation.

3EC83: EMBEDDED SYSTEMS AND IOT
CREDITS – 4 (LTP: 3,0,1)

Course Objective:

Understand and Design Arduino based embedded systems for branch specific applications. Understand and Integrate IoT Platforms to enhance application metrics and accessibility.

Teaching and Assessment Scheme:

Teaching Scheme (Hours per Week)			Credits	Assessment Scheme				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE	CE	ESE	CE	
3	0	2	4	60	40	20	30	150

Course Content:

Unit No.	Topics	Teaching Hours
1.	**Introduction :** Numbering and coding systems, semiconductor memory, CPU architecture, Microcontrollers and Microprocessors, embedded system, Introduction to Arduino Uno and Arduino IDE, Structuring an Arduino Program, Using data types and operations.	04
2.	**IO Port Programming :** Atmega328p pins and functions, IO port programming, Using a Switch, Reading a Keypad, Visual Output, Connecting and Using LEDs, Driving a 7-Segment LED Display, LCD Display.	07
3.	**Serial Communication :** Introduction to serial communication, Sending Formatted Text and Numeric Data from Arduino, Sending and Receiving Serial Data in Arduino, GSM modem, Bluetooth.	07
4.	**Getting Input from Sensors :** Reading Analog Values, Detecting Light, Detecting Motion (Integrating Passive Infrared Detectors), Measuring Distance, Detecting Vibration, Detecting Sound, Measuring Temperature, Reading RFID Tags, Tracking Rotary Movement, Detecting Acceleration.	09

Unit No.	Topics	Teaching Hours
5.	**Physical Output :** Controlling a Servo, driving a Brushless Motor, Controlling Solenoids and Relays, making an Object Vibrate, Controlling the Direction and Speed of a Motor with an H-Bridge, Driving a Stepper Motor.	08
6.	**Introduction to IoT :** Defining IoT, Characteristics of IoT, design of IoT, Functional blocks of IoT, Communication models & APIs, IOT platforms. ESP8266- Introduction. Domain specific applications of IoT : Home automation, Industry applications, Environmental applications.	10
	Total	**45**

List of References:

1. Michael Margolis, "*Arduino Cookbook*", First Edition, O'Reilly Media, March 2011.
2. Muhammad Ali Mazidi, SarmadNaimi and SepehrNaimi, "*The AVR Microcontroller and Embedded Systems: Using Assembly and C*", 1st Edition, Pearson Education, 2012.
3. Michael McRoberts, "*Beginning Arduino*", 2/E, Apress, 2013
4. Cornel Amariei, "*Arduino Development Cookbook*", Packt Publishing, 2019.
5. Michael McRoberts, "*Beginning Arduino*", Second Edition, Apress, 2013
6. Marco Schwartz, "*Internet of Things with ESP8266*", Packt Publishing Ltd., July 2016
7. Marco Schwartz, "*ESP8266 Internet of Things Cookbook*", Packt Publishing, 2017

Course Outcomes (COs) :

At the end of this course students will be able to …

1. Recollect basic knowledge about Digital Systems and microcontroller architecture.
2. Understand functions of Arduino pins and illustrate its use.
3. Integrate serial communication for device interfaces and debugging in applications.
4. Make use of sensors for monitoring different quantities in application.
5. Integrate actuators in application for physical movement and control.
6. Understand concepts of IoT and design IoT applications.

3ME83: RENEWABLE ENERGY SOURCES
CREDITS - 4 (LTP: 3,0,1)

Course Objective:

To illustrate renewable energy sources and its effective technologies.

Teaching and Assessment Scheme:

Teaching Scheme (Hours Per Week)			Credits	Assessment Scheme				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE	CE	ESE	CE	
3	0	2	4	60	40	20	30	150

Course Contents:

Unit No.	Topics	Teaching Hours
1	**Introduction:** Energy Consumption & Standard of living, Forms of Energy, Classification of Energy Resources, Application of non-conventional energy sources, Energy scenario	4
2	**Solar Energy:** Solar radiation - beam and diffuse radiation, solar constant, earth sun angles, attenuation and measurement of solar radiation, local solar time, derived solar angles, sunrise, sunset and day length. flat plate collectors, concentrating collectors, Solar air heaters-types, solar driers, storage of solar energy-thermal storage, solar pond , solar water heaters, solar distillation, solar still, solar cooker, solar heating & cooling of buildings, photo voltaic - solar cells & its applications	10
3	**Wind Energy:** Principle of wind energy conversion; Basic components of wind energy conversion systems; wind mill components, various types and their constructional features; wind data and site selection considerations	4
4	**Biomass Energy:** Biomass conversion technologies, Biogas generation plants, Classification, advantages and disadvantages, constructional details, site selection, digester design consideration, filling a digester for starting, maintaining biogas production, Fuel properties of bio gas, utilization of biogas.	8
5	**Geothermal Energy:** Estimation and nature of geothermal energy, geothermal sources and resources like hydrothermal, geo-pressured hot dry rock, magma. advantages, disadvantages and application of geothermal energy, prospects of geothermal energy in India **Ocean Energy:** Tidal Energy-Principle of working, performance and limitations. Wave Energy-Principle of working, performance and limitations. Ocean Thermal Energy-Availability, theory and working principle, performance and limitations	10
6	**Miscellaneous Technologies:** **Magneto Hydrodynamic Power Conversion:** Principle of working of MHD Power plant, performance and limitations. **Fuel Cell:** Principle of working of various types of fuel cells and their working, performance and limitations **Hydrogen Energy:** Hydrogen Production methods, Hydrogen storage, hydrogen transportation, utilization of hydrogen gas, hydrogen as alternative fuel for vehicles.	6
	Total	**42**

List of References:

1. G. D. Rai, "*Non-Conventional Energy Sources*", 1th Edition, Khanna Publishers, Reprint 2010
2. S. P. Sukhatme, "*Solar Energy*",3rd Edition, Tata Mc Graw Hill Education Pvt Ltd, 2008
3. B H Khan , " *Non-Conventional Energy Resources*", 2nd Edition, Tata Mc Graw Hill Education Pvt Ltd, 2011
4. S.Hasan Saeed and D.K.Sharma, "*Non-Conventional Energy Resources*",3rd Edition,S.K.Kataria & Sons, 2012
5. G.N.Tiwari and M.K.Ghosal, "*Renewable Energy Resource: Basic Principles And*

Applications", Narosa Publishing House,2004
6. Shobh Nath Singh, "*Non-Conventional Energy Resources*", Pearson Education India; First edition (2015).

Course Outcomes (COs):

At the end of this course students will be able to …

1. Identify energy demand and relate with available energy resources.
2. Analyze solar energy technologies.
3. Outline the wind energy sources.
4. Analyze harnessing of biomass energy.
5. Outline the geothermal and ocean energies.
6. Describe magneto hydrodynamics, hydrogen energy and fuel cell technology.

3ME84: ENERGY CONSERVATION AND MANAGEMENT
CREDITS – 4 (LTP: 3,0,1)

Course Objective:

To apply energy conservation principles and management techniques to different energy conversion systems

Teaching and Assessment Scheme:

Teaching Scheme (Hours per week)			Credits	Assessment Scheme				
L	T	P	C	Theory Marks		Practical Marks		Total Marks
				ESE	CE	ESE	CE	
3	0	2	4	60	40	20	30	150

Course Contents:

Unit No.	Topics	Teaching Hours
1	**Energy Scenario:** Introduction to energy & power scenario of world, National Energy consumption data and environmental aspects associated with energy utilization; Energy Auditing- need, types, methodology and barriers, role of energy managers, instruments of energy auditing.	8
2	**Energy Conservation Act 2001 and related policies:** Energy conservation Act 2001 and its features, notifications under the Act, Schemes of Bureau of Energy Efficiency (BEE) including Designated consumers, State Designated Agencies, ECBC code for Building Construction.	3
3	**Financial Management:** Energy Economics- discount period, payback period, internal rate of return, net present value; Life Cycle costing- ESCO concept.	5
4	**Energy Monitoring and Targeting:** Defining monitoring & targeting, elements of monitoring & targeting, data and information-analysis, techniques – energy consumption, production, cumulative sum of differences (CUSUM).	5

Unit No.	Topics	Teaching Hours
5	**Energy Conservation in Electrical Utilities :** Components of EB billing, HT and LT supply, transformers, cable sizing; Concept of capacitors, power factor improvement, harmonics; Electric motors- motor efficiency computation, energy efficient motors; Illumination- Lux, Lumens, types of lighting, efficacy, LED lighting and scope of energy conservation in lighting.	8
6	**Energy Efficiency in Thermal Utilities and systems:** Thermal systems, Boilers, Furnaces, Heat exchangers and Thermic Fluid heaters- efficiency computation and energy conservation measures; Steam distribution and usage, steam traps, condensate recovery, flash steam utilization; Insulation & Refractories. Energy conservation in major utilities; pumps, fans, blowers, compressed air systems, Refrigeration& Air Conditioning systems, Cooling Towers, DG sets	13
	Total	**42**

List of References:

1. Witte L.C., Schmidt P.S. and Brown D.R., "*Industrial Energy Management and Utilization*", Hemisphere Publ., Washington, 1988..
2. Callaghan P.W., "*Design and Management for Energy Conservation*", Pergamum Press, Oxford
3. Murphy W.R. and McKay G., "*Energy Management*", Butterworth's, London, 1987.
4. Bureau of Energy Efficiency, "*Energy Manager Training Manual*", Reference book No:1 to 4.
5. Dale R Patrick, Stephen W Fardo, "*Energy Conservation Guidebook*", 2nd Edition, CRC Press.
6. Shobh Nath Singh, "*Non-Conventional Energy Resources*", Pearson Education India; First edition (2015).

Course Outcomes (COs):

After learning the course the students should be able to:

1. Outline energy scenario, audit and management.
2. Apply energy conservation policy, regulations in industrial practices.
3. Evaluate energy economics.
4. Identify opportunities for rational use of energy.
5. Analyze electrical systems for energy conservation.
6. Analyze the thermal systems for energy efficiency.

3PE83: MANAGING PROJECT
CREDITS – 4 (LTP: 3,0,1)

Course Objective:

To provides a systematic and thorough introduction to all the aspects of project management.

Teaching and Assessment Scheme:

Teaching Scheme (Hours per Week)			Credits	Assessment Scheme				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE	CE	ESE	CE	
3	0	2	4	60	40	20	30	150

Course Contents:

Unit No.	Topics	Teaching Hours
1	**Introduction to Project Management:** Definition of Project, Program and Portfolio, Project parameters: Scope, Quality, Cost, Time, Resources, And The scope triangle: Time, Cost, and Resource Availability, The life cycles of Projects. Project Classification. Project Management, Project Management Vs General Management, Principles of Project Management: Defining, Planning, Executing, Controlling, Closing, Phases of Project Management: Scope the Project, Develop the project plan, Launch the plan, Monitor/control project progress, Close out the Project.	06
2	**Organizing the Project and Scope of the Project:** The PM's Roles, The PM's responsibility to the project, Selection of a project Manager, and The Project team. Developing Conditions of Satisfaction, Establishing Clarity of Purpose, Creating the Project Overview Statement, Parts of the POS, Attachments Submitting a Project for Approval, Submitting a project for Approval, Participants in the Approval Process, The Project Definition Statement.	07
3	**Planning the Project and Budgeting the Project:** The contents of a Project Plan, The Planning Process- Overview, The Planning Process- Nuts and Bolts, The project action plan, The Work breakdown Structure, Use for the WBS, Generating the WBS, Six criteria to test for completeness in the WBS, Approaches to Building the WBS, Representing the WBS. Methods of Budgeting: Top-Down Budgeting, Bottom-Up Budgeting, Cost Estimating, Improving Cost Estimates, Budget Uncertainty and Risk Management.	07
4	**Scheduling the Project- Network Analysis-PERT:** **Elements of network:** Introduction to Project Evaluation and Review Technique, Event, Activity, Dummy, Network rules, Graphical guidelines for network, Common partial situations in network, numbering the events, cycles. **Developing the Network:** Planning for network construction, modes of network construction, steps in developing network, hierarchies. **Time Estimates in PERT:** Uncertainties and use of PERT, Time estimates, Frequency distribution, Mean, Variance & standard deviation, Probability distribution, Beta distribution, Expected time. **Time Computations:** Earliest expected time, Formulation for T_E, Latest allowable occurrence time, Formulation for T_L, Combined tabular computations for T_E, T_L. **Network Analysis**: Slack, Critical Path and Probability of meeting schedule date.	08
5	**Scheduling the Project- Network Analysis-CPM and Allocating the Resources to the Project:** **Network Analysis** :Introduction to Critical Path Method, CPM- Process, CPM - networks, Activity time estimate, Earliest event time, Latest allowable occurrence time, Combined tabular computations for T_E and T_L, Start & Finish times of activity, Float, Critical activities & Critical path.	08

Unit No.	Topics	Teaching Hours
	Cost Model: Introduction, Project cost, Indirect project cost, Direct Project cost, Crashing of project network. Introduction, Resources Usage Profiles: Histograms, Resources Smoothing, Resources Levelling.	
6	**Monitoring and Controlling the Project and Closing out the Project:** Control versus Risk, Purpose of Controls, Control versus Quality, Progress reporting System, Applying Graphical Reporting Tools: Cost Schedule control, Deciding on Report Level of Detail, Managing project Status meetings, Managing Change, Managing Problem Escalation. Steps in Closing a project, Getting client Acceptance, Installing Project Deliverables, Documenting the Project, Post Implementation Audit, The Final Report.	06
	Total	**42**

List of References:

1. Robert K. Wysocki, Robert Beck. Jr., and David B. Crane, "*Effective Project Management*", Wiley India.
2. Samuel Mantel, Jack Meredith, Scott Shafer, Margaret Sutton, M. R. Gopalan, *"Project Management Core Textbook",* Wiley India.
3. Harold Kerzner, "*Project Management: A Systems Approach to Planning, Scheduling and Controlling*", Wiley India.
4. Dr. B.C. Punamia & K. K. Khandelwal, *"Project Planning and Control with CPM and PERT"*, Laxmi Publications, New Delhi.

Course Outcomes (COs):

After completion of this subject, the students will be able to…

1. Understand about Project, Project management and role of project manager.
2. Define& develop project statement & project plan.
3. Develop & analyze project network diagram with cost model.
4. Estimate project budget and resource allocation.
5. Monitor, control and close out the Project.

3PE84: ADDITIVE MANUFACTURING
CREDITS - 4 (LTP: 3,0,1)

Course Objective:

The revolutionary change in factory production techniques & management require a direct involvement of computer-controlled systemsin the entire production process with every operation, fromproduct design, to manufacturing, to assembly & product inspection, being monitored & controlled by computers. This subject enhances knowledge-base with possible applications in respective fields of engineering of the students of various disciplines.

Teaching and Assessment Scheme:

Teaching Scheme (Hours per Week)			Credits	Assessment Scheme				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE	CE	ESE	CE	
3	0	2	4	60	40	20	30	150

Course Contents:

Unit No.	Topics	Teaching Hours
1	**Introduction:** Fundamentals of Prototype & Rapid prototyping, Commonly used terms, Difference between rapid prototyping & additive manufacturing (AM) concepts including classes of prototypes and basic aspects of additive manufacturing, Classification & advantages of AM Systems, Applications in engineering field of mechanical, production, civil, structural as well as electronics & information technology (machine part printing, concrete printing, metallic & ceramic part printing, circuit board printing, etc.).	04
2	**(a) Additive Manufacturing Process Chain:** Fundamental automated processes, Process chain, 3D modeling, Data conversion & transmission, Checking & preparing, Building, and post-processing. **(b) Additive Manufacturing Data Formats:** STL format, STL file problems/errors & repairing, Consequences of building a valid & invalid tessellated model, Other translators, Standards for representing objects manufactured by additive manufacturing methods.	08
3	**Liquid-based Additive Manufacturing:** Stereolithography Apparatus (SLA), Polyjet, Perfactory, Solid Object Ultraviolet-Laser Printer (SOUP),Bioplotter & Bioprinting, Rapid Freeze Prototyping (RFP), Other notable liquid-based AM systems - Two Laser Beams, Solid Ground Curing (SGC).	09
4	**Solid-based Additive Manufacturing:** Laminated Object Manufacturing (LOM), Fused Deposition Modeling (FDM), Selective Deposition Lamination (SDL), Paper Lamination Technology (PLT), Ultrasonic Consolidation, Benchtop System, Multi-Jet Modeling System (MJM), Other notable solid-based AM systems – Offset Fabber, Shape Deposition Manufacturing (SDM) process	09
5	**Powder-based Additive Manufacturing:** Selective Laser Sintering (SLS), EOSINT Systems, Laser Engineered Net Shaping (LENS),Electron Beam Melting (EBM),Selective Laser Melting (SLM), ColorJet Printing (CJP), Aerosol Jet System (AJS), Digital Part Materialisation (DPM), Other notable powder-based AM systems, Three Dimensional Printing (3DP) to be covered in laboratory.	09
6	**Evaluation and Benchmarking:** Using Bureau Services, Setting Up a Service Bureau, Technical Evaluation Through Benchmarking, Industrial Growth, Future Trends.	03

Unit No.	Topics	Teaching Hours
	Total	**42**

List of References:

1. Chua C. K., Leong Kah Fai & Lim Chu Sing, *"3D Printing & Additive Manufacturing*", World Scientific Publishing Co. Pvt. Ltd., 2017.
2. Chua C. K., Leong Kah Fai & Lim Chu Sing *"Rapid Prototyping: Principles and Applications",* World Scientific Publishing Co. Pvt. Ltd. 2nd Edition
3. Ian Gibson, *"Additive Manufacturing Technologies"*, Springer, 2015.
4. Amit Bandyopadhyay, *"Additive Manufacturing"*, CRC Press, 2015.
5. Andreas Gebhardt, *"Additive Manufacturing"*, Hanser Publications, 2016.
6. Adedeji B. Badiru, "Additive Manufacturing Handbook", CRC Press, 2017.

Course Outcomes (COs):

At the end of this course students will be able to …

1. Understand and differentiate the concept of rapid prototyping & additive manufacturing (AM) including classes of prototypes and basic aspects of AM & its applications.
2. Understand and describe the AM process chain, classification & advantages of AM Systems.
3. Understand AM data formats, their limitations/errors & Standards for AM parts.
4. Understand and describe basic terminology/specifications, principles, benefits, limitations & applications of various additive manufacturing techniques.
5. Explain the process steps, set-ups and case studies related to liquid-based, solid-based & powder-based AM methods.
6. Understand and explain the requirement of service bureau, the procedure and reasons for evaluation & benchmarking as well as futuristic development of these manufacturing techniques.

4EE01: POWER SYSTEM PROTECTION
CREDITS - 3 (LTP: 3, 1, 0)

Course Objective:

To explain the basic concepts of protective relays and their applications to power systems.

Teaching and Assessment Scheme:

Teaching Scheme (Hours per Week)			Credits	Assessment Scheme				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE	CE	ESE	CE	
3	0	0	3	60	40	0	0	100

Course Contents:

Unit No.	Topics	Teaching Hours
1	**Protective Relaying System** Functions of protective relaying schemes, basic tripping circuit with system transducers, zones of protection, main and backup protection, evolution of protective relaying technology, classification of relays, characteristics of inverse time overcurrent relays, directional relays, differential relays,	8

Unit No.	Topics	Teaching Hours
	advantages of numerical relaying, numerical relaying hardware	
2	**Overcurrent Protection of Transmission Lines:-** Basic radial feeder, time-current discrimination, rules for setting phase and ground IDMT relays, features of numerical overcurrent relays, concept of relay coordination using communication between numerical relays, detailed protective scheme of directional overcurrent protection of a high-voltage transmission line, limitations of overcurrent relays	4
3	**Distance and Carrier Current Protection of Transmission Lines:** Impedance relays, reactance relays, ohm relays, mho relays, quantities to be fed to distance relays, stepped distance characteristics, problems in distance measurement, switched and polyphase distance relaying schemes, limitations of distance protection of transmission lines, pilot wire protection, AC wire pilot wiring, limitations of AC wire pilot wiring, carrier current protection, carrier based distance protection	10
4	**Generator Protection:** Protective relaying schemes for differential, inter-turn fault, stator earth-fault , rotor earth-fault, negative phase sequence, field failure, overload, over-voltage, reverse power, pole-slipping, back-up impedance, under-frequency; class A, class B and class C protections and conditions causing alarms, field suppression, numerical relaying for generator protection	8
5	**Transformer Protection:** Faults in transformers; gas-operated relays; protective relaying schemes for overcurrent restricted earth-fault, differential, over fluxing, grounding transformers, overheating, and small transformers; numerical relaying for transformer protection	6
6	**Bus-zone and Induction Motor Protection:** Requirements of bus-zone protection, busbar differential protection schemes, starting characteristics of an induction motor, faults in induction motors, abnormalities of induction motors, protection of small and large induction motors, numerical induction motor protection relay.	4
7	**Current and Potential Transformers:** Equivalent circuit and vector diagram of a current transformer, construction of current transformers, CT saturation characteristics, difference between CT cores used for measurement and protection purpose, CT errors, Calculation of CT accuracy, factors to be considered while selecting a CT, Problems encountered in a CT, CT requirements for different protective schemes, Specifications of a CT, Equivalent circuit of a PT, construction of a PT, Capacitive Voltage Transformer (CVT), specifications of a PT, introduction to wireless CT and PT	4
	Total	**44**

List of References:

1. B. A. Oza, N.C. Nair, R.P. Mehta and V.H. Makwana, "*Power System Protection and Switchgear*", McGraw Hill Education Ltd., 2010
2. Y. G. Paithankar, S.R. Bhide*, "Fundamentals of Power System Protection",* Prentice Hall, India, 2003
3. S. S. Rao, *"Switchgear Protection And Power Systems"*, Khanna Publisher, New Delhi, 13th Edition, 2012

4. Stanley H. Horowitz, Arun G. Phadke, *"Power System Relaying",* Wiley Publication, 4th Edition, 2014

Web Resources:

1. Web course on *"Power System Protection*" by Prof. S. A. Soman, IIT, Bombay available on NPTEL at http://nptel.ac.in/courses/108101039/
2. **Scilab Textbook Companion for S. S. Rao, *"Switchgear Protection And Power Systems",* Khanna Publisher, New Delhi, 13th Edition, 2012 available at: http://scilab.in/textbook_run/1067**

Course Outcomes (COs):

At the end of this course students will be able to:

1. Understand the principles of protection and the different components involved in protection.
2. Compare advantages and disadvantages of various protective relaying technology like electromagnetic, static and numerical.
3. Compare and analyze the over-current protection, distance protection and carrier-current protection of transmission line
4. Understand the protective schemes used in practice for protection of generator and transformer and compute relay settings.
5. Understand the protective schemes used in practice for protection of bus-zone and induction motor
6. Analyze the working of current transformers and potential transformers and apply them for use in power system protection

4EE02: POWER SYSTEM PROTECTION LABORATORY

CREDITS - 1 (LTP: 0,0,1)

Course Objective:

To understand and test the various types of relays used in the power system protection by conducting various hardware experiments. To perform the relay settings calculations and their coordination and verify various types of protection on hardware simulation panels.

Teaching and Assessment Scheme:

Teaching Scheme (Hours per Week)			Credits	Assessment Scheme				
				Theory Marks		Practical Marks		Total Marks
L	T	P	C	ESE	CE	ESE	CE	
0	0	2	1	-	-	40	60	100

Details of Assessment Instruments under CE Practical Component:

Term work [30]	Allied Evaluation [30]
Attendance/report/presentations/Assignment	Performance/Attitude-Aptitude/Quiz/ Questions & Answers/ Discussion

Experiment List:

Sr. No.	Suggested List of Experiments
1.	Construction and testing of Inverse Definite Minimum Time Overcurrent Relay
2.	Hands-on training on EE make CFB Relay Testing Set
3.	Hands-on training and testing of Numerical Overcurrent Relay - REF615
4.	Application of Numerical Overcurrent Relay to 3-phase two section transmission line
5.	Radial feeder protection – relay setting calculations and coordination
6.	Radial feeder protection – Performance and Verification
7.	Construction and testing of Directional Overcurrent Relay
8.	Parallel feeder protection
9.	Construction & testing of Static Differential relay DTTM-11 and differential protection of transformer using DTTM-11
10.	Differential protection of generator using Static Differential Relay TMAR-10
11.	Hands-on training and application of Numerical Transformer Protection Relay - 7UT513.
12.	Hands-on training and application of Numerical Induction Motor Protection Relay - 7SJ6001.
13.	Hands-on training and application of Numerical Generator Protection Relay - 7UM511
14.	Introduction to protection audit

List of References:

1. B.A. Oza, N.C. Nair, R.P. Mehta and V.H. Makwana, "*Power System Protection and Switchgear"*, McGraw Hill Education Ltd., 2010

Course Outcomes (COs):

At the end of this course students will be able to:

1. To understand the construction and internal connection diagram of various electromagnetic, static and numerical relays.
2. To perform testing and verify the characteristics of various electromagnetic, static and numerical relays.
3. To design relay settings and its coordination for transmission line, transformer, induction motor and generator protection.
4. To apply various electromagnetic, static and numerical relays for protection on hardware simulation in laboratory.

4EE03: COMPUTER AIDED ELECTRICAL MACHINE DESIGN
CREDITS - 3 (LTP: 2, 0, 1)

Course Objective:
To explain the basic concepts of electrical machine design by using different computer optimization techniques.

Teaching and Assessment Scheme:

Teaching Scheme (Hours per Week)			Credits	Assessment Scheme				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE	CE	ESE	CE	
2	0	2	3	30	20	20	30	100

Details of Assessment Instruments under CE Practical Component:

Term work [20]	Evaluation [10]
Presentations/Assignment/Design data/ Sketches	Performance/Quiz/ Questions & Answers/ Discussion

Course Contents:

Unit No.	Topics	Teaching Hours
1	**General Design Aspects:** Calculations of MMF for air gap and teeth, real and apparent flux density, field form, air gap flux distribution factor (field form factor), magnetizing current calculation, leakage reactance calculation for various types of slots, iron loss calculation concepts.	03
2	**Design Of Starter, Field Regulators And Armature Winding:** Schematic diagrams of control circuit and power circuit for starters with contactors and timers, design of starters and field regulators **DC windings:** Simplex & duplex windings; lap & wave windings, basic terms related to armature windings; dummy coils; equalizer connections **AC windings:** Introduction, number of phases, Mush winding, double layer windings.	05
3	**Transformer Design:** Magnetic circuit specific electric and magnetic loadings selection, output equation, core and yoke sections, main dimensions design, core loss from design data, winding design, calculations of magnetizing current, winding resistances and leakage reactance's, losses, performance, temperature rise, cooling methods, radiators, tank wall dimensions.	08
4	**Induction Motor Design:** Output equation, specific electrical and magnetic loading, main dimensions, selection of slots, stator design, stator slots, turns per phase, selection of air gap, unbalanced magnetic pull estimation, harmonic minimization, squirrel cage and wound rotor design, calculation of magnetic circuit, MMF calculations, stator teeth, stator core, effect of saturation, magnetizing current, no load current and its core loss component, leakage fluxes and reactance calculations, performance	08

Unit No.	Topics	Teaching Hours
	calculations - losses, efficiency, temperature rise, maximum torque from circle diagram.	
5	**Computer Aided Design (CAD) of Electrical Machines:** Limitations and assumptions in traditional designs, need of CAD, analysis, synthesis and hybrid methods, design optimization methods, variables, constraints and objective function, problem formulation. Analytical design modules, 2D and 3D machine models, analyzing steady state and transient performance of the designs by different software.	04
	Total	**28**

List of References:

1. A. K. Sawhney – "*A Course in Electrical Machine Design"* 10th Edition, - Dhanpat Rai And sons New Delhi.
2. K. M. Vishnu, "*Computer Aided Design of Electrical Machines*", B.S. Publications, 2008.
3. M Ramamoorty, "*Computer-Aided Design Of Electrical Equipment*", John Wiley & Sons
4. M. G. Say –The Performance and Design of A.C. Machines, 3rd Edition, CBS Publishers and distributors, Delhi, Reprint 2002.
5. R. K. Agarwal, "*Principles of Electrical Machine Design",* S. K. Kataria & Sons, Fifth Edition 2016, New Delhi.

Course Outcomes (COs):

At the end of this course students will be able to:

1. Select proper commercial materials, their properties and selection criterions, IS standards used in electrical machine design.
2. Design commercial starter, armature winding, transformers and induction motors as per specifications.
3. Apply computer aided optimization techniques for design of electrical machines.

4EE04: HARDWARE AND SOFTWARE SKILLS
CREDITS - 1 (LTP: 0,0,1)

Course Objective:

To provide practical exposure to students for measurement, testing simulation and design of various electrical machines, power systems and power electronic based real-life case-studies using hardware and software tools.

Teaching and Assessment Scheme:

Teaching Scheme (Hours per Week)			Credits	Assessment Scheme				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE	CE	ESE	CE	
0	0	2	1	-	-	40	60	100

Experiment List:

Sr. No.	Suggested List of Experiments
1.	Hands on training on various Equipments like ultra-sonic flow meter, power analyzer, thermal imager, van anemometer, sling pshyclometer and lux meter required for energy audit in industry.
2.	Hands-on training for harmonics measurements using Power Quality Analyzer
3.	Hardware simulation of string of insulators for determination of voltage distribution and string efficiency
4.	Hands on training of V/f control method of induction motor (Simatic VF Drive) using PLC
5.	Demonstration of Elevator Control using PLC.
6.	Interfacing and programming of PIC microcontroller kit
7.	Interfacing and programing Field Programmable Gate Array (FPGA) kit
8.	Interfacing and programming of Mixed Signal Processor (MSP) kit
9.	Introduction to Finite Element Method software for high voltage engineering
10.	Symmetrical Fault Analysis using PSCAD software
11.	Unsymmetrical fault Analysis using PSCAD software
12.	Introduction to various library of ETAP software
13.	Load flow of DG connected networks using ETAP software
14.	Overcurrent Relay coordination using ETAP software
15.	Maxwell 2D machine design of transformer using ANSYS software
16.	Maxwell 2D machine design of motors like induction motor, permanent magnet motor using ANSYS software
17.	Simulation and Analysis of three phase controlled bridge rectifier using PSIM software
18.	Simulation and Analysis of three phase inverter circuit using PSIM software
19.	Simulation and analysis of PWM based inverter in MATLAB
20.	Simulation and analysis of AC voltage controller and cycloconvertor in MATLAB

Details of Assessment Instruments under CE Practical Component:

Term work [30]	Allied Evaluation [30]
Attendance/report/presentations/Assignment	Performance/Attitude-Aptitude/Quiz/ Questions & Answers/ Discussion

Course Outcomes (COs):

At the end of this course students will be able to:

1. To provide hands-on training and develop skills for hardware implementation of measurement, testing and commissioning of various equipment in Electrical Engineering.
2. To simulate, design and analyze various power system circuits using software packages
3. To simulate, design and analyze various electrical machines and power electronics circuits using software packages

4EE32: PROJECT STAGE-I
CREDITS – 2 (LTP: 0,0,2)

Course Objective:

The objective of Electrical Project is to enable the student to identify the areas and scope of building new and innovative projects in the broad field of Electrical Engineering, using various software and hardware tools under the guidance of a Supervisor. The aim is to create awareness about the concept of electrical engineering, circuit simulation, analysis, evaluation, hardware development, program development, etc. to act like a beginners guide to do larger projects later in their career.

Teaching and Assessment Scheme:

Teaching Scheme (Hours per Week)			Credits	Assessment Scheme				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE	CE	ESE	CE	100
0	0	4	2	0	0	40	60	

Course Contents:

Under the subject the students are supposed to:

1. Explore and strengthen the understanding of fundamentals through practical application of theoretical concept.
2. Survey and study of published literature on the assigned topic.
3. Working out a preliminary Approach to the Problem relating to the assigned topic.
4. Conducting preliminary Analysis/ Modelling /Simulation /Experiment /Design/Feasibility.
5. Preparing a Written Report on the Study conducted for presentation to the Department

Course Outcomes (COs):

At the end of this course students will be able to …

1. Learning latest trends and technology in the selected field of interest.
2. Apply the acquired knowledge to practical situations.
3. Boost their skills and widen your horizon of thinking
4. Enhance presentation and documentation skills.

4EE42: HIGH VOLTAGE DC TRANSMISSION SYSTEMS
CREDITS - 3 (LTP: 3,0,0)

Course Objective:

To impart fundamental and advanced technologies of HVDC transmission system with its control aspects.

Teaching and Assessment Scheme:

Teaching Scheme (Hours per Week)			Credits	Assessment Scheme				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE	CE	ESE	CE	**100**
3	0	0	3	60	40	0	0	

Course Contents:

Unit No.	Topics	Teaching Hours
1.	**Introduction to HVDC Technology:** Evolution of HVDC Transmission, comparison of EHVAC and HVDC systems, Type of HVDC Transmission systems, components of HVDC transmission systems, modern trends in DC transmission, types of HVDC systems, HVDC cables: design and challenges, DC power cables design and challenges, undersea cables technology: design and challenges.	06
2.	**Analysis of HVDC Converters:** Analysis of rectifier circuits, required features of rectification circuits for HVDC transmission, analysis of HVDC converter, pulse number-choice of converter configuration, different modes of converter operation, output voltage waveforms and DC voltage in rectification, output voltage waveforms and DC in inverter operation, 12- pulse converter based HVDC systems and characteristics, thyristor voltages, protection of valve circuit, harmonic analysis, filter design basics	12
3.	**Control of HVDC links:** HVDC system control features, principal of DC link control, control modes of converters, firing angle control schemes, comparison of control schemes, converter mal-operations, commutation failure, converter protection, starting and stopping of DC link, reactive power requirements	08
4.	**Power Flow Analysis of HVDC System Connected with AC Grid:** Power flow analysis of AC-DC systems, transient stability analysis, dynamic stability analysis, faults and its control, HVDC system control and renewable energy generation, multi-terminal HVDC system.	08
5.	**VSC based HVDC Converters:** Concepts of VSC based converters, pulse width and advanced techniques for VSC converters, harmonic elimination and voltage control technology, control of VSC based HVDC for smooth integration of renewable energy systems in grid, HVDC light and HVDC plus technology	08
6.	**Case Studies and Analysis of HVDC Technology:** Case study of HVDC link in India, case study of HVDC link in World, Introduction to design and analysis software's like MATLAB and PSS®E Xplore	03
	Total	**45**

List of References:

1. K R Padiyar, *"HVDC Power Transmission Systems*", 2nd edition, New Age International Publication, 2012.
2. S. Kamakshaiah, V. Kamaraju, *"HVDC Transmission"*, 2nd edition, McGraw Hill Publications, 2011.
3. EHV-AC, HVDC Transmission & Distribution Engineering (Theory, Practice and Solved Problems), 3rd Edition, 5th Reprint, 2016, Khanna Publications.
4. J Arrillaga, *"High Voltage Direct Current Transmission",* Peter Peregrinus Ltd, UK.
5. E W Kimbark, *"Direct Current Transmission"*, Wiley-Inter science, New York.
6. S N Singh, *"Electric Power Generation, Transmission and Distribution"*, PHI Publications, New Delhi 2nd edition, 2008.

Web Resources:

1. Web course on "High Voltage DC Transmission" by Dr. S N Singh, IIT Kanpur available on NPTEL at https://nptel.ac.in/courses/108/104/108104013/

Course Outcomes (COs):

At the end of this course students will be able to:

1. Understand and compare various aspects of HVDC systems with reference to EHV AC systems.
2. Analyze and design the control strategies for HVDC Converters
3. Analyze the different control strategies for power flow between HVDC and grid
4. Justify the use of VSC based HVDC technology for tapping of renewable energy in grid.

4EE43: POWER QUALITY AND FACTS
CREDITS - 3 (LTP: 3,0,0)

Course Objective:

To explain the basic concepts of power quality issues in power systems, and its measurement techniques. Also explain working principles of FACTS devices, their operating characteristics and understand the characteristics of ac transmission and the effect of shunt and series reactive compensation.

Teaching and Assessment Scheme:

Teaching Scheme (Hours per Week)			Credits	Assessment Scheme				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE	CE	ESE	CE	
3	0	0	3	60	40	00	00	100

Course Contents:

Unit No.	Topics	Teaching Hours
1.	**Introduction to Power Quality:** Terms and definitions of transients, long duration voltage variations: under voltage, under voltage and sustained interruptions; short duration voltage variations: interruption, sag, swell, voltage imbalance; notching DC offset, waveform distortion, voltage fluctuation; power frequency variations.	06
2.	**Voltage Sag:** Sources of voltage sag, motor starting, arc furnace, fault clearing, estimating voltage sag performance and principle of its protection; solutions at end user level- Isolation Transformer, Voltage Regulator, Static UPS, rotary UPS, introduction of active series compensator.	07
3.	**Harmonics:** Causes of harmonics, current and voltage harmonics, measurement of harmonics, effects of harmonics on –transformers, ac motors, capacitor banks, cables, and protection devices, energy metering, communication lines etc., harmonic mitigation techniques, IEEE 519 guideline for harmonics, harmonic analysis using computer software, Introduction to active and passive filters in	08

Unit No.	Topics	Teaching Hours
	power system.	
4.	**Power Quality Measurement:** Power quality measurement devices, power quality measurements, number of test locations, test duration, instrument setup and instrument set up guidelines.	04
5.	**Transmission Lines and Series/Shunt Reactive Power Compensation:** Basics of EHV AC transmission line and importance of interconnections, analysis of uncompensated AC transmission lines, passive reactive power compensation, shunt and series compensation at the mid-point of an AC line. comparison of series and shunt compensation	04
6.	**Thyristor-based Flexible AC Transmission Controllers (FACTS):** Description and Characteristics of Thyristor-based FACTS devices: Static VAR Compensator (SVC), Thyristor Controlled Series Capacitor (TCSC), configurations/modes of operation, harmonics and control of SVC and TCSC, applications of SVC's and case studies.	06
7.	**Voltage Source Converter based (FACTS) Controllers:** Fundamentals of Voltage Source Converters (VSC) for FACTs, six pulse VSC, Multi-pulse and Multi-Level Converters, Pulse-Width Modulation for VSCs. Selective Harmonic Elimination (SHE), Sinusoidal PWM and Space Vector Modulation (SVM), STATCOM: Principle of operation and applications, Static Synchronous Series Compensator (SSSC): Operation and applications, Unified Power Flow Controller (UPFC): Principle of Operation and control, GTO Controlled Series Compensator, application of FACTS devices for power-flow control and stability improvement with case studies.	10
	Total	**45**

List of References:

1. Roger C. Dugan, Mark F. Mcgranaghan, Surya Santoso, "*Electrical Power Quality*", Tata McGraw-Hill Publications.
2. Jos Arrillaga, Neville R. Watson, "*Power System Harmonics*", John Wiley and Sons Ltd.
3. Bhim Singh, Ambrish Chandra and Kamal Al-Haddad, "*Power Quality: Problems and Mitigation Techniques*", Wiley 2015.
4. N.G. Hingorani, L. Gyugyi, *"Understanding FACTS: Concepts and Technology of Flexible AC Transmission Systems,"* IEEE Press, N.Y., 2000.
5. R. Mohan Mathur, R K Verma, *"Thyristor-based FACTS controllers for Electrical Transmission Systems",* Wiley IEEE Press
6. Padiyar K R,, *"FACTS Controllers in Power Transmission & Distribution",* New Age International Publications.

Web Resources:

1. Web course on *"Power Quality in distribution systems*" by Dr. Mahesh Kumar Professor Department of Electrical Engineering Indian Institute of Technology Madras, available on NPTEL at https://nptel.ac.in/courses/108/106/108106025/
2. Video course on "FACTS Devices" by Prof. Avik Bhattacharya, IIT Roorkee, available on NPTEL at https://nptel.ac.in/courses/108/107/108107114/

Course Outcomes (COs):

At the end of this course students will be able to:

1. Understand the major power quality problems.
2. Understand and analyze harmonics in power systems.

3. Use equipment that are required to measure the quality of power.
4. Understand FACTS devices and analyze reactive power requirement and management.

4EE44: INDUSTRIAL ELECTRICAL SYSTEMS
CREDITS - 3 (LTP: 3,0,0)

Course Objective:
To explain basic concepts and applications of industrial electrical systems

Teaching and Assessment Scheme:

Teaching Scheme (Hours per Week)			Credits	Assessment Scheme				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE	CE	ESE	CE	
3	0	0	3	60	40	0	0	100

Course Contents:

Unit No.	Topics	Teaching Hours
1	**Electrical System Components:** 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.	08
2	**Residential and Commercial Electrical Systems:** Types of residential and commercial wiring systems, general rules and guidelines for installation, load calculation and sizing of wire, rating of main switch, distribution board and protection devices, earthing system calculations, requirements of commercial installation, deciding lighting scheme and number of lamps, earthing of commercial installation, selection and sizing of components.	08
3	**Illumination Systems:** Understanding various terms regarding 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 for a residential and commercial premises, floodlighting.	06
4	**Industrial Electrical Systems I:** HT connection, industrial substation, Transformer selection, Industrial loads, motors, starting of motors, SLD, 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, introduction to Ring Main Unit (RMU), introduction to communication technology in power utility, village electrification.	08

Unit No.	Topics	Teaching Hours
5	**Industrial Electrical Systems II:** DG Systems, UPS System, electrical systems for the elevators, battery banks, Sizing the DG, UPS and battery banks, selection of UPS and battery banks.	06
6	**Industrial Electrical System Automation:** Study of basic PLC, Role of in automation, advantages of process automation, PLC based control system design, panel metering and Introduction to SCADA system for distribution automation.	06
	Total	**45**

List of References:

1. S. L. Uppal and G.C. Garg, *"Electrical Wiring, Estimating & Costing*", Khanna publishers, 2008.
2. K. B. Raina, "*Electrical Design, Estimating & Costing*", New age International, 2007.
3. S. Singh and R. D. Singh, *"Electrical estimating and costing*", Dhanpat Rai and Co., 1997.
4. H. Joshi, "*Residential Commercial and Industrial Systems*", McGraw Hill Education, 2008.

Course Outcomes (COs):

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

1. Understand the electrical wiring systems for residential, commercial and industrial consumers, representing the systems with standard symbols and drawings, SLD.
2. Understand various components of industrial electrical systems.
3. Analyze and select the proper size of various electrical system components.

4EE45: POWER SYSTEM DYNAMICS AND CONTROL
CREDITS - 3 (LTP: 3, 0, 0)

Course Objective:

This course aims to give an insight into the dynamic models of power system components. It also deals with analysis and control strategies for the smooth and reliable operation of a power system.

Teaching and Assessment Scheme:

Teaching Scheme (Hours per Week)			Credits	Assessment Scheme				
				Theory Marks		Practical Marks		Total Marks
L	T	P	C	ESE	CE	ESE	CE	
3	0	0	3	60	40	0	0	100

Course Contents:

Unit No.	Topics	Teaching Hours
1	**Generator Modeling - I (Machine View Point):** Introduction, classical machine description, voltage generation, open-circuit voltage, examples, armature reaction, terminal voltage, examples, power delivered by generator, synchronizing generator to an infinite bus, example, synchronous condenser, role of synchronous machine excitation in controlling reactive power.	05

Unit No.	Topics	Teaching Hours
2	**Generator Modeling - ii (Circuit View Point):** introduction, energy conversion, examples, application to synchronous machine, the park transformation, exercise, park's voltage equation, park's mechanical equation, circuit model, instantaneous power output, applications, application 1: voltage buildup, application 2: symmetrical short circuit, application 3 : non synchronous operation, synchronous operation, examples, steady-state model, simplified dynamic model, examples, generator connected to infinite bus (linear model), problems.	11
3	**Excitation and Prime Mover Controllers:** Excitation system, excitation system modeling, excitation systems- standard block diagram, system representation by state equations, prime mover control system, examples.	04
4	**Transmission Lines, SVC and Loads:** Transmission lines, d-q transformation using α-β variables, static var compensators, loads.	04
5	**Dynamics of a Synchronous Generator Connected to Infinite Bus:** System model, synchronous machine model, application of model, calculation of initial conditions, system simulation, consideration of other machine model, inclusion of svc model.	06
6	**Analysis of Single Machine System:** Small signal analysis with block diagram representation, characteristic equation and application of Routh-Hurwithz criterion, synchronizing and damping torques analysis, small signal model: state equation, nonlinear oscillations – HOPF bifurcation.	06
7	**Analysis of Multi-machine System:** A simplified system model, detailed models: CASE I, detailed models, CASE II, inclusion of load and svc dynamics, modal analysis of large power systems, case studies.	06
	Total	**42**

List of References:

1. Vijay Vittal, Bergen , "Power Systems Analysis", Pearson Education
2. K R Padiyar, "Power System Dynamics Stability and Control", B S Publications
3. P.Kundur, "Power System Stability & Control", Tata Mcgraw hill
4. Paul C. Krause, Oleg Wasynczuk and Scott D. Sudhoff, "Analysis of Electric Machinery and Drive Systems", John Wiley & Sons, New York

Course Outcomes (COs):

At the end of this course students will be able to:

1. Explain the dynamic models of power system components.
2. Select the appropriate model depending on the analysis to be done.
3. Explain the controllers and their significance in power system.
4. Prepare the detailed simulations for single machine and multi-machine systems.

4EE46: DIGITAL CONTROL SYSTEMS
CREDITS - 3 (LTP: 3, 0, 0)

Course Objective:

To provide knowledge of conceptual evolution of digital control systems and analytical techniques for digital control systems. Also to brief about compensation and its manifestation in digital control domain.

Teaching and Assessment Scheme:

Teaching Scheme (Hours per Week)			Credits	Assessment Scheme				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE	CE	ESE	CE	100
3	0	0	3	60	40	00	00	

Course Contents:

Unit No.	Topics	Teaching Hours
1	**Introduction To Digital Control Systems:** Discrete time system representation, mathematical modelling of sampling process, data reconstruction.	05
2	**Modelling Discrete-Time Systems:** Pulse transfer function: revisiting Z-transform, mapping of s-plane to z-plane, pulse transfer function of closed loop system.	06
3	**Stability Analysis of Discrete Time Systems:** Jury stability test, stability analysis using bi-linear transformation, time response of discrete systems.	04
4	**Design of Sampled Data Control Systems:** Root locus method, controller design using root locus, Root locus based controller design using MATLAB, Bode plot.	08
5	**Discrete State Space Model:** Introduction to state variable model, various canonical forms, characteristic equation, state transition matrix, solution to discrete state equation.	06
6	**Controllability, Observability and Stability of Discrete State Space Models:** Controllability, observability and stability of discrete state space models, controllability and observability, Lyapunov stability theorem.	08
7.	**Models of Digital Control Devices and Systems:** Implementation of digital controllers, tunable PID controllers, digital temperature control system, digital position control system, stepping motors and their control, Programmable Logic Controllers (PLC).	08
	Total	**45**

List of References:

1. B. C.Kuo, "Digital Control Systems", Oxford University Press, 2nd Edition, Indian Edition, 2007.
2. K. Ogata, "Discrete Time Control Systems", Prentice Hall, 2nd Edition, 1995.
3. M. Gopal, "Digital Control and State Variable Methods", Tata McGraw Hill, 2nd Edition, 2003.
4. G. F. Franklin, J. D. Powell and M. L. Workman, Digital Control of Dynamic Systems, Elliskagle Press.
5. A. K. Triphathi D. Chandra, and Rajeev Gupta, "Control System Analysis and Design", 2nd Edition, New Age International Publication 2015.
6. Constantine H. Houpis, Gary B. Lamont, "Digital Control Systems--theory, Hardware and Software", 1985 McGraw Hill Publications.

Web Resources:

1. Web course on "Digital Control Systems", by Dr. Indrani Kar and Prof. S. Majhi, IIT, Guwahati NPTEL at *https://nptel.ac.in/courses/108/103/108103008/*
2. Video course on "Control Engineering", by Dr. S D Agashe, IITB, NPTEL at *https://nptel.ac.in/courses/108/101/108101037*/

Course Outcomes (COs):

At the end of this course students will be able to:

1. Understand the analysis techniques for digital control systems.
2. Explores and practices different analysis in different parlance
3. Apply and analyze/compare techniques to understand design of digital controllers.
4. Analyze practical digital control systems and get a grip on its working.

4EE47: DIGITAL SIGNAL PROCESSING
CREDITS - 3 (LTP: 3, 0, 0)

Course Objective:

To understand the fundamental and advanced concepts of digital signal processing, filter design, digital signal processors and frequency domain analysis of discrete time systems as well.

Teaching and Assessment Scheme:

Teaching Scheme (Hours per Week)			Credits	Assessment Scheme				
				Theory Marks		Practical Marks		Total Marks
L	T	P	C	ESE	CE	ESE	CE	
3	0	0	3	60	40	0	0	100

Course Contents:

Unit No.	Topics	Teaching Hours
1	**Introduction to Digital Signal Processing:** Revising signals and systems classification, fundamentals of signal processing, block diagram and elements of digital signal processing system, concept of frequency in continuous and discrete time signals, periodic sampling, frequency domain representation of sampling, reconstructions of band limited signals from its samples	08
2	**Discrete-Time Signals and Systems (Frequency Domain analysis):** Z-transform & Inverse z-transform with their properties, linear convolution and its properties, difference equations and solutions by Z transform, frequency domain representation of discrete-time signals & systems, representation of sequences by Discrete Time Fourier Transform, (DTFT), properties of Discrete Time Fourier Transform, and correlation of signals, Fourier Transform theorems.	06
3	**Structures for Discrete Time Systems:** Block Diagram and signal flow diagram representations of difference equations, basic structures of IIR systems, lattice and lattice-ladder structures, transposed forms, direct and cascade form structures for FIR systems, linear phase FIR structure, effects of co-efficient quantization.	12

Unit No.	Topics	Teaching Hours
4	**Design of Digital Filters:** FIR & IIR filter realization – parallel & cascade forms. FIR design: windowing techniques – need and choice of windows – linear phase characteristics, analog filter design – Butterworth and Chebyshev approximations; IIR Filters, digital design using impulse invariant and bilinear transformation warping, pre warping.	08
5	**Advance DSP Techniques:** Multi-rate signal processing: decimation, interpolation, sampling rate conversion by rational factor adaptive filters: Introduction, basic principles of forward linear predictive filter and applications such as system identification, echo cancellation, equalization of channels and beam forming using block diagram representation study.	06
6	**Architecture of Digital Signal Processors and their Applications:** Introduction to architecture, features and addressing formats, Multiplier-Accumulator (MAC) hardware, functional modes, fixed and floating mode DSP processors, introduction to commercial Digital Signal Processors and their applications.	05
	Total	**45**

List of References:

1. Lawrance Rabiner, Barnar Gold, "Theory And Application Of Digital Signal Processing", Eastern Economy Edition, PHI Publications.
2. J.G. Proakis and D.G. Manolakis, "Digital Signal Processing Principles, Algorithms and Applications", Pearson Education, New Delhi, 2003.
3. S.K. Mitra, "Digital Signal Processing" – A Computer Based Approach", McGraw Hill Education, 2013.
4. N. G. Palan, "Digital Signal Processing", TechMax Publications Pune, 2012
5. Lonnie C. Ludeman , "Fundamentals of Digital Signal Processing", Wiley Publications, 2013.

Delivery Methods:

1. Lectures
2. Assignments/Seminar
3. Power Point Presentation
4. Expert talk by Industry/Academician

Web Resources:

1. Video course on "Digital Signal Processing" by Prof. S C Dutta Roy, IIT Delhi, available on NPTEL at https://nptel.ac.in/courses /117/102/117102060/
2. Web course on "Digital Video Signal Processing" by Prof. Sumana Gupta IIT kanpur, available on NPTEL at https://nptel.ac.in/courses /117/104/117104020/

Course Outcomes (COs):

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

1. Understand fundamental and advanced concepts of digital signal processing.
2. Analyze discrete time systems in frequency domain.
3. Design digital filters.
4. Acquire knowledge of programming of various processors and their applications.

4EE49: CONDITION MONITORING OF ELECTRICAL EQUIPMENTS
CREDITS - 3 (LTP: 3, 0, 0)

Course Objective:
This course will enable the students to acquire basic skills of condition monitoring and diagnostic techniques of electrical equipment's**.**

Teaching and Assessment Scheme:

Teaching Scheme			Credits	Assessment Scheme				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE	CE	ESE	CE	
3	0	0	3	60	40	00	00	100

Course Content:

Unit No.	Topics	Teaching Hours
1	**Introduction –** Review of today's Industry and role of condition monitoring.	01
2	**Maintenance Management and Applied Strategies:** Maintenance and management systems, basic principles of maintenance strategies – preventive maintenance, predictive maintenance, proactive maintenance, reliability entered maintenance, total productive maintenance, structure of the maintenance management system – maintenance objectives, assets management, human resources in maintenance, spare parts management, determination of maintenance (strategy) per equipment, Introduction to asset management softwares: ArcGIS for asset mapping	05
3	**Condition Monitoring and Diagnostics of Transformer:** Introduction, transformer diagnostics, transformer maintenance and power plant rehabilitation. **Dissolved Gas Analysis** – Background, transformer diagnosis using individual and total dissolved key gas concentrations, diagnosing a transformer problem using dissolved gas analysis and the Duval triangle, expertise needed. **Oil Physical / Chemical Tests** – Transformer oil tests that should be performed annually with the dissolved gas analysis, dielectric strength, Inter Facial Tension (IFT), acid number, furans, oxygen, oxygen inhibitor, oil power factor, moisture. **Age Test on Insulation –** Insulation power factor test, capacitance tests, excitation current test, bushing tests, percentage impedance / leakage reactance test, sweep frequency response analysis tests. **Visual Inspection** – Background, temperature indicators online, temperature indicators offline, conservator, conservator breather, nitrogen, oil leaks, pressure relief device, oil pumps, fans and radiators, Buchholz relay, bladder failure relay, **Infrared Temperature Analysis** – IR for transformer tanks, IR for surge arresters, IR for	15

Unit No.	Topics	Teaching Hours
	bushings, IR for radiators and cooling systems. **Corona Scope Scan** **Ultrasonic and Sonic Fault Detection –** Background, process. **Vibration Analysis** – Background. **Turns Ratio Test** – Background, process. **DC Winding Resistance Measurement** – Background, process. **Core Insulation Resistance and Inadvertent Core Ground Test** – Background, process. **Estimate of Paper Deterioration (Online)** – CO_2 and CO accumulated total gas values, CO_2/CO ratio, furans. **Estimate of Paper Deterioration (Offline During Internal Inspection) –** Degree of Polymerization (DP), background, process. **Internal Inspection** – Background. **Transformer Borescope** **Transformer Operating History** – Background **Transformer Diagnostics / Condition Assessment Summary**	
4	**Condition Monitoring of Rotating Electrical Machines:** **Construction, operation and failure modes of electrical machines –** Introduction, materials and temperature, construction of electrical machines – general, stator and frame, rotors, windings, enclosures, connections, summary. structure of electrical machines and their types**,** machine specification and failure modes, insulation ageing mechanism **–** general, thermal ageing, electrical ageing, mechanical ageing, environmental ageing, synergism between ageing stresses. insulation failure modes **–** general, stator winding insulation, stator winding faults, rotor winding faults. other failure modes **–** stator core faults, connection faults (high-voltage motors and generators), water coolant faults (all machines), bearing faults, shaft voltages. conclusion. **Instrumentation requirements –** Introduction, temperature measurement, vibration measurement – general, displacement transducers, velocity transducers, accelerometers. force and torque measurement, electrical and magnetic measurement, wear and debris measurement, signal conditioning, data acquisition conclusion. **Temperature Monitoring –** Introduction, local temperature measurement, hot-spot measurement and thermal images, bulk measurement, conclusion. **Vibration monitoring** – Introduction, stator core response – general, calculation of natural modes, stator electromagnetic force wave. stator end-winding response, rotor response – transverse response, torsional response. bearing response – general, rolling element bearings, sleeve bearings. monitoring techniques – overall level monitoring, frequency spectrum monitoring, faults detectable from the stator force wave, torsional oscillation monitoring, shock pulse monitoring. conclusion. **Electrical techniques: current, flux and power monitoring** Introduction, generator and motor stator faults – generator stator winding fault detection, stator current monitoring for stator faults, brush gear fault detection,	23

Unit No.	Topics	Teaching Hours
	rotor-mounted search coils. generator rotor faults – general, earth leakage faults on-line, turn-to-turn and earth leakage faults off-line. motor rotor faults – general, air gap search coils, stator current monitoring for rotor faults, rotor current monitoring, generator and motor comprehensive methods – general, shaft flux, stator current, power, shaft voltage or current, mechanical and electrical interaction. effects of variable speed operation, conclusion.	
5	**Condition-based maintenance and asset management:** Introduction, condition-based maintenance, life-cycle costing, asset management, conclusion	02
	Total	**45**

List of References:

1. Zhaklina Stamboliska, Eugeniusz Rusinski, Przemyslaw Moczko, "Proactive Condition Monitoring of Low-Speed Machines", Springer International Publishing Switzerland 2015.
2. Hydroelectric Research and Technical Services Group, "Facilities Instructions, Standards, and Techniques (FIST) Volume 3-31, Transformer Diagnostics", United States Department of the Interior, Bureau of Reclamation, June 2003.
3. Peter Tavner, Li Ran, Jim Penman, Howard Sedding, "Condition Monitoring of Rotating Electrical Machines", The Institution of Engineering and Technology, London, United Kingdom, 2008.
4. Hamid A. Toliyat, Subhasis Nandi, Seungdeog Choi, Homayoun Meshgin-kelk "Electric Machines Modeling, Condition Monitoring and Fault Diagnosis", CRC Press, Taylor & Francis Group.
5. Kulkarni S. V. and Khaparde S. A., " Transformer Engineering – Design, Technology and Diagnostics" Second Edition, CRC Press, New York

Web Resources:

1. http://www.bis.org.in/index.asp
2. http://www.ieee.org/publications_standards/publications_standards_index.html
3. http://www.nema.org/Standards/About-Standards/pages/default.aspx
4. http://www.ni.com/condition-monitoring/
5. http://spectraquest.com/resources/technotes/
6. CIGRE working group report: WA2.34, Guide for Transformer maintenance.
7. CIGRE working group report: A2.26 Mechanical-Condition Assessment of Transformer winding using Frequency Response Analysis (FRA)
8. Rogers RR (1978) IEEE and IEC codes to interpret incipient faults in transformers using gas in oil analysis, IEEE Trans Electrical Insulation 13(5): 348-354.
9. IEC 60076 – 18 Ed. 1: Power Transformer Part – 18, "Measurement of Frequency Response", United Kingdom, July 2012.

Course Outcomes (COs):

At the end of this course students will be able to:

1. Identify and understand the significance of role of condition monitoring.
2. Assess the condition of various electrical equipments.
3. Identify amount of damage/deterioration in the electrical equipments.
4. Check the mechanical integrity of the electrical equipments.
5. Implement condition monitoring plan for complete electrical system

4EE50: DISTRIBUTED GENERATION
CREDITS - 3 (LTP: 3, 0, 0)

Course Objective:
To explain basic concepts & issues related to distribution generation and impact of distribution generation on power system.

Teaching and Assessment Scheme:

Teaching Scheme (Hours per Week)			Credits	Assessment Scheme				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE	CE	ESE	CE	
3	0	0	3	60	40	00	00	100

Course Content:

Unit No.	Topic	Teaching Hours
1	**Sources of Energy:** Brief introduction of solar energy, wind energy, combined heat-and-power, hydro energy, tidal power, wave energy, geothermal energy, biomass and fuel cell, micro turbines, internal combustion engines.	06
2	**Distributed Generation Technologies For Increased Efficiency:** Single phase & three phase distributed generation technologies, integration issues, future network architectures with DG's, economics of distributed generation.	08
3	**Impact of Distributed Generation on the Power System:** Power quality, voltage quality and design of distributed generation overloading: radial distribution networks overloading: redundancy and meshed operation	07
4	**Power Quality Disturbances:** Impact of distributed generation on power system protection, over current protection, calculation of fault currents, protection of distributed generators.	07
5	**Transmission System Operation:** Impact of distributed generation: before the fault, during the fault, critical fault-clearing time, after the fault, importing area.	05
6	**Energy Storage:** Various batteries, ultra-capacitors, fly wheels, super conducting magnetic storage, pumped hydroelectric storage, compressed air energy storage.	05
7	**Overview of Micro-Grid** Concept and definition of microgrid, microgrid drivers and benefits, review of sources of microgrids, typical structure and configuration of a microgrid, AC and DC microgrids, stability issues of microgrid.	04
	Total	**42**

List of References:

1. N. Jenkins, J. B. Ekanayake, G. Strbac, "Distributed Generation", IET, Renewable Energy Series, 2010.
2. Math H. Bollen, Fainan Hassan, "Integration of Distributed Generation in the Power System", Wiley – IEEE Press, July 2011.
3. Magdi S. Mahmoud, Fouad M. Al-Sunni, "Control and Optimization of Distributed Generation Systems", Springer.
4. Ranjan Rakesh, Kothari D. P., Singal K. C., "Renewable Energy Sources and Emerging Technologies", 2nd Edition, Prentice Hall India Learning Private Limited, 2011.
5. Li Fusheng, Li Ruisheng, Zhou Fengquan, "Microgrid Technology and Engineering Appication", Elsevier.

Web Resources:

1. Video Lecture: http://nptel.ac.in/courses/108108034/21/ Electrical Engineering – Power Electronics and Distributed Generation, IISc Bangalore
2. Video lecture :http://freevideolectures.com/Course/3383/Power-Electronics-and-Distributed-Generation, IISc Bangalore, Prof. Vinod John

Course Outcomes (COs):

At the end of this course students will be able to:

1. Identify and understand the significance of various sources of energy.
2. Appreciate economics of distributed generation.
3. Understand power quality, voltage quality and design of distributed generation.
4. Appreciate impact of distributed generation on power system protection.
5. Understand the function and importance of various energy storage devices.
6. Appreciate brief introduction of Micro Grid.

4EE51: RESTRUCTURING OF POWER SYSTEMS
CREDITS - 3 (LTP: 3, 0, 0)

Course Objective:

To explain basic concepts and issues related with restructuring and deregulation of power industry.

Teaching and Assessment Scheme:

Teaching Scheme (Hours per Week)			Credits	Assessment Scheme				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE	CE	ESE	CE	
3	0	0	3	60	40	0	0	100

Course Contents:

Unit No.	Topics	Teaching Hours
1	**Introduction to Restructuring of Power Industry:** Introduction, reasons for restructuring/deregulation, understanding the restructuring process and frame work, issues involved in deregulation, reasons	05

Unit No.	Topics	Teaching Hours
	and objectives of deregulation of various power systems across the world.	
2	**Fundamentals of Economics and Market Models:** Introduction, consumer behavior, supplier behavior, market equilibrium, short-run and long-run costs, various costs of production, perfectly competitive market, philosophy of market models, market models based on contractual arrangements, comparison of various market models, electricity vis-a-vis other commodities, market architecture, trading of electric energy.	08
3	**Transmission Congestion Management and Locational Marginal Prices:** Classification of congestion management methods, calculation of ATC, non-market methods, nodal pricing, inter-zonal and intra-zonal congestion management, price area congestion management, capacity alleviation method; fundamentals of Locational Marginal Pricing (LMP), LMP formulation and implementation, LMP using DCOPF.	08
4	**Ancillary Service Management:** Introduction, types of ancillary services, classification, load-generation balancing related services, voltage control and reactive power support services, black start capability services, mechanism for ancillary services, co-optimization of energy and reserve services, international comparison.	08
5	**Pricing of Transmission Network Usage and Loss Allocation:** Introduction, principles of transmission pricing, classification of transmission pricing method, rolled in transmission pricing, marginal transmission pricing, composite pricing paradigms, comparison between different paradigms, debated issues in transmission pricing; introduction to loss allocation methods, classification of loss allocation methods, comparison between various methods.	08
6	**Reforms in Indian Power Sector:** Framework of Indian Power Sector, reform initiatives during 1990-1995, The Availability Based Tariff (ABT) and Deviation Settlement Mechanism (DSM), Indian Electricity Act 2003, open access issues, power exchange, discussion of role of RLDC, NLDC and ALDC.	05
	Total	**45**

List of References:

1. S. A. Khaparde and A. R. Abhyankar, “Restructured Power Systems”, Alpha Science, U.K., 2011.
2. PRAYAS Energy Group, “Know Your Power, A citizens Primer on the Electricity Sector”, Second Edition, PRAYAS Energy Group, Pune, 2006.
3. S. R. Paranjothi, “Modern Power Systems – The Economics of Restructuring”, 1st Edition, New Age International Pvt. Ltd., 2017.
4. Lo Lei Lai, “Power System Restructuring and Deregulation: Trading, Performance and Information Technology”, Indian Edition, Wiley India Ltd., 2001.
5. Mohammad Shahidehpour, Muwaffaq Alomoush, “Restructured Electrical Power Systems: Operation, Trading and Volatility”, CRC Press, 2001.
6. Daniel Krischen and Goran Strbac, “Fundamental of Power System Economics”, John Wiley and Sons Ltd ,2004.
7. Sally Hunt, “Making Competition Work in Electricity”, John Wiley and Sons, Inc.,2002.
8. Steven Stoft , “Power System Economics: Designing Markets for Electricity” , Wiley- IEEE Press

Web Resources:

1. Web course on “Restructured Power Systems” by Prof. Abhijit Abhayankar IITD, Prof. S A Khaparde, IITB available on nptel at https://nptel.ac.in/courses/108/101/108101005/

Course Outcomes (COs):

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

1. Identify, formulate and solve electrical engineering problems in the broad area like power systems and its economics.
2. Understand market models and mechanisms for electricity as a commodity.
3. Appreciate legal, financial and economic issues related with transmission congestion management, locational marginal pricing and ancillary management.
4. Appreciate issues like fairness and social welfare with reference to transmission system usage and loss allocation.
5. Appreciate the need of reforms in power sector with focus on Indian power sector.

4EE52: SMART GRID
CREDITS - 3 (LTP: 3, 0, 0)

Course Objective:

To provide students with a working knowledge of fundamentals and *d*evelopment of Smart Grid, from the basic concepts of power systems.

Teaching and Assessment Scheme:

Teaching Scheme			Credits	Assessment Scheme				
L	T	P	C	Theory Marks		Practical Marks		Total Marks
				ESE	CE	ESE	CE	
3	0	0	3	60	40	0	0	100

Course Contents:

Unit No.	Topics	Teaching Hours
1	**Smart Grid Architectural Designs:** Introduction, smart grid definition and development , today's grid versus the smart grid, stakeholders in smart grid, energy independence and security act of 2007: rationale for the smart grid, computational intelligence, power system enhancement, communication and standards, environment and economics, general view of the smart grid market drivers, stakeholder roles and function, smart grid based performance measures, representative architecture, functions of smart grid components	07
2	**Smart Grid Communications And Measurement Technology :** Communication and measurement, monitoring PMU, Smart Meters, and measurements technologies, GIS and Google mapping tools, Multi Agent Systems (MAS) technology, Micro grid and Smart Grid comparison	07
3	**SCADA Fundamentals:** Intelligent electronic devices (IEDs), Data concentrators and merging units, SCADA communication systems, Master station, Human-Machine Interface (HMI), Building the SCADA systems, legacy, hybrid, and new systems, Classification of SCADA systems	07

Unit No.	Topics	Teaching Hours
4	**Substation Automation:** Introduction: Conventional substations: islands of automation, new smart devices for substation automation, and the new integrated digital substation, substation automation: technical issues, the new digital substation, substation automation architectures, new versus existing substations, substation automation (SA) application functions.	08
5	**Energy Management Systems (Ems) For Control Centers:** Introduction. operating states of the power system and sources of grid vulnerability, energy control centers, EMS framework, data acquisition and communication (SCADA systems), generation operation and management, transmission operations and management: real time, study-mode simulations, post- event analysis and energy scheduling and accounting, dispatcher training simulator, smart transmission, EMS with WAMS, future trends in EMS and DMS with WAMS, case studies in EMS and WAMS.	08
6	**Distribution Automation And Distribution Management (DA/DMS) Systems:** Overview of distribution systems, Introduction to distribution automation, Subsystems in a distribution control center, DMS framework: Integration with subsystems, DMS application functions, Advanced real-time DMS applications, Advanced analytical DMS applications, DMS coordination with other systems, Customer automation functions, Social media usage for improved reliability and customer Satisfaction.	07
	Total	**44**

List of References:

1. James Momoh, "SMART GRID: Fundamentals of Design and Analysis", Wiley India limited, March 2012.
2. Mini. S Thomas and John D McDonald, "Power Systems SCADA and Smart Grids", CRC Press, 2015.
3. Nouredine Hadjsaïd, Jean-Claude Sabonnadière, "Smart grids", 1st edition, Wiley India limited, 2012
4. Clark W. Gellings, "The Smart Grid: Enabling Energy Efficiency and Demand Response", CRC press Taylor and Francis Group, 2009
5. A manual on "ABB digital substation" Available at: https://library.e.abb.com/public/60353dfb50bd4d3d8e0fcefb8f1d4c29/ABB%20Digital%20Substation_9AKK107045A8458_180112.pdfList of References:

Web Resources:

1. Web course on "Introduction to smart grid" by Prof. N P Padhy, and Prof Premalatta Jena IIT, Roorkee available on NPTEL at https://onlinecourses.nptel.ac.in/noc20_ee65/preview

Course Outcomes (COs):

At the end of this course students will be able to …

1. Understand the fundamental element of the smart grid and power grid.
2. Understand different communication technologies used in smart grids.
3. Get accustomed with the fundamentals of SCADA and IED
4. Understand the Importance of Automation in Substation and substation Automation.
5. Understand the Energy management systems in era of smart grid.
6. Understand the distribution automation for smart grid development.

4EE53: COMMISSIONING OF ELECTRICAL EQUIPMENTS
CREDITS: 3 (LTP: 3, 0, 0)

Course Objective:
To explain the basic concepts of testing, commissioning, maintenance and supervises of various electrical equipment.

Teaching and Assessment Scheme:

Teaching Scheme (Hours per Week)			Credits	Assessment Scheme				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE	CE	ESE	CE	
3	0	0	3	60	40	00	00	100

Course Contents:

Unit No.	Topic	Teaching Hours
1.	**Safety Management:** Objectives, safety management during operation and maintenance, clearance and creepages, electric shock, need of earthing, different methods of earthing, factors affecting the earth resistance, methods of measuring the earth resistance, equipment earthling and system grounding, earthling procedure-building installation, domestic appliances, industrial premises, earthing of substation, generating station and overhead line.	05
2.	**Installation of Electrical Equipment:** Inspection of electrical equipment at site, storage electrical equipment at site, foundation of electrical equipment at site, alignment of electrical machines, tools/instruments necessary for installation, technical report, inspection, storage and handling of transformer, switchgear and motors, introduction to megger and earth resistance tester and their applications.	04
3.	**Testing of Transformer, Plant and Equipment:** General requirements for type, routine and special tests, measurement of winding resistance; measurement of voltage ratio and check of voltage vector relationship; measurement of impedance voltage/short-circuit impedance and load loss; measurement of no-load loss and current; measurement of insulation resistance; dielectric tests; temperature-rise, insulation and HV test, dielectric absorption, switching impulse test, testing of current transformer and voltage transformer, power transformer, distribution transformer, CVT and special transformer with reference to Indian Standard (IS). Drying out procedure for transformer. PI index, commissioning steps for transformer, troubleshooting& maintenance of transformer. [Ref:IS2026: Part_1-10-PowerTransformers: Methods of Test; IS13956:1994-Testing Transformers]	13
4.	**Installation and Commissioning of Rotating Electrical Machines:** Degree of protection, cooling system, degree of cooling with IP- IC code (brief discussion), enclosures, rating of industrial rotating electric machine, installation, commissioning and protection of induction motor and rotating electric machine, drying out of electric rotating machine, insulation resistance measurement, site	12

Unit No.	Topic	Teaching Hours
	testing and checking, care, services and maintenance of motors, commissioning of synchronous generator, protection and automation of synchronous generator, synchronous motor, D.C. generator and motor with reference to Indian Standard (IS). [Ref: IS 4029:2010-Guide for Testing Three Phase Induction Motors; IS 7132:1973-Guide for Testing Synchronous Machines; IS 9320:1979-Guide for Testing of Direct Current (dc) Machines]	
5	**Switch Gear & Protective Devices:** Standards, classification, specification, rating and duties of CB, installation, commissioning tests, maintenance schedule, type & routine tests, operation of sub-station (steps) for line circuit breaker maintenance, location of lightening arrester with reasons.	04
6	**Transmission line:** Commissioning of A.C transmission line and HVDC transmission, galvanize steel structure, towers and insulator for transmission and distribution line, tower footing resistance, substation equipment, bus bar system, power cable, low power control cable, contactor, GIS (gas insulated substation).	04
	Total	**42**

List of References:

1. Rao, S., "Testing, commissioning, operation and maintenance of electrical equipment", 6th edition., Khanna Publishers, NewDelhi
2. Paul Gill, "Electrical power equipment maintenance and testing", CRC Press,2008.
3. SinghTarlok, "Installation, commissioning and maintenance of Electrical equipment", S.K.Kataria and Sons, NewDelhi,
4. Philip Kiameh, "Electrical Equipment Handbook: Troubleshooting and Maintenance", McGraw- Hill,2003.
5. Relevant Indian Standards (IS Code) and IEEE Standards for-Installation, maintenance and commissioning of electrical equipment's /machines.
6. R.C.H. Richardson, "Commissioning of Electrical Plant and Associated Problems" , Chapman and Hall Ltd., 196

Web Resources:

1. http://www.bis.org.in/index.asp
2. http://164.100.105.199:8071/php/BIS/IndStndrdLocatr/StandrdsSelection.php
3. http://www.ieee.org/publications_standards/publications_standards_index.html
4. http://www.nema.org/Standards/About-Standards/pages/default.aspx
5. http://www.electricalsafetyfirst.org.uk/guides-and-advice/around-the-home/first-aid/

Course Outcomes (Cos):

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

1. Familiar about electrical safety regulations and rules during maintenance.
2. Procedure of different types of earthing for different types of electrical installations.
3. Preparation of maintenance schedule of different equipment and machines.
4. Trouble shooting chart for various electrical equipment's, machines and domestic appliances.

4EE54: INDUSTRIAL INSTRUMENTATION
CREDITS – 4 (LTP: 3, 0, 1)

Course Objective:

This subject provides the knowledge of various transducers, sensors and measurement of various physical parameters like force, velocity, displacement, viscosity, temperature using various types of sensors and measurement techniques.

Teaching and Assessment Scheme:

Teaching Scheme (Hours per Week)			Credits	Assessment Scheme				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE	CE	ESE	CE	
3	0	2	4	60	40	20	30	150

Details of Assessment Instruments under CE Practical Component:
Hands-on and experiments related to the course contents.

Term work [15]	Allied Evaluation [15]
Attendance/report/Assignment	Performance/Attitude-Aptitude/Quiz/ Questions & Answers/ Discussion

Course Contents:

Unit No.	Topics	Teaching Hours
1	**Transducers:** Introduction to instrumentation system, static and dynamic characteristics of an instrumentation system, Principles and classification of transducers, electrical transducers, basic requirements of transducers	**06**
2	**Strain Gauge and Strain Measurement:** Factors affecting strain measurements, Types of strain gauges, theory of operation of resistive strain gauge, gauge factor, types of electrical strain gauges, strain gauge materials, gauging techniques and other factors, strain gauge circuits and temperature compensation, applications of strain gauges.	**06**
3	**Displacement Measurement:** Resistive potentiometer (Linear, circular and helical), L.V.D.T., R.V.D.T. and their characteristics, variable inductance and capacitance transducers, Piezo electrical transducers-output equations and equivalent circuit, Hall effect devices and Proximity sensors, Large displacement measurement using synchro's and resolvers, Shaft encoders.	**06**
4	**Force and Torque Measurement:** Load cells and their applications, various methods for torque measurement, use of torque wrenches.	**06**
5	**Pressure, Flow & Level Measurement:** Mechanical devices like Diaphragm, bellows, and bourdon tube for pressure measurement, variable inductance and capacitance transducers, Piezo electric transducers, Orifice plate, Venturi tube, flow nozzle, pitot tube, rotameter, turbine flow meter, electromagnetic flow meter, ultrasonic flow meter. resistive, inductive and capacitive techniques for level measurement, ultrasonic and radiation methods	**08**

Unit No.	Topics	Teaching Hours
6	**Temperature Measurement:** Resistance type temperature sensors–RTD & thermistor, thermocouples & thermopiles, laws of thermocouple –fabrication of industrial thermocouples signal conditioning of thermocouples output-radiation methods of temperature measurement–radiation fundamentals –total radiation & selective radiation pyrometers –optical pyrometer –two colour radiation pyrometers	**06**
7	**Smart and Advanced Sensors :** Measurement of Magnetic field, pH and viscosity, dissolved oxygen sensors, pollution measurement, infrared camera and thermal image sensors, field survey and problems.	**07**
	Total	**45**

List of References:

1. S. K. Singh, "Industrial Instrumentation & Control", 9th Reprint, TMH Publication, 2007.
2. A K Sawhney, "Electrical and Electronics Measurement and Instrumentation", Dhanpatrai & sons publications, 2013.
3. E. O. Doebelin, "Measurement Systems –Application and Design", 7th Edition, TMH Publication, 2013.
4. D Patranabis "Principles of Industrial Instrumentation", 3rd edition, McGraw hill, 2013.

Web resources:

1. NPTEL video course on "Industrial Instrumentation" By Prof Alok Barua,IIT Kharagpur https://nptel.ac.in/courses/108/105/108105064/

Course Outcome:

After learning this course the students will be able to:

1. Select a transducer based on its operating characteristics for the required application.
2. Select appropriate sensors to obtain satisfactory task for the parameters like strain, stress force and torque to be measured
3. Acquainted with advantages and limitations of pressure flow and level measurement techniques used in process industries.
4. Actual use of routine as well as advance sensors and interpret the measurement results and cause of any possible error.

List of experiments:

Experiment No.	Suggested List of Experiment
1	Instrument and Process Equipment line diagram and various Symbols used in Industries.
2	Measurement of linear displacement using Linear Variable Differential Transformer LVDT).
3	The Performance Of Strain Gauge Amplifier And Strain Gauge Transducer
4	Measurement and control of temperature using Resistance Temperature Detector (RTD).
5	Measurement of flow using Electromagnetic flow-meter.
6	Measurement of flow using Ultrasonic Flow meter.
7	Measurement of speed using Opto transducer.
8	Measurement of torque. And force.
9	To Perform The Characteristic Of Various Optical Transducers

10 Characteristics Of Photoconductive Cell

11 Characteristics Of Photovoltaic Cell

12 Hands on training of Solar PV Transducers.

13 Mini Project based on sensors

4EE55: ELECTRICAL DRIVES
CREDITS - 4 (LTP: 3, 0, 1)

Course Objective:
To understand the basic concept of working and control of modern electrical drives.

Teaching and Assessment Scheme:

Teaching Scheme (Hours per Week)			Credits	Assessment Scheme				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE	CE	ESE	CE	150
3	0	2	4	60	40	20	30	

Details of Assessment Instruments under CE Practical Component:

Term work [20]	Allied Evaluation [10]
Report/Presentations/Assignment/Journal	Performance/Quiz/ Questions & Answers/ Discussion

Course Contents:

Unit No.	Topics	Teaching Hours
1	**Basics of Electric Drives and Control:** Definition and block diagram, advantages of electrical drives, components of electric drive system, selection factors, various drives (DC & AC), speed control and drive classifications, close loop control of drives and, drives for commercial buildings(Heating Ventilation and Air Conditioning), drives for light & medium industries and heavy industries, modern electrical drives.	08
2	**Dynamics of Electrical Drives:** Motor-load dynamics, speed torque conventions and multi quadrant operation, equivalent values of drive parameters, load torque components, nature and classification of load torques, constant torque and constant power operation of a drive, steady state stability, load equalization.	10
3	**Dc Motor Drives:** DC motors and their performance starting, transient analysis, speed control, ward Leonard drives, controlled rectifier fed drives, (full controlled 3 phase rectifier control of dc separately excited motor), multi-quadrant operation, chopper controlled drives closed loop speed control of DC motor.	10
4	**Induction Motor Drives**: Induction motor analysis, starting and speed control methods- voltage and frequency control, breaking and speed control, V/f control, VVVF control, vector control, field oriented control.	12

Unit No.	Topics	Teaching Hours
5	**Synchronous Motor and Brushless DC Motor Drives:** Synchronous motor types, operation with fixed frequency, variable speed drives, permanent magnet ac motor drives, Sinusoidal PMAC motor drives and BLDC motor drives.	05
	Total	**45**

List of References:

1. Bimal K. Bose, "Modern Power Electronics and AC Drives", Pearson Education.
2. P. C. Krause, Oreg Wasynczuk, Scott D. Sudhoff, P.C.Krause, "Analysis of Electric Machinery and drive systems", IEEE Press, 2002
3. P. S. Bhimbra," Generalized Theory of Electrical Machines", Khanna Publications.
4. Vedam Subrahmanyam, "Electric Drives", TMH (I), 2nd edition,
5. G. K. Dubey, "Fundamentals of Electrical Drives", Narosa Publishing House, New Delhi, 2nd edition,2001.
6. M. H. Rashid, "Power Electronics -Circuits, devices and Applications", 3rd edition, PHI Publication. 2004

Web resources:

1. Video course on "Fundamentals of Electrical Drives" by Prof. Shyama Prasad Das IITK, available on nptel at https://nptel.ac.in/courses/108/104/108104140/#
2. Video course on "Advanced Electric Drives" by Dr. S P Das, IITM, available on nptel at https://nptel.ac.in/courses/108/104/108104011/

Course Outcomes (COs):

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

1. Understand the basics of electric drives and fundamentals of drive dynamics.
2. Learn and analyze DC drive.
3. Learn and analyze different steady state speed control methods for Induction motors, and understand the closed loop block diagrams for different methods.
4. Get introduced to modern synchronous motors and drives.

List of Experiments:

Experiment No.	Suggested List of Experiment
1	Modeling of separately excited DC Motor
2	Armature control of separately excited DC Motor - Constant Torque, Constant HP.
3	Four quadrant DC Drive - Motoring and Braking Speed control and Breaking of induction motor.
4	Torque-speed characteristics of induction motor by using voltage control.
5	Torque-speed characteristics of induction motor by V/f Control and different loads for AC motors.
6	Simulation of speed control of induction motor by V/f (constant) method.
7	Speed control of induction motor by AC voltage controller.
8	Simulation of closed loop DC drive.
9	Simulation of closed loop AC drive.
10	Simulation of BLDC motor drive.
11	Simulation of PMSM motor drive.

4EE56: ELECTRICAL TRANSIENTS AND SWITCHGEAR

CREDITS -4 (LTP: 3, 0, 1)

Course Objective:
To understand and analyze the causes, phenomena and consequences of electrical transients in power systems. To explain the theory, construction, applications and testing of electrical switchgear.

Teaching and Assessment Scheme:

Teaching Scheme (Hours per week)			Credits	Assessment Scheme				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE	CE	ESE	CE	
3	0	2	4	60	40	20	30	150

Course Contents:

Unit No.	Topics	Teaching Hours
1	**Simple Switching Transients and Damping:** Introduction, circuit closing transient, recovery transient initiated by the removal of a short circuit, double frequency transients, Observations on the RLC circuit, basic transforms of the RLC circuit, generalized damping curves, Series RLC circuit, resistance switching, load switching, other forms of damping, damping and frequency	08
2	**Abnormal Switching Transients:** Normal and abnormal switching transients, current suppression, capacitance switching, other restriking phenomena, transformer magnetizing inrush current, Ferro-resonance	06
3	**Transients in Three-phase circuits:** Importance of the type of neutral connection, switching a three-phase reactor with an isolated neutral, three-phase capacitance switching, Symmetrical component method for solving three-phase switching transients	06
4	**Traveling Waves and other Transients on Transmission Lines:** Circuits with distributed constants, the wave equation, reflection and refraction of travelling waves, behavior of travelling waves at line termination, lattice diagrams, attenuation and distortion of travelling waves, switching operations involving transmission lines	08
5	**Circuit Breakers:** Functions of circuit breakers, types of circuit breakers, fundamentals of circuit breaking, the gaseous discharges, ionization process and decay process in a gaseous insulating medium, quenching of AC arc, arc interruption theories, factors affecting rate of restriking voltage, restriking voltage and recovery voltage, resistance switching. Air-break circuit breakers, minimum oil circuit breakers, air-blast circuit breakers, sulphur hexafluoride circuit breakers, vacuum circuit breakers, quenching of DC arc, HVDC circuit breakers.	12

Unit No.	Topics	Teaching Hours
6	**Short Circuit Testing of Circuit Breakers:** Specifications of a circuit breaker, basic short circuit testing plant, short time withstand capacity test, single phase testing, and unit testing, synthetic testing.	04
	Total	**44**

List of Experiments:

Sr. No.	Suggested List of Experiments
1.	To perform C.T./P.T polarity testing and CT Saturation Characteristics
2.	To perform experiment to see effect of floating neutral point in supply systems
3.	To perform hardware simulation experiment of Ground Constant to see effect of supply systems on voltage appearing across circuit breaker contacts
4.	Introduction to Alternate Transient Program (ATP) software and PSCAD software
5.	Simulation of resistance switching and transients in ATP/PSCAD
6.	Simulation of load switching and transients in ATP/PSCAD
7.	Simulation of switching a three-phase reactor with an isolated neutral in ATP/PSCAD
8.	Simulation of three-phase capacitance switching in ATP/PSCAD
9.	Solution of a parallel L-C circuit using inverse laplace command in MATLAB
10	Solution of a transformer circuit using inverse laplace command in MATLAB

List of References:

1. Allan Greenwood, "*Electrical Transients in Power Systems",* Second edition, Wiley Student Edition, Wiley India Pvt. Ltd., 1991
2. Paul J. Nahin, *"Transients for Electrical Engineers (with a touch of MATLAB)",* First edition, Springer, 2018
3. J. C. Das, "Transients in Electrical Systems Analysis, Recognition, and Mitigation", First Edition, McGraw Hill, 2010
4. B.A. Oza, N.C. Nair, R.P. Mehta and V.H. Makwana, "Power System Protection and Switchgear" McGraw Hill Education Ltd., 2010
5. S. Rao, "Electrical Substation Engineering & Practice: EHVAC, HVDC & SF_6 - GIS ", Khanna Publishers, 2003
6. N. D. Anisimova V. A. Venikov V. V. Ezhkov, "Transient Phenomena in Electrical Power Systems - Problems and Illustrations ", Elsevier, eBook ISBN: 9781483226712, 1965

Web Resources:

1. Video course on "Power System Engineering" by Prof. Prof. Debapriya Das,, IIT Kharagpur available on NPTEL at https://nptel.ac.in/courses/108/105/108105104/

Course Outcomes (COs):

After learning the course the students should be able to:

1. Understand how the various types of transients in the system produced and provide an internal description of the system including possible transients in the systems.
2. Analyze power system transients and design ideas of insulations under the presence of transients.

3. Analyze inception and impact of travelling waves and other transients on transmission lines.
4. Compare the different type of circuit breakers performance based on which selection of circuit breaker can be made for a given application.
5. Understand testing of circuit breakers.

4EE57: POWER SYSTEM PRACTICE AND DESIGN

CREDITS - 4 (LTP: 3, 0, 1)

Course Objective:
To understand the electrical as well as mechanical design of overhead transmission line and design of distribution system.

Teaching and Assessment Scheme:

Teaching Scheme (Hours per Week)			Credits	Assessment Scheme				
				Theory Marks		Practical Marks		Total Marks
L	T	P	C	ESE	CE	ESE	CE	
3	0	2	4	60	40	20	30	150

Details of Assessment Instruments under CE Practical Component:

Term work [20]	Allied Evaluation [10]
Report/Presentations/Assignment/Journal	Performance/Quiz/ Questions & Answers/ Discussion

Course Contents:

Unit No.	Topics	Teaching Hours
1	**Elements of Power Station Practice:** Flow diagram; main components of a thermal power plant – boiler plant, turbines, control room, electrostatic precipitators, coal and ash handling plants, circulating water system; combined cycle power plants – flow diagram.; hydro-electric power plants – classification, arrangement and layout, types of water turbines, discharge and specific speed, discussion on Central Electricity Regulatory Commission(CERC), Central Bureau Of Irrigation And Power(CBIP)	10
2	**Electrical Packages of a Power Plant:** Generator, exciter, bus-duct, generator transformer, auxiliary transformers and motors, batteries, instrumentation and control equipment, neutral grounding equipment, 6.6 kV and 415 V switchgear, switchyard equipment's	08
3	**Design of EHV Transmission Line:** Requirements and specifications, selection of voltage, choice of conductors, spacing of conductors, corona, radio and television interference, insulation coordination, insulators, surge impedance loading, main considerations of mechanical design, sag-tension relation, stringing of transmission lines, transmission towers.	07

Unit No.	Topics	Teaching Hours
4	**Design of Distribution Systems:** AC 3-phase 4-wire distribution, types of primary distribution systems, types of secondary distribution systems, voltage drop in ac distributors, kelvin's law, limitations of kelvin's law, general design considerations, load estimation, design of primary distribution, sub-stations, secondary distribution design, economical design of distributors, design of secondary network, lamp flicker.	06
5	**Substation Design:** Classification, terms and definitions, stresses on substation equipment, clearances, maintenance zones, designing a sub-station layout; design of 66/11 kV distribution substation; selection and specification of main equipment's.	08
6	**SF6 Gas Insulated Sub-stations (GIS):** Introduction, applications of GIS, range of ratings, demerits of GIS, configuration of GIS, circuit arrangement and single-line diagram of GIS, design aspects, earthing switches in GIS.	06
	Total	**45**

List of References:

1. M. V. Deshpande , "Electrical Power System Design" , McGraw-Hill Education - Europe, 1985.
2. B. R. Gupta, "Power System Analysis and Design", Sixth Edition, S. Chand & Sons, 2011
3. P. M. Reynolds (Editor), "Modern Power Station Practice – volumes A to D", Third Edition, Elsevier, 1990
4. S. Rao, "Electrical Substation Engineering & Practice: EHVAC, HVDC & SF6 - GIS ", Khanna Publishers, 2003.

Web resources:

1. Website of Central Board of Irrigation and Power(CBIP) available at http://www.cbip.org/

Course Outcomes (COs):

After learning this course the students will be able to:

1. Understand steam cycle and water cycle with electrical key-line diagram.
2. Estimate the electrical design of overhead transmission lines.
3. Estimate the mechanical design of overhead transmission lines.
4. Choose the proper size of the cables at distribution system.
5. Identify different switchgears in substation.

List of Experiments:

Sr. No.	Suggested List of Experiments
1	Electrical design of transmission line.
2	Mechanical design of transmission line.
3	Power circle diagram of transmission line.
4	Transmission tower design.
5	Electrical design of 220 kV / 400 kV substation.
6	Electrical of design and survey of rural feeder.

4EE58: NON-CONVENTIONAL ENERGY SOURCES
CREDITS = 4 (LTP: 3, 0, 1)

Course Objective:
The subject aims to provide the student with the knowledge of various renewable energy sources, systems and applications in the present context and need.

Teaching and Assessment Scheme:

Teaching Scheme (Hours per Week)			Credits	Assessment Scheme				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE	CE	ESE	CE	150
3	0	2	4	60	40	20	30	

Details of Assessment Instruments under CE Practical Component:
Hands-on and experiments related to the course contents. .

Term work [15]	Allied Evaluation [15]
Attendance/report/Assignment	Performance/Attitude-Aptitude/Quiz/ Questions & Answers/ Discussion

Course Contents:

Unit No.	Topics	Teaching Hours
1	**Introduction:** Renewable sources of energy, grid-supplied electricity, distributed generation- renewable, various non-conventional energy resources; introduction, availability, classification, relative merits and demerits, energy policy and regulations, CDM prospects (carbon credits).	4
2	**Solar Energy:** Introduction, photo voltaic power generation, spectral distribution of energy in solar radiation, solar cell configurations, voltage developed by solar cell, solar cell efficiency and losses, methods to get MPPT, practical solar cell performance, commercial photo voltaic systems, specifications for PV systems, applications of PV systems, design of roof top solar PV system, introduction and application of solar thermal energy, various converter topologies and their comparison, integration issues of solar energy with grid, case studies.	11
3	**Wind Energy:** Introduction, site selection criterion, classification of wind power plants, wind characteristics, performance and limitations of energy conversion systems. power from wind, properties of air and wind, types of wind turbines, operating Characteristics, converter topologies, onshore and offshore wind farms, new developments, integration issues of wind energy with grid case studies.	08

Unit No.	Topics	Teaching Hours
4	**Geothermal Energy:** Introduction, resources of geothermal energy, types of geo thermal energy, environmental consideration, power generation methods, and hybrid systems.	04
5	**Wave and Tidal Energy:** Introduction, mechanism and wave motion, properties of waves and power content, vertex motion of waves, device applications, types of ocean thermal energy conversion systems, application of Ocean Thermal Energy Conversion (OTEC) systems, numerical.	04
6	**Biomass Energy Conversion:** Introduction, technologies available for thermal and power generation applications, bio-fuels and decentralized energy systems (co—operative rural power plant, biogas generation, waste minimization and utilization.	06
7	**Advanced Technologies:** Introduction of green building concepts, CO_2 sequestration, electric vehicle, fuel cells, hydrogen energy, building material selection, designing of building, heat transfer concepts, green building rating systems etc. introduction to software for renewable energy system.	08
	Total	**45**

List of References:

1. G.D Rai, "Non-conventional energy sources", Khanna Publishers.2008
2. Chetan Singh Solanki, "Solar Photovoltaic Technology and Systems: A Manual for Technicians, Trainers and Engineers", PHI Publisher, 2013.
3. S. P. Sukhatme, "Solar Energy - Principles of thermal collection and storage", TMH, 2008.
4. Dr.R.K Singal, "Non-Conventional Energy Resources", S.K Kataria & Sons.2012
5. Thomas Ackermann, "Wind Power in Power System", John Willey &Sons, 2005.

Web resources:

1. NPTEL Video Lectures on "Non-conventional energy source" by Prof. Prathap Haridoss, IIT Madras at https://nptel.ac.in/courses/121/106/121106014/

2. NPTEL Web Course on "Non-Conventional energy source "by Dr .L.Umanand, IISC Banglore at https://nptel.ac.in/courses/108/108/108108078/#

Course outcomes (cos):

After learning this course the students will be able to:

1. Understand Energy technologies
2. To solve the problems related to solar and wind energy system
3. Ability to solve the problems in different other renewable energy fields.
4. Understand Energy generation and Problem using field case studies.

List of experiments:

Experiment No.	Suggest List of Experiment
1	To understand the basic concept of Solar Energy
2	To measure the voltage and current of the solar cells
3	To measure of the voltage and current of the solar cells in series & parallel combinations
4	To calculate the efficiency (η) of solar cell
5	Solar Power and V-I Characteristics
6	Various modes of Constant Voltage Charging technique
7	Buck Converter topology and measurement of voltage
8	Boost Converter topology and measurement of voltage
9	To find out Torque and axial thrust using computer program
10.	To find out energy generated from tidal power plant using computer program
11	To understand the basic concept of wind energy and Hybrid Energy
12	Mini Project

4EE59: POWER SYSTEM OPERATION AND CONTROL
CREDITS - 4 (LTP: 3, 0, 1)

Course Objective:
To understand the concepts of power system economics and optimal operation of power system and controls.

Teaching and Assessment Scheme:

Teaching Scheme			Credits	Assessment Scheme				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE	CE	ESE	CE	150
3	0	2	4	60	40	20	30	

Details of Assessment Instruments under CE Practical Component:

Term work [20]	Allied Evaluation [10]
Report/Presentations/Assignment/Journal	Performance/Quiz/ Questions & Answers/ Discussion

Course Contents:

Unit No.	Topics	Teaching Hours
1	**Load flow for AC Systems**: AC load flow studies: load flow problem and its solution techniques, concept of static and dynamic load flow, static load flow equations, computer programming for Gauss-Seidel method, Newton-Raphson method, decoupled method, fast decoupled method.	06
2	**Economic Operation of Power System**: Introduction, methods of loading turbo generators, operating cost of a thermal power plant, economic dispatch neglecting Transmission losses and no generator limits, economic dispatch neglecting losses and including generator limits, economic dispatch including losses, derivation of loss formula. Loss co-efficient & Exact loss co-efficient **Unit Commitment**: Introduction, Constraints of unit commitment, Priority list method, Dynamic programming method of unit commitment.	10
3	**Power System Security**: Introduction, Factors Affecting Power System Security contingency analysis: detection of network problems, generation outages, transmission outages, An overview of security analysis, linear sensitivity factors, monitoring power transactions using "Flowgates", voltage collapse, AC power flow methods, contingency selection, concentric relaxation, Bounding.	06
4.	**State Estimation:** Introduction: Power System State Estimation, Maximum Likelihood Weighted Least-Squares Estimation, Introduction, Maximum Likelihood Concepts, Matrix Formulation, An Example of Weighted Least-Squares State Estimation, State Estimation of an Ac Network, Development of Method, Typical Results of State Estimation on an AC Network, Introduction to Advanced Topics in State Estimation, Sources of Error in State Estimation, Detection and Identification of Bad Measurements, Estimation of Quantities Not Being Measured, Network Observability and Pseudo-measurements, The Use of Phasor Measurement Units (PMUS), Application of Power Systems State Estimation.	08
5.	**Preventive, Emergency and Restorative Control and Power System Structures:** Overview of Indian power scenario, Introduction to power system operating states, Normal and Alert State in a Power System, Emergency Control, Emergency Control – an example, A Blackout, Power System Restoration; case study: blackout and restoration A vertical integrated utility, Structure of a Deregulated Industry, Indian Scenario, Future Challenges in Power System Operation and Control.	08
6.	**Load Forecasting:** Introduction; Forecasting Methodology; Estimation of Average and Trend Terms; Estimation of Periodic Components; Estimation of ys(k) load model : Time Series Approach; Long-Term Load Predictions Using Econometric Models; Reactive Load Forecasting	06
	Total	**44**

List of References:

1. Allen J. Wood and Bruce F. Wollenburg "Power System Operation and Control" Willey India edition, 2nd edition, 2009.
2. I. J. Nagrath and D. P. Kothari, "Modern Power System Analysis", Tata Mcgraw Hill publications.4th Edition
3. B. R. Gupta, "Power System Operation and Control", 7th revised Edition, S. Chand & Co., 2014
4. Hadi Saadat, "Power system Analysis", 2th Edition, Tata McGraw-Hill, 2002
5. S. Sivanagaraju, "Power System Operation and Control", Pearson Education, 9th Edition 2013
6. Abhijit Chakrabarti and Sunita Halder, "Power System Analysis Operation and Control", PHI Learning Private Limited, 3rd Edition.

Web Resources:

1. Web course on "Power System Operation and Control" by Prof. A M Kulkarni IITB, available on nptel at https://nptel.ac.in/courses/108/101/108101040/
2. Video course on "Computer Aided Power System Analysis" by Prof. Biswarup Das, IIT Roorkee, available on nptel at https://nptel.ac.in/courses/108/107/108107127/
3. Web course on "Computer Aided Power System Analysis" by Prof. Dr. B. Das and Dr. Vinay Pant, IIT Roorkee, available on NPTEL at https://nptel.ac.in/courses/108/107/108107028/
4. Scilab Textbook Companion for Power System Analysis And Design by B. R. Gupta, available At https://www.academia.edu/10119681/Scilab_Textbook_Companion_for_Power_System Analysis_A nd_Design
5. Scilab Textbook Companion for. Modern Power System Analysis by D. P. Kothari And I. J. Nagrath available at https://scilab.in/textbook_companion/generate_book/83
6. Scilab Textbook Companion for Power System Operation and Control by B. R. Gupta, available at https://scilab.in/Textbook_Companion_Project/ Download Codes

Course Outcomes (COs):

At the end of this course students will be able to:

1. Employ and Compare the various techniques for load flow Analysis.
2. Understand the different solution methods of Economic load dispatch and unit commitment and develop the mathematical model for Economic Load Dispatch.
3. Learn power system security and system state estimation to explore its importance and application as a system operator
4. Appraise the power system blackouts and the restoration process.
5. Carry out load forecasting using available method.

List of Experiments:

Experiment No.	Suggested List of Experiments
1	Formation of bus Admittance matrix
2	Load flow Solution using Gauss Seidel method
3	Load flow solution using Newton Raphson method.
4	Load flow solution using Fast Decoupled method.
5	Optimal dispatch neglecting Losses
6	Optimal dispatch including Losses

7	Economic dispatch using lambda-iteration method
8	Contingency analysis: Generator shift factors and line outage distribution factors
9	Unit Commitment: Priority-list schemes and dynamic programming
10	State Estimation by weighted least squares method
11	Methods of short term, medium term and long term load forecasting
12	Case studies of blackout and Restoration.

4EE60: ELECTRICAL ENERGY CONSERVATION AND AUDITING
CREDITS - 4 (LTP: 3, 0, 1)

Course Objective:
To explain basic concept of to reduce electrical as well as thermal energy consumption in industrial utilities.

Teaching and Assessment Scheme:

Teaching Scheme (Hours per Week)			Credits	Assessment Scheme				
				Theory Marks		Practical Marks		Total Marks
L	T	P	C	ESE	CE	ESE	CE	
3	0	2	4	60	40	20	30	150

Course Contents:

Unit No.	Topics	Teaching Hours
1	**General Aspects:** Basics of electrical & thermal energy, energy units and conversion. Energy Scenario: Primary & secondary energy, commercial & noncommercial energy, nonrenewable & renewable energy, globally energy reserves and production, energy conservation and its importance, Energy Conservation Acts: 2001, 2010, Electricity act 2003, National action plan on climate changes, Integrated energy policy, Schemes under EC act 2001. ISO 50001. Bureau of Energy Efficiency (BEE) and Performance Achieve and Trade (PAT) schemes. Industry 4.0.	**05**
2	**Energy Management & Audit:** Definition as per EC act-2001, Objective, Need, Types, Benchmarking. Management: Top management commitment & support, Energy policy & planning, Evaluating Energy Performance, Management Tools for Effective Implementation- 5S, KAIZEN, TPM, TQM, ISO 50001, Financial analysis: techniques, role of ESCOs, project management technique- critical path method, pert analysis. energy monitoring & targeting: definition, key elements, CUSUM analysis.	**07**

Unit No.	Topics	Teaching Hours
3	**Renewable Energy Sources:** Concept & fundamental, applications: solar-thermal, solar –electrical, wind energy, biomass energy, hydro energy, fuel cell, energy from waste, wave energy, tidal energy, geothermal energy. global energy issues: acid rain, ozone layer, depletion, global warming & climate change, loss of biodiversity.	**05**
4	**Energy Efficiency and Performance of Electrical Utilities:** Electric motor, air compressed system, Heating, ventilation, and air conditioning (HVAC), fans & blowers, pumps & pumping system, cooling towers, lighting system, DG, ECBC codes. case study.	**13**
5	**Energy Efficiency & Performance of Thermal Utilities:** Boiler, furnace & relevant example, insulation & refractories with relevant example, heat exchangers. case study.	**10**
6	**Energy Audit Case Study** Energy audit case study and saving opportunities in thermal power plant, textile industry, ceramic industry and cement industry.	**05**
	Total	**45**

List of References:

1. General aspects of energy management and energy audit, Guide book EA-EM, BEE, India.
2. Energy efficiency in electrical utilities, Guide book EA-EM, BEE, India.
3. Energy efficiency in thermal utilities, Guide book EA-EM, BEE, India.
4. Energy performance assessment for equipment and utility systems, Guide book EA-EM, BEE, India.
5. Doty, Steven; Turner, Wayne C, Energy Management Handbook (8th Edition), Fairmont Press, Inc., 978-0-88173-707-3
6. Amlan Chakrabarti, Energy Engineering and management, PHI Publication.

Web Resources:

1. www.aipnpc.org
2. www.beeindia.gov.in
3. www.pcra.org

Course Outcomes (COs):

After learning this course the students will be able to:

1. Understand the problems and solution of electrical, thermal and mechanical Industrial utilities.
2. Understand how to coordinate with other engineering branches in industries.
3. Understand Energy Management technologies.
4. Understand application of renewable energy sources.
5. Learn about environment issues due to emission from fossil fuel consumption.
6. Handle administration and technical issue in industrial plant.

List of Experiments:

Exp. No.	Suggested List of Experiments
1	Hands on training on various Equipments like ultra-sonic flow meter, power analyzer, thermal imager, van anemometer, sling pshyclometer and lux meter required for energy audit in industry.
2	Practical case/study of energy conservation, management & audit
3	Performance assessment of HT distribution transformer operation in campus.
4	Practical case studies of Bill analysis of HT consumer.
5	Practical case studies on significance of power factor in HT consumer billing and working of Automatic Power Factor Controller (APFC) panel in distribution control room.
6	Performance analysis of energy saving in lightning systems in the campus using energy saving devices like LED lights and motion control sensors.
7	Study and analysis of Heating, ventilation, and air conditioning (HVAC) system with real system case study.
8	Visit and demonstration of actual air compressor system.
9	Practical case studies of power quality issues using Power Quality Analyzer.
10	Simulation and analysis Electrical motor efficiency and remedial measures to improve efficiency.
11	Performance and analysis of water pump efficiency
12	Hands on experiment of Harmonic analysis of supply system at source point
13	Hands on experiment on thermography of insulation using Thermal imager

4EE61: EMBEDDED SYSTEMS
CREDITS - 4 (LTP: 3, 0, 1)

Course Objective:
To familiarize with the concept of Embedded system and recognize the domains of its applications by understanding the microcontrollers used in embedded systems and creating innovative products and solutions for real time problems.

Teaching and Assessment Scheme:

Teaching Scheme (Hours per Week)			Credits	Assessment Scheme				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE	CE	ESE	CE	
3	0	2	4	60	40	20	30	150

Course Contents:

Unit No.	Topics	Teaching Hours
1.	**Introduction to Internet of Things:** Brief History and evolution of IoT, IoT Architecture, Sensing, Actuation, Basics of Networking, Communication Interface, Trends in Adoption of IoT	03
2.	**Introduction to Embedded System:** Introduction to Embedded System, Embedded Systems Vs General Computing Systems, History of Embedded Systems, Classification of Embedded Systems, Design considerations & requirements, Major application areas of Embedded Systems.	03
3.	**Designing Embedded Systems with Microcontrollers:** Introduction of Single purpose processors ,General purpose processors, Application specific instruction set processors (ASIPs), DSP processors and SHARC processors, CISC vs. RISC, Factors to be considered in selecting microcontroller, an exemplary Microcontroller (MCS-51/AVR/PIC/ARM etc.), CPU Architecture and Organization, Instruction Set Architecture, Memory System Architecture, I/O Sub-system, Processor Performance Enhancement.	04
4.	**The ARM Microcontroller:** Introduction to ARM microcontroller, Internal architecture, I/O pins, Ports, Timers, Interrupts, Memory organization, Concept of Pipelining, Programming model, Instruction classification and format, Addressing modes, Data transfer instructions, Arithmetic instruction, Logical group of instructions, Branching instructions, I/O interfacing & Programming in C, ADC-DAC applications, PWM applications, MATLAB interface with ARM, Embedded code generation.	18
5.	**Embedded Design Case Studies:** Applications of embedded systems: Measurement of analog and electrical variables, control of electrical devices, user interface in embedded systems, data communication in embedded systems	4
6.	**Digital Signal Processors and Applications:** Tms320xx Digital signal processors, Introduction, Architecture, Features, timer, memory control, interrupts, external interface.	12
	Total	**44**

List of References:

1. Shibu K. V, "Introduction to Embedded Systems", 1st Edition, Tata Mc Graw Hill Publishers, 2013.
2. Raj Kamal, "Embedded Systems: Architecture, Programming and Design", 2nd Edition, Tata Mc Graw Hill Publishers, 2011.
3. Steve Furber, "ARM System-on-Chip Architecture", 2nd Edition, Pearson, 2012.
4. B. Venkataramani, M. Bhaskar, "Digital Signal Processors: Architecture, Programming and Applications", Tata McGraw-Hill Education, 2002.
6. LPC1768 32-bit Arm Cortex®-M3 Microcontroller datasheet.
7. TMS320F28335 Digital Signal Controller datasheet.

Web Resources:

1. https://nptel.ac.in/courses/106/105/106105166/ Lecture Series on Introduction to Internet of Things by Prof. Sudip Misra, Department of Computer Science & Engineering, IIT Kharagpur
2. http://www.nptelvideos.in/2012/11/embedded-systems.html Lecture Series on Embedded Systems by Dr. Santanu Chaudhury, Department of Electrical Engineering, IIT Delhi.

Course Outcomes (COs):

At the end of this course students will be able to …

1. Familiarized with the basics of Internet of Things.
2. Learn the classification of Embedded Systems based on performance, complexity and the era in which they evolved.
3. Understand ARM processor architecture and its programming.
4. Acquire knowledge about different entities of Embedded System Applications.
5. Be accustomed with the basics of Digital Signal Processors.

Suggested list of Experiments

Exp. No.	EXPERIMENT
1.	Introduction to ARM Cortex LPC1768 controller.
2.	To demonstrate LED interfacing using ARM Cortex LPC1768 controller.
3.	To demonstrate the interfacing of switches to change the status of LEDs.
4.	To demonstrate the application of LCD interfacing.
5.	To demonstrate use of Matrix Keyboard and its interfacing.
6.	Hands on Stepper motor interfacing and control.
7.	To demonstrate transmission of characters using Uart0.
8.	To demonstrate ADC and DAC interfacing.
9.	Introduction to TMS320F28335 DSP processor.
10.	PWM generation using TMS320F28335 DSP processor.
11.	Demonstration of use of timer in TMS320F28335 DSP processor.
12.	To demonstrate use of UART using TMS320F28335 DSP processor.

4EE62: OPTIMIZATION OF POWER SYSTEMS
CREDITS - 4 (LTP: 3, 0, 1)

Course Objective:

To introduce fundamentals of optimization theory to students with specific focus on applications for power systems.

Teaching and Assessment Scheme:

Teaching Scheme (Hours per Week)			Credits	Assessment Scheme				
L	T	P	C	Theory Marks		Practical Marks		Total Marks
				ESE	CE	ESE	CE	
3	0	2	4	60	40	20	30	150

Details of Assessment Instruments under CE Practical Component:
Hands-on and computational experiments related to the course contents. Exposure to linear system solvers for linear programming (optimization) using MATLAB, SCILAB, GAMS, GUROBI, CBC, GLPK etc.

Term work [15]	Allied Evaluation [15]
Attendance/report/Assignment	Performance/Attitude-Aptitude/Quiz/ Questions & Answers/ Discussion

Course Contents:

Unit No.	Topics	Teaching Hours
1	**Introduction to Optimization:** Engineering applications of optimization, Statement of an optimization Problem, Classification of optimization problems, Optimization techniques, Solution of optimization problems using linear system solvers.	06
2	**Classical Optimization Techniques:** Single-Variable optimization, Multivariable Optimization with no constraints, Multivariable optimization with equality constraints, Multivariable optimization with inequality constraints, Convex programming problem.	08
3	**Linear Programming :** Applications of linear programming, Standard form of a linear programming problem, Geometry of linear programming problems, Definitions and theorems, Solution of a system of linear simultaneous equations, Pivotal reduction of a general system of equations, Motivation of the simplex method, Simplex algorithm, Two phases of the simplex method, Solution of LP Problems.	08
4	**Economic Load Dispatch of Thermal Generating Units:** Generator operating cost, Economic dispatch problem on a bus-bar, Optimal Generation Scheduling, Economic dispatch using Newton-Raphson method, Classical method to calculate loss coefficients, Loss coefficient calculation using YBUS, Loss coefficient calculation using sensitivity factors, Transmission loss coefficients, Transmission loss formula as a function of generation and loads, economic load dispatch using exact loss formula, economic load dispatch using loss formula as a function of real and reactive power, economic dispatch for	08

Unit No.	Topics	Teaching Hours
	active and reactive power balance	
5	**Infrastructure Planning:** Nodal placement and sizing, Problem types and greedy algorithms, Power sources, Multiple scenarios, Energy storage, Transmission expansion, Basic approach, Linearized models, Branch flow approximation, Relaxations, Feasibility issues	06
6	**Power System Economics:** Background, Lagrangian duality, Pricing and the welfare theorems, Game theory, Electricity markets, Nodal pricing, Multi- period and dynamic pricing, Transmission cost allocation, Pricing under non- convexity, Market power, Supply function equilibrium, Complementarity models, Capacitated price competition	06
	Total	**42**

List of Experiments:

Sr. No.	Suggested List of Experiments
	Hands-on training on optimization toolbox in MATLAB/SCILAB
1.	Implementation of a linear programming problem in MATLAB/SCILAB
2.	Introduction and Hands-on training on – Formulation and Modelling of optimization problem using THE GENERAL ALGEBRAIC MODELING SYSTEM (GAMS) Optimization Solver
3.	Practice of linear programming assignments on unconstrained optimization problem
4.	Practice of linear programming assignments on constrained optimization problem
5.	Thermal Unit Economic Dispatch problem using GAMS
6.	Thermal Unit Environmental Dispatch using GAMS
7.	Hydro Unit Economic Dispatch using GAMS
8.	Multi-Area Mix Unit Dynamic Dispatch using GAMS
9.	Cost-based Dynamic Economic Dispatch using GAMS
10.	Wind-based Dynamic Economic Dispatch using GAMS
11.	Price-based Dynamic Economic Dispatch using GAMS

List of References:

1. Singiresu S. Rao, “Engineering Optimization: Theory and Practice”, 3rd , New Age International, 2013
2. D.P.Kothari and J.S.Dhillon, “Power System Optimization”, 2nd Edition, PHI Learning Private Ltd., 2011
3. Alireza Soroudi, “Power System Optimization Modeling in GAMS”, Springer, 2017
4. Mahmoud Pesaran Hajiabbas Behnam Mohammadi-Ivatloo - Editors, “Optimization of Power System Problems Methods, Algorithms and MATLAB Codes”, Springer, 2020

5. Thomas Coleman, Mary Ann Branch and Andrew Grace, "User's Guide Version 2 – Optimization Toolbox for use with MATLAB", Mathworks Inc., 1999
6. Jizhong Zhu, "Optimization of Power System Operation", John Wiley and Sons, 2009.

Web Resources:
1. GAMS - https://www.gams.com/latest/docs/UG_TutorialQuickstart.html
2. Tutorial for Optimization Toolbox - https://in.mathworks.com/help/optim/ug/optimization - toolbox-tutorial.html

Course Outcomes (COs):
At the end of this course students will be able to …
1. Comprehend the engineering applications of optimization
2. Understand and analyze the classical optimization techniques
3. Apply optimization theory to power system domain
4. Formulate and solve optimization problem for economic load dispatch of thermal generating units
5. Formulate and solve optimization problem for infrastructural planning problems of power system
6. Formulate and solve optimization problem for power system economics problems

4EE63: ELECTRIC AND HYBRID VEHICLES
CREDITS - 4(LTP: 3, 0, 1)

Course Objective:
To deliver and discuss the about architecture, power electronics based drive control systems, battery management systems and grid integration issues of Electric and Hybrid vehicles.

Teaching and Assessment Scheme:

Teaching Scheme (Hour per Week)			Credits	Assessment Scheme				
				Theory Marks		Practical Marks		Total Marks
L	T	P	C	ESE	CE	ESE	CE	
3	0	2	4	60	40	20	30	150

Details of Assessment Instruments under CE Practical Component:

Term work [15]	Allied Evaluation [15]
Attendance/report/presentations/Assignment	Performance/Attitude-Aptitude/Quiz/ Questions & Answers/ Discussion

Course Contents:

Unit No.	Topics	Teaching Hours
1	**Introduction to Electric Vehicle (EV) & Hybrid Vehicle(HV):** A brief history of Electric and Hybrid vehicles, basic architecture of hybrid drive train and analysis of series drive train., vehicle motion and the dynamic	06

Unit No.	Topics	Teaching Hours
	equations for the vehicle, types of HV and EV, advantages over conventional vehicles, limitations of EV and HV, impact on environment of EV and HV technology, disposal of battery, cell and hazardous material and their impact on environment.	
2	**Power Management and Energy Sources of EV and HV:** Power and Energy management strategies and its general architecture of EV and HV, various battery sources, energy storage, battery based energy storage and simplified models of battery, Battery Management Systems (BMS), fuel cells, their characteristics and simplified models, Super capacitor based energy storage, its analysis and simplified models, flywheels and their modeling for energy storage in HV/BEV, hybridization of various energy storage devices, Selection of the energy storage technology.	08
3	**Power Electronics in EV & HV:** Introduction, various power electronics converter topologies and its comparisons, Control of convertor operations in EV and HV, battery chargers used in EV & HV, emerging power electronic devices.	06
4	**DC and AC Machines & Drives in EV & HV:** Various types of motors, selection and size of motors, Induction motor drives and control characteristics, Permanent magnet motor drives and characteristics, Brushed & Brushless DC motor drive and characteristics, switched reluctance motors and characteristics, IPM motor drives and characteristics, mechanical and electrical connections of motors.	08
5	**Components & Design Considerations of EV & HV:** Design parameters of batteries, ultra-capacitors and fuel cells, aerodynamic considerations, calculation of the rolling resistance and the grade resistance, calculation of the acceleration force, total tractive effort, torque required on the drive wheel, transmission efficiency, consideration of vehicle mass, electric vehicle chassis & body design, general issues in design, specifications and sizing of components	08
6	**Electric and Hybrid Vehicles and Grid interconnection Issues:** Introduction to smart charging: Grid to vehicle and vehicle to grid, smart metering and ancillary services, preliminary discussion on vehicle to vehicle and vehicle to personal communication systems, introduction to battery charging stations and its installation and commissioning, preliminary discussion on estimation on station capacity and associated technical issues, different connectors, policy regulations and standards for EV and HV, BEE standards, Indian and Global scenario, case studies.	08
	Total	**45**

List of Experiments:

Sr. No.	Suggested List of Experiments
1.	Study and analysis of different topologies used in electrical and hybrid vehicles
2.	Simulation and analysis of Induction motor characteristics used for electric vehicle
3.	Simulation and analysis of BLDC motor characteristics used for electric motor vehicle

Sr. No.	Suggested List of Experiments
4.	Simulation and analysis of Switch Reluctance motor characteristics used for electric motor vehicle
5.	Simulation and analysis of IPMSM motor characteristics used for electric motor vehicle
6.	Analysis of selection of drives used for electric and hybrid vehicle
7.	Simulation and analysis of speed control characteristics of Induction motor used for electric vehicle
8.	Simulation and analysis of speed control characteristics of BLDC motor used for electric motor vehicle
9.	Simulation and analysis of torque control characteristics of IPMSM motor characteristics used for electric motor vehicle
10.	Analysis of Vector control methods for Induction motor used for electric vehicle
11.	Simulation and analysis of field control of IPMSM motor used for electric vehicle

List of References:

1. Iqbal Hussain, "Electric and Hybrid Vehicles Design Fundamentals", 1st Edition, CRC Press, 2003.
2. James Larminie, John Lowry "Electric Vehicle Technology Explained", 1st Edition, John Wiley and Sons, 2003.
3. Chris Mi, M. Abul Masrur, David Wenzhong Gao, "Hybrid Electric Vehicles: Principles and Applications with Practical Perspectives", Wiley publication ,2011.
4. Allen Fuhs, "Hybrid Vehicles and the future of personal transportation", CRC Press, 2009.

Web Resources:

1. Web course on "Introduction to Hybrid and Electric Vehicles" by Dr. Praveenkumar and Prof. S Majhi, IIT Guwahati available on NPTEL at https://nptel.ac.in/courses/108/103/108103009/
2. Video Course on "Electric Vehicles" by Prof. Amitkumar Jain, IIT Delhi available on NPTEL at https://nptel.ac.in/courses/108/102/108102121/

Course Outcomes (COs):

At the end of this course students will be able to …

1. Understand the architecture and vehicle dynamics of electric and hybrid vehicles
2. Analyze and model the power management systems for electric and hybrid vehicles
3. Devise power electronics based control strategies for electric and hybrid vehicles
4. Analyze and design various components of electric and hybrid vehicles with environment concern.
5. Investigate and model the issues in mathematical domain related to grid interconnections of electric and hybrid vehicle.

4EE64: WIDE AREA MEASUREMENT SYSTEMS (WAMS) AND APPLICATIONS
CREDITS - 4 (LTP: 3, 0, 1)

Course Objective:

To explain the basic concepts of synchronized phasor measurements and their applications to Power Systems Monitoring, Operation, Protection and Control.

Teaching and Assessment Scheme:

Teaching Scheme (Hours per Week)			Credits	Assessment Scheme				
				Theory Marks		Practical Marks		Total Marks
L	T	P	C	ESE	CE	ESE	CE	
3	0	2	4	60	40	20	30	150

Details of Assessment Instruments under CE Practical Component:

Term work [15]	Allied Evaluation [15]
Attendance/report/presentations/Assignment	Performance/Attitude-Aptitude/Quiz/ Questions & Answers/ Discussion

Course Contents:

Unit No.	Topics	Teaching Hours
1	**Basic Concepts and Definitions:** Introduction, Phasor Measurement Unit (PMU), a short history of the PMU, basic definitions of Synchrophasors, frequency, and ROCOF, steady state and dynamic conditions in power systems, importance of the model: classical phasor versus dynamic phasor, basic definitions of accuracy indexes.	06
2	**Algorithms for Synchrophasors, Frequency, and ROCOF:** Methods to Calculate Synchrophasors Based on a Steady State Model, Methods Based on DFT, Methods Based on Direct Model Matching, Methods Based on Demodulation and Filtering, Methods Based on a Dynamic Signal Model, Methods Based on Discrete Fourier Transform, Methods Based on Time Domain Model Matching, Other Estimation Methods, Evaluation of Frequency and ROCOF, Dynamic Behavior of Phasor Measurement Algorithms.	08
3	**Hardware and Software for PMU Integration:** Introduction, PMU Architecture, Data Acquisition System, Synchronization Sources, Communication and Data Collector, Distributed PMU, Introduction to Phasor Data Concentrator (PDC) and Historian, Introduction to communication networks employed for WAMS.	
4	**International Standards for PMU and Tests for Compliance:** The Synchrophasors Standard, IEEE C37.118.1(2011) and IEEE C37.118.2(2011),, Introduction to IEC 61850 Standard, Standard Communication Services and Bus Architecture, Comparison of IEC 61850 Communication Services and C37.118, IEC TR 61850-90-5 Guidelines for Reporting Synchrophasors, Test for Compliance: Examples, Examples of PMU Testing Results	08
5	**Benefits of Synchrophasors to the Protection and Control of Power Systems:** Introduction to SIPS, SIPS architecture, Practical examples of SIPS, SIPS based on synchronized measurement technologies, Oscillatory Stability Monitoring, Wide-area Voltage Stability Monitoring, Instability Detection and Control, SMU/PMU Supported Applications for Inter-area Oscillations, WAMPAC for Frequency Stability, System (disturbance) recording and Analysis using PMUs, Main and Backup Protection.	08

Unit No.	Topics	Teaching Hours
6	**Transmission Line Fault Location:** Fault Location Applications, Implementation Issues, The Use of Synchronized Samples from Two Ends - Theoretical Formulation Implementation Details and Results, Features and Benefits; The Use of Sparse Synchronized Phasor Measurement for Fault Location - Theoretical Formulation, Implementation Details and Results, Features and Benefits	08
	Total	**44**

Experiment List:

Sr. No.	Suggested List of Experiments
1.	Hands-on training on interfacing software of a Phasor Measurement Unit
2.	Hands-on training on interfacing hardware of a Phasor Measurement Unit
3.	Hands-on Training and Testing of Numerical Distance Relay with PMU inbuilt
4.	Hands-on training on simulation and visualization software for PMU and Phasor Data Concentrator
5.	Simulation and interfacing of a PMU model in PSCAD
6.	Introduction to Open PDC Software for Phasor Data Concentrator
7.	Modelling and simulation of PMU using MATLAB/SIMULINK
8.	Hands-on training on fault and dynamic disturbance recorder using ETAP
9.	Hands-on training on data capture from PMUs using ETAP
10.	Case studies based on PMU data available on RLDC and NLDC
11.	Visit to SLDC to understand implementation of data analytics and visualization software for WAMS

List of References:

1. Antonello Monti, Carlo Muscas, and Ferdinanda Ponci , “Phasor Measurement Units and Wide Area Monitoring Systems From the Sensors to the System”, Academic Press, Elsevier, 2016
2. Working Group B5.14, “Wide area protection & Control technologies”, CIGRE, September 2016. Available at: https://e-cigre.org/publication/664-wide-area-protection--control-technologies
3. M. Kezunovic, S. Meliopoulus, V. Venkatasubramanian and V. Vittal, “Application of Time-Synchronized Measurements in Power System Transmission Networks”, Springer, 2014
4. A. G. Phadke and J. S. Thorp, “Synchronized Phasor Measurements and their Applications”, Springer, 2008

Web Resources:

1. Web course on “Power System Protection” by Prof. S. A. Soman, IIT, Bombay available on NPTEL at http://nptel.ac.in/courses/108101039/
2. Website of RLDC, NLDC etc. available at https://www.wrldc.in/, https://posoco.in/

Course Outcomes (COs):

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

1. Understand the basics concepts related to Phasor measurement units.
2. Implement the algorithms related to compute synchrophasors, frequency and rate of change of frequency.
3. Apply the knowledge of hardware of PMU for the integration of PMUs for wide area measurement systems.
4. Analyze the international standards for Phasor measurement units and design of tests for compliance to the standards.
5. Apply synchronized Phasor measurements to protection and control of power systems.
6. Apply synchronized Phasor measurements to transmission line fault location.

4EE65: ARTIFICIAL INTELLIGENCE (AI) APPLICATIONS TO ELECTRICAL ENGINEERING

CREDITS - 4(LTP: 3, 0, 1)

Course Objective:

To familiarize with the concept of Artificial Intelligence, fuzzy logic, artificial neural networks, optimization, machine learning and its applications in electrical engineering.

Teaching and Assessment Scheme:

Teaching Scheme (Hours per Week)			Credits	Assessment Scheme				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE	CE	ESE	CE	150
3	0	2	4	60	40	20	30	

Details of Assessment Instruments under CE Practical Component:

Hands-on and computational experiments related to the course contents. Exposure to Artificial Neural Networks and Machine Learning toolboxes using MATLAB and /or SCILAB

Term work [15]	Allied Evaluation [15]
Attendance/report/Assignment	Performance/Attitude-Aptitude/Quiz/ Questions & Answers/ Discussion

Course Contents:

Unit No.	Topics	Teaching Hours
1.	**Introduction to Artificial Intelligence and Fuzzy Systems:** Artificial Intelligence: Definition, significance, scope and applications. Fuzzy Systems: Fuzzy sets and operations, membership functions, Fuzzification and Defuzzification, rule base, introduction to Fuzzy Logic Control, architecture of Mamdani and Takagi-Sugeno Fuzzy Models, implementation in Electric Drives, Industrial Automation, Renewable Energy Systems, Electric Vehicles, Smart Grids etc.	10

Unit No.	Topics	Teaching Hours
2.	**Artificial Neural Networks:** Introduction to Artificial Neural Networks, Biological Neuron, Artificial Neuron, Activation functions of Artificial Neuron, Structure of Artificial Neural Network, feed forward and recurrent Artificial Neural Networks, training of Artificial Neural Networks, Learning Methods, Back Propagation Algorithm, Implementation in Electric Drives, Industrial Automation, Renewable Energy Systems, Electric Vehicles, Smart Grids etc.	10
3.	**Random Search Optimization:** Modelling of the Optimization Problems, 1-D Optimization Algorithms (Bisection Method and Newton–Raphson Method), of operation, guided random search methods (Genetic Algorithm, Simulated Annealing, Particle Swarm Optimization), Implementation in Electric Drives, Industrial Automation, Renewable Energy Systems, Electric Vehicles, Smart Grids etc.	10
4.	**Machine Learning:** Introduction to Machine Learning (ML), Types of ML (Supervised Learning, Unsupervised Learning, Reinforcement Learning & Evolutionary Learning), support vector regression, Support Vector Machine (SVM), Kernel SVM, Application in Electric Drives, Industrial Automation, Renewable Energy Systems, Electric Vehicles, Smart Grids etc.	10
	Total	**40**

List of Experiments:

Sr. No.	Suggested List of Experiments
1.	Introduction to Artificial Neural Networks toolbox in MATLAB/SCILAB
2.	Programming practice for Fitting a Function using ANN toolbox
3.	Programming practice for Network Models, Network Architectures, Training Styles and Data structures using ANN toolbox
4.	Programming practice for Multi-layer networks and Back-propagation training using ANN toolbox
5.	Programming practice for Dynamic Networks using ANN toolbox
6.	Programming practice for Control Systems using ANN toolbox
7.	Programming practice for Descriptive Statistics and Visualization using Statistics and Machine Learning toolbox in MATLAB/SCILAB
8.	Programming practice for Probability Distribution using Statistics and Machine Learning toolbox in MATLAB/SCILAB
9.	Programming practice for Cluster Analysis using Statistics and Machine Learning toolbox in MATLAB/SCILAB
10.	Programming practice for Regression using Statistics and Machine Learning toolbox in MATLAB/SCILAB
11.	Programming practice for Regression using Support Vector Machine (SVM) in Statistics and Machine Learning toolbox in MATLAB/SCILAB
12.	Application of Artificial Intelligence Techniques for the Control of the Asynchronous Machine using MATLAB

List of References:

1. Saifullah Khalid, "Applications of Artificial Intelligence in Electrical Engineering, "Business Science Reference, 2020.
2. T.J.Ross, "Fuzzy Logic with Engineering Applications," 3rd edition, Wiley, 2011.
3. Simon S. Haykin, "Neural Networks – A Comprehensive Foundation," Pearson Education, 1997.
4. Thomas Weise, "Global Optimization Algorithms Theory and Application," 2nd Edition, Institute of Applied Optimization.
5. Rajesh Kumar Arora, "Optimization Algorithms and Applications," CRC Press, 2015.
6. EthemAlpaydin, "Introduction to Machine Learning," MIT press, 2010.
7. Stephen Marsland, "Machine Learning: An Algorithmic Perspective," CRC Press, 2015.

Lab Resources:

1. Mark Hudson BealeMartin T. HaganHoward B. Demuth, "Neural Network Toolbox™ 7 User's Guide", Mathworks Inc.
2. Primoz Potocnik , "Neural Networks: MATLAB examples", Available at: http://lab.fs.uni-lj.si/lasin/wp/IMIT_files/neural/NN-examples.pdf
3. Heikki N. Koivo, "Neural Networks: Basics using MATLAB Neural Network Toolbox", Available at: http://staff.ttu.ee/~jmajak/Neural_networks_basics_.pdf
4. Documentation and Examples on Statistics and Machine Learning Toolbox in MATLAB, Available at: https://in.mathworks.com/help/stats/index.html
5. Tutorial on Support Vector Machine in MATLAB, Available at: https://in.mathworks.com/discovery/support-vector-machine.html
6. F. Khammar and N. E. Debbache, "Application of Artificial Intelligence Techniques for the Control of the Asynchronous Machine", Journal of Electrical and Computer Engineering, available at: https://www.hindawi.com/journals/jece/2016/8052027/

Course Outcomes (COs):

At the end of this course students will be able to …

1. Recognize the idea of Artificial Intelligence and its applications in various sectors.
2. Demonstrate the understanding of fuzzy system and fuzzy controller to various electrical systems.
3. Understand and implement artificial neural networks in various domains of electrical systems.
4. Appreciate the concepts and different types of Machine Learning Algorithms.

EEIS1: INTERNSHIP-I
Non-Credit Mandatory Course
CREDITS - 0 (LTP:0,0,30 Hours/Week)
2nd Year, B. Tech. (Electrical)

Course Objective:

Expose students to the industrial environment, which cannot be simulated in the classroom and hence creating competent professionals in the industry. Provide possible opportunities to learn, understand and sharpen the real time technical / managerial skills required at the job.

Teaching and Assessment Scheme:

Teaching Scheme (Hours per Week)			Credits	Assessment Scheme				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE	CE	ESE	CE	
0	0	Minimum 30 Hours/Week preferably in Summer Vacation	0	0	0	40	60	**100**

Details of Assessment Instruments under CE Practical Component:
Evaluation of Daily Diary/Log, Internship Report and interaction with students by the Faculty Counselor.

Instructional Method and Pedagogy:

1. Internship shall preferably be at least 90 hours or 3 Weeks during the summer vacation.
2. During the summer vacation after 4th semester, students are ready for industrial experience. Therefore, they may choose to undergo Internship / Innovation / Entrepreneurship related activities. Students may choose either to work on innovation or entrepreneurial activities resulting in start-up or undergo internship with industry/ NGO's/ Government organizations/ Micro/ Small/ Medium enterprises to make themselves ready for the industry.
3. Faculty Counsellor of the Department will help students to find an appropriate company/industry/organization for the summer internship. Summer internships in research centers is also allowed.
4. The student must fill up and get approved a Summer Internship Acceptance form by the company and provide it to the departmental Training and Placement Coordinator of the department within the specified deadline.
5. Students shall commence the internship after the approval of the departmental Training and Placement Coordinator. During the entire period of internship, the student shall obey the rules and regulations of the company/industry/organization and also those of the University.
6. The student shall submit two documents to the Faculty Counsellor for the evaluation of the summer internship:
   - Summer Internship Report
   - Summer Internship Assessment Form
7. Upon the completion of summer internship, a hard copy of "Summer Internship Report" must be submitted to the Faculty Counsellor by the first day of the new term.
8. The report must outline the experience and observations gained through practical internship, in accordance with the required content and the format described in this guideline. Each report will be evaluated by the Faculty Counsellor of the department on a satisfactory/unsatisfactory basis at the beginning of the semester.
9. The students have to present their work in a seminar arranged in the department.
10. If the evaluation of the report and seminar presentation is unsatisfactory, it shall be returned to the student for revision and/or rewriting.

11. If the revised report is still unsatisfactory the student shall be requested to repeat the summer internship to complete the non-credit mandatory course.

Course Outcomes (COs):
After completion of the course students will be able:

1. To apply knowledge and skills learned in company/industry/organization to real-world problems
2. To function in a team work
3. To use experience related to professional and ethical issues in the work environment
4. To explain the impact of engineering solutions, developed in a project, in a global, economic, environmental, and societal context
5. To find relevant sources (e.g., library, Internet, experts) and gather information
6. To use new tools and technologies

EEIS2: INTERNSHIP-2
Non-Credit Mandatory Course
CREDITS - 0 (LTP: 0,0, 30 Hours/Week)
3rd Year, B. Tech. (Electrical)

Course Objective:
Expose students to the industrial environment, which cannot be simulated in the classroom and hence creating competent professionals in the industry. Provide possible opportunities to learn, understand and sharpen the real time technical / managerial skills required at the job.

Teaching and Assessment Scheme:

Teaching Scheme			Credits	Assessment Scheme				
L	T	P	C	Theory		Practical		Total Marks
				ESE	CE	ESE	CE	
0	0	Minimum 30 Hours/Week preferably in Summer Vacation	0	0	0	40	60	100

Details of Assessment Instruments under CE Practical Component:
Evaluation of Daily Diary/Log, Internship Report and interaction with students by the Faculty Counselor.

Instructional Method and Pedagogy:

1. Internship shall preferably be at least 90 hours or 3 Weeks during the summer vacation.
2. During the summer vacation after 6th semester, students are ready for industrial experience. Therefore, they may choose to undergo Internship / Innovation / Entrepreneurship related activities. Students may choose either to work on innovation or entrepreneurial activities resulting in start-up or undergo internship with industry/ NGO's/ Government organizations/ Micro/ Small/ Medium enterprises to make themselves ready for the industry.
3. Faculty Counsellor of the Department will help students to find an appropriate

company/industry/organization for the summer internship. Summer internships in research centers is also allowed.

4. The student must fill up and get approved a Summer Internship Acceptance form by the company and provide it to the departmental Training and Placement Coordinator of the department within the specified deadline.
5. Students shall commence the internship after the approval of the departmental Training and Placement Coordinator. During the entire period of internship, the student shall obey the rules and regulations of the company/industry/organization and also those of the University.
6. The student shall submit two documents to the Faculty Counsellor for the evaluation of the summer internship:
   - Summer Internship Report
   - Summer Internship Assessment Form
7. Upon the completion of summer internship, a hard copy of "Summer Internship Report" must be submitted to the Faculty Counsellor by the first day of the new term.
8. The report must outline the experience and observations gained through practical internship, in accordance with the required content and the format described in this guideline. Each report will be evaluated by the Faculty Counsellor of the department on a satisfactory/unsatisfactory basis at the beginning of the semester.
9. The students have to present their work in a seminar arranged in the department.
10. If the evaluation of the report and seminar presentation is unsatisfactory, it shall be returned to the student for revision and/or rewriting.
11. If the revised report is still unsatisfactory the student shall be requested to repeat the summer internship to complete the non-credit mandatory course.

Course Outcomes (COs):

After completion of the course students will be able:

1. To apply knowledge and skills learned in company/industry/organization to real-world problems
2. To function in a team work
3. To use experience related to professional and ethical issues in the work environment
4. To explain the impact of engineering solutions, developed in a project, in a global, economic, environmental, and societal context
5. To find relevant sources (e.g., library, Internet, experts) and gather information
6. To use new tools and technologies