ACADEMIC REGULATIONS

COURSE STRUCTURE AND DETAILED SYLLABUS

ELECTRICAL AND ELECTRONICS ENGINEERING

for

B. Tech

(Applicable for batches admitted from 2020-2021)

VASIREDDY VENKATADRI INSTITUTE OF TECHNOLOGY

(Autonomous)

Approved by AICTE, Permanently Affiliated to JNTUK,

NAAC Accredited with ‘A’ Grade, ISO 9001:2015 Certified

Nambur (V), Pedakakani (M), Guntur (Dt.), Andhra Pradesh – 522 508

About Institute

VasireddyVenkatadri Institute of Technology (VVIT) was established in the year 2007, with an intake of 240 students in four B. Tech programs under Social Educational Trust in Nambur village, Guntur, AP, by Er. VasireddyVidyaSagar. It is located strategically between Guntur and Vijayawada in the capital region of Amravati, AP. In a short span of ten years, with an annual intake capacity of 1260 students into B.Tech (CE, EEE, ME, ECE, CSE, IT, CSM, CSO, CIC and AID) and 81 students into M. Tech (CSE, VLSI&ES, PEED, MD, SE) programs respectively, today almost 4000 students, 345 teaching staff and 225 non-teaching staff strive to fulfill the vision of VVIT.

VVIT has emerged as one of the top ten Engineering Colleges from the 200 engineering colleges affiliated to JNTU Kakinada. The Institute signedMoUs with Industry and Training & Placement Companies like Infosys, Tech Mahindra, Social Agro, Efftronics, AMCAT and Cocubes. Centre of Excellence (CoE) by Siemens India was established in the year 2016 byAPSSDCto promote Industry Institute interface and strengthen employability skills in students, Google Inc. USA for establishing Google Code labs, University Innovative Fellowship (UIF) program by Stanford University USA and VDC established by Northeastern University

On achieving permanent affiliation to JNTUK, Kakinada, NAAC ‘A” grade certification (CGPA 3.09) and B. Tech programs (CE, EEE, ME, ECE, CSE, IT) accredited by NBA, VVIT has set its sight on centrally funded research projects with 10 completed and 6 running DST projects and consultancy service from other departments. VVIT as part of its commitment to research, has published 13 patents, 16 books and nearly 690 journal papers and also has a ‘Research Centre affiliated to JNTUK’.

Institute Vision

To impart quality education through exploration and experimentation and generate socially conscious engineers, embedding ethics and values, for the advancement in science and technology.

Institute Mission

- To educate students with a practical approach to dovetail them to industry-needs.
- To govern the institution with a proactive and professional management with passionate teaching faculty.
- To provide holistic and integrated education and achieve over all development of students by imparting scientific and technical, social and cognitive, managerial and organizational skills.
- To compete with the best and be the most preferred institution of the studious and the scholarly.
- To forge strong relationships and linkage with the industry.

AboutEEEDepartment

The department of Electrical and Electronics Engineering (EEE) was establishedduring the inception of the institute in 2007 with an annual intake of 60 students. In theacademicyear 2012-2013 theintake capacity rose to 120 andin the year 2018-2019itrose to 180.The department has a faculty student ratio of 1:15 as per AICTE norms.Theaverage teaching experience is more than 5 years. The department also offers one post graduate programs in Power Electronics and Electrical Drives (PE & ED) with an intake of 18.The department is re-accredited by National Board of Accreditation for three years from 2020. ThemajorgoaloftheEEEdepartmentistoproducehighlyknowledgeable, competent and resourceful young engineers who can perform well in awide variety of job profiles. To achieve this goal the department is putting dedicatedefforts in nurturing a strong foundation both in analytical and technological aspects laiddown in the curriculum. It also provides ample opportunities to students to work on miniprojects, develop communication skills, explore internship opportunities in industry andtakepartinnationalandinternationaldesigncontests.

The laboratory practical classes are conducted in a systematic manner, where completeplan is given at the time of commencement of the semester. The laboratories are wellequipped with modern training facilities that cater to the requirements of the universitysyllabus. This department plays a vital role in training students of other branches ofengineeringtoo. The department also encourages students to take up Graduate Aptitude Test for Engineers (GATE), Graduate Record Examination (GRE) during their final year so they can pursuetheir higher education either in India or countries like USA, UK, Canada, Australia etc.Thedepartmenthasan IE (I) studentchapterwhere students learn to do projects and organize technical events like symposiums, paperpresentations toinculcate abroader perceptive on the profession. These efforts haveculminatedintheformofplacementsinvariousleadingindustriesandorganizations.

Department Vision

To nurture young and fresh minds into disciplined and globally competent technocrats with ethical values to excel in the arena of Electrical and Electronics Engineering leading to sustainable development of society.

Department Mission

- To produce qualified engineers with technical knowledge and innovative skills to cater the dynamic requirements in the field of Electrical and Electronics Engineering.
- To provide state-of-the-art resources that contributes to achieve excellence in teaching-learning, research and development activities.
- To produce graduates with leadership and Entrepreneurship qualities.
- To make our students life-long learners capable of building their careers upon a solid foundation of knowledge.
- Ensure that our students are well trained in interpersonal skills, team work, professional ethics, environmental awareness and participate in professional society activities.

Program Educational Objectives

- **PEO-1**: To prepare the students for academic and professional life of Electrical and Electronics Engineering.
- **PEO-2:** To train the students to adapt to the technological developments, innovations and updates in order to prepare them for their profession.
- **PEO-3:** To impart knowledge and skills that enables the students to work effectively with professional ethical values, as individuals and as team members in multidisciplinary environments.
- **PEO-4:** To encourage the graduates to pursue higher studies, research assignments and as entrepreneurs.

PROGRAM OUTCOMES (POs)

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

PO2: Problem analysis: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3: Design/development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4: Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5: Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

PO6: The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

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

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

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

PO10: Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO11: Project management and finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO12: Life-long learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PROGRAM SPECIFIC OUTCOMES (PSOs)

Electrical and Electronics Engineering Graduates will be able to:

PSO1: Apply the engineering fundamental knowledge to identify, formulate, design and investigate complex engineering problems of electric circuits, power electronics, electrical machines and power systems and to succeed in competitive exams like GATE, IES, GRE, TOEFL, GMAT, etc.

PSO2: Apply appropriate techniques and modern engineering hardware and software tools in power systems and power electronics to engage in life-long learning and to get an employment in the field of Electrical and Electronics Engineering.

PSO3: Understand the impact of engineering solutions in societal and environmental context, commit to professional ethics and communicate effectively.

ACADEMIC REGULATIONS (R20) FOR B. TECH (REGULAR)

Applicable for the students of B.Techfrom the Academic Year 2020 – 21 onwards

1.Award of B. Tech. Degree

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

- Pursues a course of study in not less than four and not more than eight academic years.
- After eight academic years from the year of their admission, he/she shall forfeit their seat in B. Tech course and their admission stands cancelled.
- Registers for 160 credits and must secure all the 160 credits.
- A student shall be eligible for the award of **B.Tech degree with Honors or Minor if he/she earns 20 credits in addition to the 160 credits. A student shall be permitted to register either for Honors or for Minor and not for both simultaneously.**

2. Courses of Study: The following courses of study are offered at present as specializations for the B. Tech. Courses

S. No.	Branch	Branch Short Form	Branch Code
1	Civil Engineering	CIV	01
2	Electrical and Electronics Engineering	EEE	02
3	Mechanical Engineering	MEC	03
4	Electronics and Communication Engineering	ECE	04
5	Computer Science and Engineering	CSE	05
6	Information Technology	INF	12
7	CSE (Artificial Intelligence and Machine Learning)	CSM	42
8	CSE (Internet of Things and Cyber Security with Block Chain Technology)	CIC	47
9	CSE (Internet of Things)	CSO	49
10	Artificial Intelligence and Data Science	AID	54

3. **Medium of Instruction:** The medium of instruction of the entire B. Tech undergraduate programme in Engineering & Technology (including examinations and project reports) will be in English only.

4. **Admissions:** Admission to the B. Tech Programme shall be made subject to the eligibility, qualifications and specialization prescribed by the A.P. State Government/University from time to time. Admissions shall be made either on the basis of the merit rank obtained by the student in the common entrance examination conducted by the A.P. Government/University or on the basis of any other order of merit approved by the A.P. Government/University, subject to reservations as prescribed by the Government/University from time to time.

5. **Structure of the Undergraduate Engineering program:** Every course of B. Tech. Program shall be placed in one of the nine categories as listed in table below:

S.No.	Category	Breakup of Credits
1	Humanities and social science including Management courses	10.5 - 12
2	Basic Science courses	21 - 25
3	Engineering science courses	24
4	Professional core Courses	48 - 51
5	Open Elective Courses	12 - 18
6	Professional Elective Courses	15 - 18
7	Internship, seminar, project wok	15 – 16.5
8	Mandatory courses	NC
9	Skill Oriented Courses	----
	Total Credits	160

** Breakup of Credits based on AICTE /APSCHE

Assigning of Credits

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

6. Programme Pattern

i. Total duration of the of B. Tech (Regular) Programme is four (three for lateral entry) academic years

ii. Each Academic year of study is divided in to two semesters.

iii. Minimum number of instruction days in each semester is 90.

iv. Grade points, based on percentage of marks awarded for each course will form the basis for calculation of SGPA (Semester Grade Point Average) and CGPA (Cumulative Grade Point Average).

v. The total credits for the Programme are 160.

vi. A three-week induction program is mandatory for all first year UG students (Physical activity, Creative Arts, Universal Human Values, Literary, Proficiency Modules, Lectures by Eminent People, Visits to local Areas, Familiarization to Dept./Branch & Innovations etc.,) and shall be conducted as per AICTE/UGC/APSCHE guidelines.

vii. Student is introduced to “Choice Based Credit System (CBCS)”.

viii. A pool of interdisciplinary and job-oriented mandatory skill courses which are relevant to the industry are integrated into the curriculum of concerned branch of engineering (total five skill courses: two basic level skill courses, one on soft skills and other two on advanced level skill courses)

ix. A student has to register for all courses in a semester.

x. All the registered credits will be considered for the calculation of final CGPA.

xi. Each semester has - Continuous Internal Evaluation (CIE) and Semester End Examination (SEE). Choice Based Credit System (CBCS) and Credit Based Semester System (CBSS) as indicated by UGC and course structure as suggested by AICTE are followed.

xii. A 10 months industry/field mandatory internship, both industry and social, during the summer vacation and also in the final semester to acquire the skills required for job and make engineering graduates to connect with the needs of the industry and society at large.

xiii. All students shall be mandatorily registered for NCC/NSS activities. A student will be required to participate in an activity for two hours in a week during second and third semesters. Grade shall be awarded as Satisfactory or Unsatisfactory in the mark sheet on the basis of participation, attendance, performance and behavior. If a student gets an unsatisfactory Grade, he/she shall repeat the above activity in the subsequent years, in order to complete the degree requirements.

xiv. Courses like Environmental Sciences, Human Values, Ethics, Indian Constitution, Essence of Indian Traditional Knowledge etc., shall be included in the curriculum as non-credit mandatory courses. Environmental Sciences is to be offered compulsorily as mandatory course for all branches. A student has to secure 40% of the marks allotted in the internal evaluation for passing the course. No marks or letter grade shall be allotted for all mandatory non-credit courses.

xv. College shall assign a faculty advisor/mentor after admission to each student or group of students from same department to provide guidance in courses registration/career growth/placements/opportunities for higher studies / GATE / other competitive exams etc.

xvi. Departments may swap some of the courses between first and second semesters to balance the work load.

xvii. The concerned Board of studies can assign tutorial hours to such courses wherever it is necessary, but without change in the total number of credits already assigned for semester.

8. Registration for Courses

i. The college shall invite registration forms from the students at the beginning of the semester for the registration for courses each semester. The registration process shall be closed within one week. If any student wishes to withdraw the registration, he/she shall submit a letter to the principal through the class teacher/instructor and HOD. The principal shall communicate the registration and withdraw details courses of each student in a consolidated form to the college examination section and University without fail.

ii. There are four open electives in each branch. All Open Electives are offered to students of all branches in general. A student shall choose an open elective, by consulting the HOD/advisor, from the list in such a manner that he/she has not studied the same course in any form during the Programme. The college shall invite registration forms from the students at the beginning of the semester for offering professional and open elective courses. There shall be a limit on the minimum and maximum number of registrations based on class/section strength.

iii. A student shall be permitted to pursue up to a maximum of two elective courses under MOOCs during the programme. Students are advised to register for only for minimum 12 weeks in duration MOOCs courses. Student has to pursue and acquire a certificate for a MOOC course only from the SWAY/NPTE through online with the approved by the BoS in order to earn the 3 credits. The Head of the department shall notify the list of such courses at the beginning of the semester. The details of the MOOCs courses registered by the students shall be submitted to the University examination center as well as college examination center. The Head of the Department shall appoint a mentor for each of the MOOC subjects registered by the students to monitor the student's assignment submissions given by SWAYAM/NPTEL. The student needs to submit all the assignments given and needs to take final exam at the proctor center. The student needs to earn a certificate by passing the exam. The student will be awarded the credits given in curriculum only by submission of the certificate. In case if student does not pass subjects registered through SWAYAM/NPTEL, the same or alternative equivalent subject may be registered again through SWAYAM/NPTEL in the next semester with the recommendation of HOD and shall be passed.

iv. Two summer internships each with a minimum of six weeks duration shall be mandatorily done/completed respectively at the end of second and third years (during summer vacations). The internship can be done by the students at local industries, Govt. Organizations, construction agencies, Industries, Hydel and thermal power projects and also in software MNCs. After completing the summer internship, the students shall register in the immediate respective odd semester and it will be evaluated at the end of the semester as per norms of the autonomy. The student has to produce the summer internship satisfactory report and certificate taken from the organization to be considered for evaluation. The College shall facilitate and monitor the student internship programs. Completion of internships is mandatory, if any student fails to complete internship, he/she will not be eligible for the award of degree. In such cases, the student shall repeat and complete the internship.

v. In the final semester, the student should mandatorily register and undergo internship and in parallel he/she should work on a project with well-defined objectives. At the end of the semester the candidate shall submit an internship completion certificate and a project report. A student shall also be permitted to submit project report on the work carried out during the internship. The project report shall be evaluated with an external examiner.

vi. Curricular Framework for Skill oriented courses

a. There are five (05) skill-oriented courses shall be offered during III to VII semesters and students must register and pass the courses successfully.

b. For skill oriented/skill advanced course, one theory and 2 practical hours (1-0-2) or two theory hours (2-0-0) may be allotted as per the decision of concerned BOS.

c. Out of the five skill courses; (i) two shall be skill-oriented courses from the same domain and shall be completed in second year (ii) Of the remaining 3 skill courses, one shall be necessarily be a soft skill course and the remaining two shall be skill-advanced courses either from the same domain or job-oriented skill courses, which can be of inter disciplinary nature.

d. Students may register the interdisciplinary job-oriented skill courses based on the prerequisites and eligibility in consultation with HoD of the college.

e. The student shall be given an option to choose either the skill courses being offered by the college or to choose a certificate course being offered by industries/Professional bodies/APSSDC or any other accredited bodies. However, the department has to assign mentors in the college to monitor the performance of the students.

f. If a student chooses to take a certificate course offered by industries/Professional bodies/APSSDC or any other accredited bodies, in lieu of the skill advanced course offered by the department, then the department shall mark overall attendance of the student for the remaining courses in that semester excluding the skill course in all the calculations of mandatory attendance requirements upon producing a valid certificate. However, the student is deemed to have fulfilled the attendance requirement of the course, if the external agency issues a certificate with satisfactory condition. If the certificate issued by external agency is marked with unsatisfactory condition, then the student shall repeat the course either in the college or at external agency. The credits will be awarded to the student upon producing the successful course completion certificate from the agency/professional bodies and after passing in the viva-voce examination conducted at college as per BoS norms at the end of the semester.

9. Attendance Requirements:

i. A student is eligible to write the semester-end examinations if he acquires a minimum of 40% in each subject and 75% of attendance in aggregate of all the subjects.

ii. Shortage of Attendance below 65% in aggregate shall in NO case be condoned. Students whose shortage of attendance is not condoned in any semester are not eligible to take their end semester examination of that class and their registration shall stand cancelled.

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

iv. A student will not be promoted to the next semester unless he satisfies the attendance requirements of the present semester, as applicable. They may seek readmission for that semester when offered next.

v. A student will be promoted to the next semester if he satisfies the(a) attendance requirement of the present semester and (b) minimum required credits (from Vth Semester onwards).

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

vii. For induction programme attendance shall be maintained as per AICTE norms.

viii. For non-credit mandatory courses the students shall maintain the attendance similar to credit courses.

10. Evaluation-Distribution and Weightage of marks

Paper setting and evaluation of the answer scripts shall be done as per the procedures laid down by the Academic Council of the institute from time to time.

i. A student is deemed to have satisfied the minimum academic requirements if he/she has earned the credits allotted to each theory/practical design/drawing subject/ project etc. by securing not less than 35% of marks in the end semester exam and minimum 40% of marks in the total of the internal marks and end semester examination marks together.

ii. For non-credit mandatory courses, like Environmental Sciences, Universal Human Values, Ethics, Indian Constitution, Essence of Indian Traditional Knowledge, the student has to secure 40% of the marks allotted in the internal evaluation for passing the course. No marks or letter grade shall be allotted for all mandatory non-credit courses.

iii. **Distribution and Weightage of marks:** The assessment of the student's performance in each course will be based on Continuous Internal Evaluation (CIE) and Semester-End Examination (SEE). The performance of a student in each semester shall be evaluated subject–wise with a maximum of 100 marks for theory subject, 50 marks for practical subject/Mini Project/Internship/Industrial Training/ Skill Development programmes/Research Project, and 200 marks for end Project Work.

iv. Guide lines for Continuous Internal Evaluation (CIE)

a. For theory subjects, during a semester, there shall be two mid-term examinations. Each mid-term examination consists of (i) one online objective examination (ii) one descriptive examination (iii) one assignment and (iv) one Subject Seminar. The online examination (objective) shall be 10 marks with duration of 20 minutes, descriptive examination shall be for 10 marks with a duration of 1 hour 30 minutes, assignment test shall be 5 marks with duration of 50 minutes (Open book system with questions of L4 standard on Bloom's scale) and Subject Seminar 5 marks.

b. The first online examination (objective) is set with 20 multiple choice questions for 10 marks (20 questions x 1/2 marks) from first two and half units (50% of the syllabus).

c. The descriptive examination is set with 3 full questions for 10 marks each from first two and half units (50% of the syllabus), the student has to answer all questions.

d. The Assignment Test from first two and half units conducted for 20 Marks and will be scaled down to 5 Marks. The test is open book system and the duration of the exam is 50 minutes. Students can bring a maximum of three printed text books related to that subject. (Soft copies of the text books will not be allowed.) The assignments have to provide broadened exposure to the course. The questions shall include problem solving approach, problem analysis & design, implementation, case studies etc.

e. For the subject seminar 5 marks, each student shall be evaluated based on the presentation on any topic of his/her choice in the subject duly approved by the faculty member concerned.

f. For the subject having design and / or drawing (such as Engineering Graphics, Engineering Drawing, Machine Drawing) and estimation, the distribution shall be 30 marks for internal evaluation (15 marks for continuous Assessment (day–to–day work) and 15 marks for internal tests).

In the similar lines, the mid-2 examinations shall be conducted on the rest of the syllabus.

f. For practical subjects there shall be continuous evaluation during the semester for 15 marks. The internal 15 marks shall be awarded as follows: day to day work 5 marks, record 5 marks and the remaining 5 marks are to be awarded by conducting an internal laboratory test of 3 hours duration.

g. The mid marks submitted to the examination section shall be displayed in the concerned department notice boards for the benefit of the students. If any discrepancy found in the displayed Mid marks, it shall be brought to the notice of examination section within two working days from the date of display.

h. Internal marks can be calculated with 80% weightage for better of the two mids and 20% Weightage for another mid exam.

Example:

Mid-1 marks = Marks secured in (online examination-1+descriptive examination-1 +one assignment-1 + Seminar-1)

Mid-2 marks = Marks secured in (online examination-2+descriptive examination-2 +one assignment-2 + Seminar-2)

Final internal Marks = (Best of (Mid-1/Mid-2) marks x 0.8 + Least of (Mid-1/Mid-2) marks x 0.2)

v. **Semester End Examinations Evaluation:**

a. The semester end examinations for theory subjects will be conducted autonomous examination section for 70 marks consists of five questions carrying 14 marks each. Each of these questions is from one unit and may contain sub-questions. For each question there will be an "either" "or" choice, which means that there will be two questions from each unit and the student should answer either of the two questions.

b. For practical subjects shall be conducted for 35 marks by the teacher concerned and external examiner appointed by Chief superintendent/ Controller of Examinations (CoE), VVIT. All the laboratory records and internal test papers shall be preserved in respective departments as per autonomous norms and shall be produced to the Committees as and when they ask for.

c. Evaluation of the summer internships: It shall be completed in collaboration with local industries, Govt. Organizations, construction agencies, Industries, Hydel and thermal power projects and also in software MNCs in the area of concerned specialization of the UG programme. Students shall pursue this internship during summer vacation just before its offering as per course structure. The minimum duration of this course shall be at least 6 weeks. The student shall register for the internship as per course structure after commencement of academic year. A supervisor/mentor/advisor has to be allotted to guide the students for taking up the summer internship. The supervisor shall monitor the attendance of the students while taking up the internship. Attendance requirements are as per the norms of the academic regulations. After successful completion, students shall submit a summer internship technical report to the concerned department and appear for an oral presentation before the departmental committee consists of an external examiner appointed by Chief superintendent/ CoE; Head of the Department, supervisor of the internship and a senior faculty member of the department. A certificate from industry/skill development center shall be included in the report. The report and the oral presentation shall carry 40% and 60% weightages respectively. It shall be evaluated for 50 external marks at the end of the semester. There shall be no internal marks for Summer Internship. A student shall secure minimum 40% of marks for successful completion. In case, if a student fails, he/she shall reappear as and when semester supplementary examinations are conducted by the examination section.

d. The job-oriented skill courses may be registered at the college or at any accredited external agency. A student shall submit a record/report on the on the list skills learned. If the student completes job-oriented skill course at external agency, a certificate from the agency shall be included in the report. The course will be evaluated at the end of the semester for 50 marks (record: 15 marks and viva-voce: 35 marks) along with laboratory end examinations in the presence of external (appointed by the Chief superintendent/ CoE) and internal examiner (course instructor or mentor). There are no internal marks for the job-oriented skill courses.

e. Mandatory Course (M.C): Environmental Sciences, Universal Human Values, Ethics, Indian Constitution, Essence of Indian Traditional Knowledge etc. non-credit (zero credits) mandatory courses. Environmental Sciences shall be offered compulsorily as mandatory course for all branches. A minimum of 75% attendance is mandatory in these subjects. There shall be an external examination for 70 marks and it shall be conducted by the department internally. Two internal examinations shall be conducted for 30 marks and a student has to secure at least

40% of the marks for passing the course. There is no online internal exam for mandatory courses. No marks or letter grade shall be printed in the transcripts for all mandatory non-credit courses, but only Completed (Y)/Not-completed (N) will be specified.

f. Procedure for Conduct and Evaluation of MOOC: There shall be a Discipline Centric Elective Course through Massive Open Online Course (MOOC) as Program Elective course. The student shall register for the course (Minimum of 12 weeks) offered by SWAYAM/NPTEL/etc., through online with the approval of Head of the Department. The Head of the Department shall appoint one mentor for each of the MOOC subjects offered. The student needs to register the course in the SWAYAM/NPTEL portal. During the course, the mentor monitors the student's assignment submissions given by SWAYAM/NPTEL. The student needs to submit all the assignments given and needs to take final exam at the proctor center. The student needs to earn a certificate by passing the exam. The student will be awarded the credits given in curriculum only by submission of the certificate. In case if student does not pass subjects registered through SWAYAM/NPTEL, the same or alternative equivalent subject may be registered again through SWAYAM/NPTEL in the next semester with the recommendation of HOD and shall be passed.

g. Major Project (Project - Project work, seminar and internship in industry): In the final semester, the student should mandatorily register and undergo internship and in parallel he/she should work on a project with well-defined objectives. At the end of the semester the candidate shall submit an internship completion certificate and a project report. A student shall also be permitted to submit project report on the work carried out during the internship. The project report shall be evaluated with an external examiner. Evaluation: The total marks for project work 200 marks and distribution shall be 60 marks for internal and 140 marks for external evaluation. The supervisor assesses the student for 30 marks (Report: 15 marks, Seminar: 15 marks). At the end of the semester, all projects shall be showcased at the department for the benefit of all students and staff and the same is to be evaluated by the departmental Project Review Committee consisting of supervisor, a senior faculty and HOD for 30 marks. The external evaluation of Project Work is a Viva-Voce Examination conducted in the presence of internal examiner and external examiner appointed by the Chief superintendent/ CoE and is evaluated for 140 marks.

vi. Recounting/ Revaluation/ Revaluation by Challenge in the End Semester Examination: A student can request for recounting/ revaluation/ revaluation by challenge of his/her answer book on payment of a prescribed fee as per autonomous norms.

vii. Supplementary Examinations: A student who has failed to secure the required credits can appear for a supplementary examination, as per the schedule announced by the examination section.

viii. Malpractices in Examinations: Disciplinary action shall be taken in case of malpractices during Mid/End examinations as per the rules framed by the academic council.

ix. If the student is involved in indiscipline/malpractices/court cases, the result of the student will be withheld.

11. Promotion Rules:

i. A student shall be promoted from first year to second year if he fulfills the minimum attendance requirements.

ii. A student will be promoted from II year to III year if he fulfills the academic requirement of 40% of credits up to either II year I-Semester or II year II-Semester from all the examinations, whether or not the candidate takes the examinations and secures prescribed minimum attendance in II year II semester.

iii. A student shall be promoted from III year to IV year if he fulfills the academic requirements of 40% of the credits up to either III year I semester or III year II semester from all the examinations, whether or not the candidate takes the examinations and secures prescribed minimum attendance in III year II semester.

12. **Course Pattern**

i. The entire course of study is for four academic years; all years are on semester pattern.

ii. A student eligible to appear for the end semester examination in a subject, but absent from it or has failed in the end semester examination, may write the exam in that subject when conducted next.

iii. When a student is detained for lack of credits/shortage of attendance, he may be re-admitted into the same semester/year in which he has been detained. However, the academic regulations under which he was first admitted shall continue to be applicable to him.

13.Grading:

The grade points and letter grade will be awarded to each course based on students' performance as per the grading system shown in the following Table.

% of Marks	Letter Grade	Level	Grade Points
≥ 90	**A+**	Outstanding	10
80 to 89	**A**	Excellent	9
70 to 79	**B**	Very Good	8
60 to 69	**C**	Good	7
50 to 59	**D**	Fair	6
40 to 49	**E**	Satisfactory	5

<40	**F**	Fail	0
ABSENT	**Ab**	Absent	0

14. Computation of SGPA and CGPA

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

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

where, C_i is the number of credits of the ith subject and G_i is the grade point scored by the student in the ith course

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

$CGPA = \Sigma (C_i \times Si)/ \Sigma Ci$

where 'S_i' is the SGPA of the ith semester and C_i is the total number of credits in that semester

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

iv. While computing the SGPA/CGPA, the subjects in which the student is awarded Zero grade points will also be included.

v. Grade Point: It is a numerical weight allotted to each letter grade on a 10-point scale.

vi. Letter Grade: It is an index of the performance of students in a said course. Grades are denoted by letters A+, A, B, C, D, E and F.

vii. As per AICTE regulations, conversion of CGPA into equivalent percentage as follows:

Equivalent Percentage = (CGPA – 0.75) x 10

viii. Illustration of Computation of SGPA and CGPA

Illustration for SGPA: Let us assume there are 6 subjects in a semester. The grades obtained as follows:

Course	Credit	Grade Obtained	Grade point	Credit x Grade Point
Subject 1	3	B	8	3 X 8 = 24
Subject 2	4	C	7	4 X 7 = 28
Subject 3	3	D	6	3 X 6 = 18
Subject 4	3	A^+	10	3 X 10 = 30

Subject 5	3	E	5	3 X 5 = 15
Subject 6	4	D	6	4 X 6 = 24
	20			139

Thus, SGPA (S_i) =139/20 =6.95=6.9 (approx.)

Illustration for CGPA:

	Sem-1	Sem-2	Sem-3	Sem-4	Sem-5	Sem-6	Sem-7	Sem-8
Credits	20	22	25	26	26	25	21	23
SGPA	6.9	7.8	5.6	6.0	6.3	8.0	6.4	7.5

$$\mathbf{CGPA} = \frac{\mathbf{20\,X6.9 + 22X7.8 + 25X5.6 + 26X6.0 + 26X6.3 + 25X8.0 + 21X6.4 + 23X7.5}}{\mathbf{188}}$$

$$= \frac{\mathbf{1276.3}}{\mathbf{188}} = \mathbf{6.78}$$

15. Award of Class:

After a student has satisfied the requirements prescribed for the completion of the program and is eligible for the award of B. Tech. degree, he/she shall be placed in one of the following:

Class Awarded	CGPA to be secured
First Class with distinction*	≥7.5
First Class	≥6.5 &<7.5
Second Class	≥5.5 &<6.5
Pass Class	≥4 &<5.5
Fail	<4

* Awarded only if all the credit courses prescribed are cleared within four years for regular candidates and three years for lateral entry candidates

The students who are approved for break in study for entrepreneurships / startups will also be considered for award of first class with distinction

For the purpose of awarding First, Second and Pass Class, CGPA obtained in the examinations appeared within the maximum period allowed for the completion of the program shall been considered

16.Gap - Year:

Gap Year – concept of Student Entrepreneur in Residence shall be introduced and outstanding students who wish to pursue entrepreneurship are allowed to take a break of one year at any time after I year/II year/III year to pursue entrepreneurship full time. This period shall be counted for the maximum time for graduation. An evaluation committee at university level shall be constituted to evaluate the proposal submitted by the student and the committee shall decide on permitting the student for availing the Gap Year.

17. Transitory Regulations

A candidate, who is detained or discontinued a semester, on re-admission shall be required to pass all the courses in the curriculum prescribed for such batch of students in which the student joins subsequently and the academic regulations be applicable to him/her which are in force at the time of his/her admission. However, exemption will be given to those candidates who have already passed in such courses in the earlier semester(s) and additional courses are to be studied as approved by Board of Studies and ratified by Academic Council.

18.Curricular Framework for Honors Programme

i. Students of a Department/Discipline are eligible to opt for Honors Programme offered by the same Department/Discipline.

ii. A student shall be permitted to register for Honors program at the beginning of 4th semester provided that the student must have acquired a minimum of 8.0 SGPA up to the end of 2nd semester without any backlogs. In case of the declaration of the 3rd semester results after the commencement of the 4th semester and if a student fails to score the required minimum of 8 SGPA, his/her registration for Honors Programme stands cancelled and he/she shall continue with the regular Programme.

iii. Students can select the additional and advanced courses from their respective branch in which they are pursuing the degree and get an honors degree in the same. e.g. If a Mechanical Engineering student completes the selected advanced courses from same branch under this scheme, he/she will be awarded B.Tech. (Honors) in Mechanical Engineering.

iv. In addition to fulfilling all the requisites of a Regular B.TechProgramme, a student shall earn 20 additional credits to be eligible for the award of B. Tech (Honors) degree. This is in addition to the credits essential for obtaining the Under Graduate Degree in Major Discipline (i.e., 160 credits).

v. Of the 20 additional Credits to be acquired, 16 credits shall be earned by undergoing specified courses listed as pools, with four courses, each carrying 4 credits. The remaining 4 credits must be acquired through two MOOCs, which shall be domain specific, each with 2 credits and with a minimum duration of 8/12 weeks as recommended by the Board of studies.

vi. It is the responsibility of the student to acquire/complete prerequisite before taking the respective course. The courses offered in each pool shall be domain specific courses and advanced courses.

vii. The concerned BoS shall decide on the minimum enrolments for offering Honors program by the department. If minimum enrolments criteria are not met then the students shall be permitted to register for the equivalent MOOC courses as approved by the concerned Head of the department in consultation with BoS.

viii. Each pool can have theory as well as laboratory courses. If a course comes with a lab component, that component has to be cleared separately. The concerned BoS shall explore the possibility of introducing virtual labs for such courses with lab component.

ix. MOOC courses must be of minimum 8 weeks in duration. Attendance will not be monitored for MOOC courses. Students have to acquire a certificate from the agencies approved by the BOS with grading or marks or pass/fail in order to earn 4 credits. If the MOOC course is a pass/fail course without any grades, the grade to be assigned will be as decided by the university/academic council.

x. The concerned BoS shall also consider courses listed under professional electives of the respective B. Tech programs for the requirements of B. Tech (Honors). However, a student shall be permitted to choose only those courses that he/she has not studied in any form during the Programme.

xi. If a student drops or is terminated from the Honors program, the additional credits so far earned cannot be converted into free or core electives; they will remain extra. These additional courses will find mention in the transcript (but not in the degree certificate). In such cases, the student may choose between the actual grade or a "pass (P)" grade and also choose to omit the mention of the course as for the following: All the courses done under the dropped Minors will be shown in the transcript. None of the courses done under the dropped Minor will be shown in the transcript.

xii. In case a student fails to meet the CGPA requirement for Degree with Honors at any point after registration, he/she will be dropped from the list of students eligible for Degree with Honors and they will receive regular B.Tech degree only. However, such students will receive a separate grade sheet mentioning the additional courses completed by them.

xiii. Honors must be completed simultaneously with a major degree program. A student cannot earn Honors after he/she has already earned bachelor's degree.

19. Curricular Framework for Minor Programme

i. Students who are desirous of pursuing their special interest areas other than the chosen discipline of Engineering may opt for additional courses in minor specialization groups offered by a department other than their parent department. For example, If Mechanical Engineering student selects subjects from Civil Engineering under this scheme, he/she will get Major degree of Mechanical Engineering with minor degree of Civil Engineering

ii. Student can also opt for Industry relevant tracks of any branch to obtain the Minor Degree, for example, a B.Tech Mechanical student can opt for the industry relevant tracks like Data Mining track, IOT track, Machine learning track etc.

iii. The BOS concerned shall identify as many tracks as possible in the areas of emerging technologies and industrial relevance / demand. For example, the minor tracks can be the fundamental courses in CSE, ECE, EEE, CE, ME etc., or industry tracks such as Artificial Intelligence (AI), Machine Learning (ML), Data Science (DS), Robotics, Electric vehicles, Robotics, VLSI etc.

iv. The list of disciplines/branches eligible to opt for a particular industry relevant minor specialization shall be clearly mentioned by the respective BoS.

v. There shall be no limit on the number of programs offered under Minor. The college can offer minor programs in emerging technologies based on expertise in the respective departments or can explore the possibility of collaborating with the relevant industries/agencies in offering the program.

vi. The concerned BoS shall decide on the minimum enrolments for offering Minor program by the department. If a minimum enrolments criterion is not met, then the students may be permitted to register for the equivalent MOOC courses as approved by the concerned Head of the department in consultation with BoS.

vii. A student shall be permitted to register for Minors program at the beginning of 4th semester subject to a maximum of two additional courses per semester, provided that the student must have acquired 8 SGPA (Semester Grade point average) up to the end of 2nd semester without any history of backlogs. It is expected that the 3rd semester results may be announced after the commencement of the 4th semester. If a student fails to acquire 8 SGPA up to 3rd semester or failed in any of the courses, his registration for Minors program shall stand cancelled. An SGPA of 8 has to be maintained in the subsequent semesters without any backlog in order to keep the Minors registration active.

viii. A student shall earn additional 20 credits in the specified area to be eligible for the award of B. Tech degree with Minor. This is in addition to the credits essential for obtaining the Under Graduate Degree in Major Discipline (i.e., 160 credits).

ix. Out of the 20 Credits, 16 credits shall be earned by undergoing specified courses listed by the concerned BoS along with prerequisites. It is the responsibility of the student to acquire/complete prerequisite before taking the respective course. If a course comes with a lab component, that component has to be cleared separately. A student shall be permitted to choose only those courses that he/she has not studied in any form during the Programme.

x. In addition to the 16 credits, students must pursue at least 2 courses through MOOCs. The courses must be of minimum 8 weeks in duration. Attendance will not be monitored for MOOC courses. Student has to acquire a certificate from the agencies approved by the BOS with grading or marks or pass/fail in order to earn 4 credits. If the MOOC course is a pass/fail course without any grades, the grade to be assigned as decided by the University/academic council.

xi. Student can opt for the Industry relevant minor specialization as approved by the concerned departmental BoS. Student can opt the courses from Skill Development Corporation (APSSDC) or can opt the courses from an external agency recommended and approved by concerned BOS and should produce course completion certificate. The Board of studies of the concerned discipline of Engineering shall review such courses being offered by eligible external agencies and prepare a fresh list every year incorporating latest skills based on industrial demand.

xii. A committee should be formed at the level of College / department to evaluate the grades/marks given by external agencies to a student which are approved by concerned BoS. Upon completion of courses the departmental committee should convert the obtained grades/marks to the maximum marks assigned to that course. The controller of examinations can take a decision on such conversions and may give appropriate grades.

xiii. If a student drops (or terminated) from the Minor program, they cannot convert the earned credits into free or core electives; they will remain extra. These additional courses will find mention in the transcript (but not in the degree certificate). In such cases, the student may choose between the actual grade or a “pass (P)” grade and also choose to omit the mention of the course as for the following: All the courses done under the dropped Minors will be shown in the transcript or None of the courses done under the dropped Minor will be shown in the transcript.

xiv. In case a student fails to meet the CGPA requirement for B.Tech degree with Minor at any point after registration, he/she will be dropped from the list of students eligible for degree with Minors and they will receive B. Tech degree only. However, such students will receive a separate grade sheet mentioning the additional courses completed by them.

xv. Minor must be completed simultaneously with a major degree program. A student cannot earn the Minor after he/she has already earned bachelor’s degree.

20. Industrial Collaborations (Case Study)

Institution-Industry linkages refer to the interaction between firms and universities or public research centers with the goal of solving technical problems, working on R&D,

innovation projects and gathering scientific as well as technological knowledge. It involves the collaboration of Industries and Universities in various areas that would foster the research ecosystem in the country and enhance growth of economy, industry and society at large.

The Institutions are permitted to design any number of Industry oriented minor tracks as the respective BoS feels necessary. In this process the Institutions can plan to have industrial collaborations in designing the minor tracks and to develop the content and certificate programs. Industry giants such as IBM, TCS, WIPRO etc., may be contacted to develop such collaborations. The Institutions shall also explore the possibilities of collaborations with major industries in the core sectors and professional bodies to create specialized domain skills.

21. Amendments to Regulations: The college may from time-to-time revise, amend or change the Regulations, Curriculum, Syllabus and Scheme of examinations through the Board of Studies with the approval of Academic Council and Governing Body of the college.

22. Transferred Students: The students seeking transfer to VVIT from various Universities/ Institutions have to obtain the credits of any equivalent subjects as prescribed by the Academic Council. Only the internal marks obtained in the previous institution will be considered for evaluation of failed subjects.

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ACADEMIC REGULATIONS (R20) FOR B. TECH.

(LATERAL ENTRY SCHEME)

Applicable for the students admitted into II-year B. Tech. from the Academic Year 2021-22 onwards

1. **Award of B. Tech. Degree:** A student will be declared eligible for the award of B. Tech. Degree if he fulfills the following academic regulations:

- A student shall be declared eligible for the award of the B. Tech Degree, if he pursues a course of study in not less than three academic years and not more than six academic years.
- The candidate shall register for 121 credits and secure all the 121 credits.
- A student shall be eligible for the award of B.Tech degree with Honors or Minor if he/she earns 20 credits in addition to the 121 credits. A student shall be permitted to register either for Honors or for Minor and not for both simultaneously.

2. The attendance regulations of B. Tech. (Regular) shall be applicable to B.Tech Lateral Entry Students.

3. **Promotion Rule**

- A student shall be promoted from second year to third year if he fulfills the minimum attendance requirement.
- A student shall be promoted from III year to IV year if he fulfills the academic requirements of 40% of the credits up to either III year I semester or III year II semester from all the examinations, whether or not the candidate takes the examinations and secures prescribed minimum attendance in III year II semester.

4. **Award of Class**

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

Class Awarded	CGPA to be secured
First Class with distinction*	≥7.5
First Class	≥6.5 &<7.5
Second Class	≥5.5 &<6.5
Pass Class	≥4 &<5.5
Fail	<4

5. All the other regulations as applicable to B. Tech. 4-year degree course (Regular) will hold good for B. Tech Lateral Entry Scheme.

MALPRACTICE RULES

DISCIPLINARY ACTION FOR IMPROPER CONDUCT IN EXAMINATIONS

S.No.	Nature of Malpractices/Improper conduct	Punishment
1. (a)	Possesses or keeps accessible in examination hall, any paper, note book, programmable calculators, Cell phones, pager, palm computers or any other form of material concerned with or related to the subject of the examination (theory or practical) in which he is appearing but has not made use of (material shall include any marks on the body of the candidate which can be used as an aid in the subject of the examination)	Expulsion from the examination hall and cancellation of the performance in that subject only.
(b)	Gives assistance or guidance or receives it from any other candidate orally or by any other body language methods or communicates through cell phones with any candidate or persons in or outside the exam hall in respect of any matter.	Expulsion from the examination hall and cancellation of the performance in that subject only of all the candidates involved. In case of an outsider, he will be handed over to the police and a case is registered against him.
2.	Has copied in the examination hall from any paper, book, programmable calculators, palm computers or any other form of material relevant to the subject of the examination (theory or practical) in which the candidate is appearing.	Expulsion from the examination hall and cancellation of the performance in that subject and all other subjects the candidate has already appeared including practical examinations and project work and shall not be permitted to appear for the remaining examinations of the subjects of that Semester/year. The Hall Ticket of the candidate is to be cancelled and sent to the University.
3.	Impersonates any other candidate in connection with the examination.	The candidate who has impersonated shall be expelled from examination hall. The candidate is also debarred and forfeits the seat. The

		performance of the original candidate who has been impersonated, shall be cancelled in all the subjects of the examination (including practical and project work) already appeared and shall not be allowed to appear for examinations of the remaining subjects of that semester/year. The candidate is also debarred for two consecutive semesters from class work and all University examinations. The continuation of the course by the candidate is subject to the academic regulations in connection with forfeiture of seat. If the imposter is an outsider, he will be handed over to the police and a case is registered against him.
4.	Smuggles in the Answer book or additional sheet or takes out or arranges to send out the question paper during the examination or answer book or additional sheet, during or after the examination.	Expulsion from the examination hall and cancellation of performance in that subject and all the other subjects the candidate has already appeared including practical examinations and project work and shall not be permitted for the remaining examinations of the subjects of that semester/year. The candidate is also debarred for two consecutive semesters from class work and all University examinations. The continuation of the course by the candidate is subject to the academic regulations in connection with forfeiture of seat.
5.	Uses objectionable, abusive or offensive language in the answer paper or in letters to the examiners or writes to the examiner requesting him to award pass marks.	Cancellation of the performance in that subject.
6.	Refuses to obey the orders of the Chief Superintendent /Assistant – Superintendent / any officer on duty or misbehaves or creates disturbance of any kind in and around the examination hall or organizes a walk out or instigates others to walk out, or threatens the officer-in charge or any	In case of students of the college, they shall be expelled from examination halls and cancellation of their performance in that subject and all other subjects the candidate(s) has (have) already appeared and shall not be permitted to appear for the remaining examinations of the subjects of that semester/year. The candidates also are

	person on duty in or outside the examination hall of any injury to his person or to any of his relations whether by words, either spoken or written or by signs or by visible representation, assaults the officer-in-charge, or any person on duty in or outside the examination hall or any of his relations, or indulges in any other act of misconduct or mischief which result in damage to or destruction of property in the examination hall or any part of the College campus or engages in any other act which in the opinion of the officer on duty amounts to use of unfair means or misconduct or has the tendency to disrupt the orderly conduct of the examination.	debarred and forfeit their seats. In case of outsiders, they will be handed over to the police and a police case is registered against them.
7.	Leaves the exam hall taking away answer script or intentionally tears of the script or any part thereof inside or outside the examination hall.	Expulsion from the examination hall and cancellation of performance in that subject and all the other subjects the candidate has already appeared including practical examinations and project work and shall not be permitted for the remaining examinations of the subjects of that semester/year. The candidate is also debarred for two consecutive semesters from class work and all University examinations. The continuation of the course by the candidate is subject to the academic regulations in connection with forfeiture of seat.
8.	Possess any lethal weapon or firearm in the examination hall.	Expulsion from the examination hall and cancellation of the performance in that subject and all other subjects the candidate has already appeared including practical examinations and project work and shall not be permitted for the remaining examinations of the subjects of that semester/year. The candidate is also debarred and forfeits the seat.

9.	If student of the college, who is not a candidate for the particular examination or any person not connected with the college indulges in any malpractice or improper conduct mentioned in clause 6 to 8.	Student of the college expulsion from the examination hall and cancellation of the performance in that subject and all other subjects the candidate has already appeared including practical examinations and project work and shall not be permitted for the remaining examinations of the subjects of that semester/year. The candidate is also debarred and forfeits the seat. Person(s) who do not belong to the College will be handed over to police and, a police case will be registered against them.
10.	Comes in a drunken condition to the examination hall.	Expulsion from the examination hall and cancellation of the performance in that subject and all other subjects the candidate has already appeared including practical examinations and project work and shall not be permitted for the remaining examinations of the subjects of that semester/year.
11.	Copying detected on the basis of internal evidence, such as, during valuation or during special scrutiny.	Cancellation of the performance in that subject and all other subjects the candidate has appeared including practical examinations and project work of that semester/year examinations.
12.	If any malpractice is detected which is not covered in the above clauses 1 to 11 shall be reported to the University for further action to award suitable punishment.	

Ragging

Prohibition of ragging in educational institutions Act 26 of 1997

Salient Features

- Ragging within or outside any educational institution is prohibited.
- Ragging means doing an act which causes or is likely to cause Insult or Annoyance of Fear or Apprehension or Threat or Intimidation or outrage of modesty or Injury to a student

	Imprisonment upto		Fine Upto
Teasing, Embarrassing and Humiliation	6 Months	+	Rs. 1,000/-
Assaulting or Using Criminal force or Criminal intimidation	1 Year	+	Rs. 2,000/-
Wrongfully restraining or confining or causing hurt	2 Years	+	Rs. 5,000/-
Causing grievous hurt, kidnapping or Abducts or rape or committing unnatural offence	5 Years	+	Rs. 10,000/-
Causing death or abetting suicide	10 Months	+	Rs. 50,000/-

In case any emergency call Toll Free No. 1800 425 1288

LET US MAKE VVIT A RAGGING FREE CAMPUS

Ragging

ABSOLUTELY

NO TO RAGGING

1. Ragging is prohibited as per Act 26 of A.P. Legislative Assembly, 1997.
2. Ragging entails heavy fines and/or imprisonment.
3. Ragging invokes suspension and dismissal from the College.
4. Outsiders are prohibited from entering the College and Hostel without permission.
5. Girl students must be in their hostel rooms by 7.00 p.m.
6. All the students must carry their Identity Cards and show them when demanded
7. The Principal and the Wardens may visit the Hostels and inspect the rooms any time.

In case any emergency call Toll Free No. 1800 425 1288

LET US MAKE VVIT A RAGGING FREE CAMPUS

COURSE STRUCTURE (R20)

Definition of Credit (C)

1 Hour Lecture (L) per week	1 Credit
1 Hour Tutorial (T) per week	1 Credit
1 Hour Practical (P) per week	0.5 Credit

Structure of B. Tech program Regulation R20

S.No.	Category	Code	Suggested Breakup of Credits by AICTE	Suggested Breakup of Credits by APSCHE	Breakup of Credits
1	Humanities and Social Sciences including Management courses	HS	12	10.5	10.5
2	Basic Science courses	BS	25	21	21
3	Engineering Science courses including workshop, drawing, basics of electrical/ mechanical/ computer etc	ES	24	24	25.5
4	Professional core courses	PC	48	51	49.5
5	Professional Elective courses relevant to chosen specialization/ branch	PE	18	15	15
6	Open subjects – Electives from other technical and /or emerging subjects	OE	18	12	12
7	Project work, seminar and internship in industry or elsewhere	PR	15	16.5	16.5
8	Mandatory Courses [Environmental Sciences, Induction training, Indian Constitution, Essence of Indian Traditional Knowledge]	NC	Non-Credit	Non-Credit	0
9	Skill Oriented Courses	SC	--	10	10
Total			**160**	**160**	**160**

SEMESTER-WISE STRUCTURE OF CURRICULUM (R20)

SEMESTER-WISE STRUCTURE OF CURRICULUM

Course structure for eight semesters during four years of study is as follows

I Year I Semester (Semester-1)

S. No.	Category	Course Name	L	T	P	C
1	HS1101	Communicative English	3	0	0	3
2	BS1101	Mathematics-I	2	1	0	3
3	BS1102	Applied Physics	3	0	0	3
4	ES1101	Problem Solving using C	3	0	0	3
5	ES1102	Engineering Graphics	1	0	4	3
6	HS1101L	Communicative English Lab	0	0	3	1.5
7	BS1102L	Applied Physics & Virtual Lab	0	0	3	1.5
8	ES1101L	Problem Solving using C Lab	0	0	3	1.5
Total Credits						**19.5**

Category	Credits
Humanities and Social Science Courses	4.5
Basic Science Courses	7.5
Engineering Science Courses	7.5
Total Credits	**19.5**

I Year II Semester (Semester-2)

S. No.	Category	Course Name	L	T	P	C
1	BS1201	Mathematics-II	2	1	0	3
2	BS1202	Applied Chemistry	3	0	0	3
3	ES1201	Basic Electronic Devices and Circuits	2	1	0	3
4	ES1202	Problem Solving using Python	3	0	0	3
5	PC1201	Basic Circuit Analysis	2	1	0	3
6	BS1202L	Applied Chemistry Lab	0	0	3	1.5
7	ES1201L	Basic Electronic Devices and Circuits Lab	0	0	3	1.5
8	ES1202L	Problem Solving using Python Lab	0	0	3	1.5
9	MC1201	Indian Constitution	2	0	0	0
Total Credits						**19.5**

Category	Credits
Basic Science Courses	7.5
Professional Core Courses	3
Engineering Science Courses	9
Mandatory course (AICTE)	0
Total Credits	**19.5**

II Year I Semester (Semester-3)

S.No	Category	Course Title	L	T	P	C
1	BS2101	Mathematics-III	2	1	0	3
2	ES2101	Data Structures	3	0	0	3
3	PC2101	Electrical Machines –I	2	1	0	3
4	PC2102	Electrical Circuit Analysis	2	1	0	3
5	PC2103	Electromagnetic Fields	2	1	0	3
6	ES2101L	Data Structures Lab	0	0	3	1.5
7	PC2101L	Electrical machines –I Lab	0	0	3	1.5
8	PC2102L	Electrical Circuit Analysis Lab	0	0	3	1.5
9	SOC2101	Skill oriented course-1	1	0	2	2
10	MC2101	Essence of Indian Traditional Knowledge	2	0	0	0
Total Credits						**21.5**

Category	Credits
Basic Science Course	3
Engineering Science Courses	4.5
Professional Core Courses	12
Skill Oriented Course	2
Mandatory Course (AICTE)	0
Total Credits	**21.5**

II Year II Semester (Semester-4)

S.No	Category	Course Title	L	T	P	C
1	BS2201	Complex Variables and Statistical Methods	2	1	0	3
2	ES2201	Thermal and Hydro Prime Movers	3	0	0	3
3	PC2201	Power Systems-I	3	0	0	3
4	PC2202	Electrical Machines – II	2	1	0	3
5	PC2203	Control Systems	2	1	0	3
6	ES2201L	Thermal and Hydro Prime Movers Lab	0	0	3	1.5
7	PC2202L	Electrical Machines - II Lab	0	0	3	1.5
8	PC2204L	Control Systems Lab	0	0	3	1.5
9	SOC2201	Skill Oriented Course-2	1	0	2	2
10	MC2201	Environmental Science	2	0	0	0
Total Credits						**21.5**
		Internship/Community Service Project 2 Months (Mandatory) during summer vacation				
		Honors/Minor courses	3	0	2	4

Category	Credits
Basic Science Courses	3
Engineering Science Courses	4.5
Professional Core Courses	12
Skill Oriented Courses	2
Mandatory course (AICTE)	0
Total Credits	**21.5**

III Year I Semester (Semester-5)

S.No	Category	Course Title	L	T	P	C
1	HS3101	Engineering Economics and Management	3	0	0	3
2	PC3101	Power Systems – II	2	1	0	3
3	PC3102	Electrical Measurements and Instrumentation	3	0	0	3
4	PC3103	Power Electronics	3	0	0	3
5	OE3101	Open Elective-I	2	0	2	3
6	PC3102L	Electrical Measurements and Instrumentation Lab	0	0	3	1.5
7	PC3103L	Power Electronics Lab	0	0	3	1.5
8	SAC3101	**Soft skills**	1	0	2	2
9	INTERN3101	Summer Internship 2 Months (Mandatory) after second year (to be evaluated during V semester	0	0	0	1.5
					Total Credits	**21.5**
		Honors/Minor courses	3	0	2	4

Category	Credits
Humanities and Social Science Courses	3
Professional Core Courses	12
Open Elective Courses	3
Skill Advanced Course	2
Summer Internship	1.5
Total Credits	**21.5**

III Year II Semester (Semester-6)

S.No	Category	Course Title	L	T	P	C
1	HS3201	Universal Human Values-2	3	0	0	3
2	PC3201	Microprocessors & Microcontrollers	3	0	0	3
3	PC3202	Power Systems -III	2	1	0	3
4	PE3201	Professional Elective I 1. Digital Electronics 2. FACTS 3. Advanced Control Systems 4. Switched Mode Power Conversion	2	0	2	3
5	PE3201	Professional Elective II 1. Power System Protection 2. Renewable Energy Sources 3. Linear system Analysis 4. NPTEL/SWAYAM Duration: 12 Weeks minimum *course /subject title can't be repeated.	2	0	2	3
6	PC3201L	Microprocessors & Microcontrollers Lab	0	0	3	1.5
7	PC3202L	Power Systems Lab	0	0	3	1.5
8	PC3203L	Electrical Simulation Lab	0	0	3	1.5
9	SAC3201	Skill Advanced Course-1	1	0	2	2
Total Credits						**21.5**
		Industrial/Research Internship 2Months (Mandatory) during summer vacation				
		Honors/Minor courses	3	0	2	4

Category	Credits
Professional Core Courses	10.5
Humanities and Social Science Courses	3
Professional Electives Course	6
Skill Advanced Course	2
Total Credits	**21.5**

IV Year I Semester (Semester-7)

S.No	Category	Course Title	L	T	P	C
1	PE4101	Professional Elective III 1. Utilization of Electrical Energy 2. Special Electrical Machines 3. High Voltage Engineering 4. Electrical Engineering Materials	2	0	2	3
2	PE4102	Professional Elective IV 1. Electric Drives 2. HVAC &DC Transmission 3. Energy Conservation & Auditing 4. Power System Reliability	2	0	2	3
3	PE4103	Professional Elective V 1. Electric Vehicles 2. Digital Control Systems 3. Advanced Power System Protection 4. Electric Power Quality	2	0	2	3
4	OE4101	Open Elective II	2	0	2	3
5	OE4102	Open Elective III	2	0	2	3
6	OE4103	Open Elective IV	2	0	2	3
7	SAC4101	Skill Advanced Course-2	1	0	2	2
8	MC4101	Entrepreneurial Skill Development	2	0	0	0
9	INTERN4101	Industrial/Research Internship 2 Months (Mandatory) after third year (to be evaluated during VII semester)	0	0	0	3
Total Credits						**23**
		Honors/Minor courses	3	0	2	4

Category	Credits
Professional Elective Courses	9
Open Elective Courses	9
Industrial/Research Internship (Mandatory)2months	3
Skill Advanced Course	2
Mandatory Course(AICTE)	0
Total Credits	**23**

IV Year II Semester (Semester-8)

S. No	Subject code	Course Name	L	T	P	C
1	PROJ4201	Major Project ,Project work, seminar, and internship in industry Internship (6 months)	0	0	0	8
2	PROJ4202	Community Service Project (CSP)	0	0	8	4
					Total Credits	**12**

Open Elective Courses

OE3101	OOPS Through JAVA	Computer Networks	MEMS	Block-chain Technology
OE4101	Principles of Signals and Systems	Machine Learning	Green Buildings	VLSI
OE4102	Data Analytics for Smart Grids	Cyber Security	Robotics	Embedded Systems
OE4103	Neural Networks & Fuzzy Logic	Linear IC Applications	Nano-Technology	Digital Signal Processing

Skill Oriented Course/Skill Advanced Courses

SOC2101	Fundaments of Internet of Things (IoT)	Industrial Safety, Codes and Standards	DC Drives	Python library tools
SOC2201	Fundaments of MATLAB and PSpice	Solar Panel installation	Sensors & Actuators for IoT	AC Drives
SAC3101	**Soft skills**	**Soft skills**	**Soft skills**	**Soft skills**
SAC3202	Low Voltage Switchgear	PLC and SCADA	PSCAD	Process Instrumentation
SAC4101	Power Bi	Amazon Web Services	MAD (Mobile Application Development)	ETAP (Electrical Transient & Analysis Program)

List of Open Elective Subjects offered by EEE Branch

1. Utilization of Electrical Energy
2. Electric Vehicles
3. Electric Power Quality
4. Neural Networks & Fuzzy Logic
5. Non Conventional Energy Sources
6. Principles of Electric Power Conversion
7. Indian Electricity Act, 2003

Courses for Honors degree

POOL-1 (II-II)	POOL-2 (III-I)	POOL-3 (III-II)	POOL-4 (IV-I)
Analysis of Linear Systems	Energy Economics	Power System Optimization	Advanced Power Converters
Energy Storage Systems	Distribution System Engineering	Power System Protection	Hybrid Electrical Vehicle
Semiconductor Device Modeling	Sensors and Transducers	Advanced Power Systems	Modern Control Theory
Renewable Energy Sources	Process Control Engineering	Real Time Control of Power System	Power System Operation and Deregulation(PSOD)
MOOC-1*(NPTEL/SWAYAM) Duration:12Weeks minimum			
MOOC-2*(NPTEL/SWAYAM) Duration:12Weeks minimum			

*Course/subject title can't be repeated

General Minor Tracks

Department of Electrical and Electronics Engineering

S.No.	Course Name	L	T	P	C
1	Special Electrical Machines	3	0	2	4
2	Electrical Measurements and Instrumentation	3	0	2	4
3	M ATLAB for Engineering Applications	3	0	2	4
4	Generation of Electric Power	3	0	2	4
5	Energy audit	3	0	2	4
6	Non-conventional energy sources	3	0	2	4

Note:

i. A student can select four subjects from the above six subjects @3-0-2-4 credits per subject.
ii. Compulsory MOOC/NPTEL courses for 04 credits (02courses @02credits each)

VVIT Life skill courses

The following courses are admitted to be the **courses beyond curriculum** to improveindividuallifeskills.Thesecoursesandwillbedemonstratedintheclassrooma ndwillbehavinganinternalassessmentforsatisfactory.

S.No	Year and Semester	Course Name
1	I Year I Semester(Semester-1)	Quantitative Aptitude
2	I Year II Semester(Semester-2)	Verbal Ability
3	II Year I Semester(Semester-3)	Understanding Self for Effectiveness
4	II Year II Semester(Semester-4)	Design Thinking
5	III Year I Semester(Semester-5)	Stress and Coping Strategies
6	III Year II Semester(Semester-6)	Research Skills

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SYLLABUS

I-Year-I Semester
HS1101

COMMUNICATIVE ENGLISH
(Common to CIV, EEE, MEC & ECE)

L	T	P	C
3	0	0	3

Course objectives:

The main objectives are

1. Adopt activity-based teaching-learning methods to ensure that learners would be engaged in use of language both in the classroom and laboratory sessions.
2. Facilitate effective listening skills for better comprehension of academic lectures and English spoken by native speakers
3. Focus on appropriate reading strategies for comprehension of various academic texts and authentic materials
4. Help improve speaking skills through participation in activities such as role plays, discussions and structured talks/oral presentations
5. Impart effective strategies for good writing and demonstrate the same in summarizing, writing well organized essays, record and report useful information
6. Provide knowledge of grammatical structures and vocabulary and encourage their appropriate use in speech and writing

Unit – 1: 13 HOURS

Detailed Study: A Proposal to Girdle the Earth (Excerpt) by Nellie Bly

Theme: Exploration

Listening: Identifying the topic, the context and specific pieces of information by listening to short audio texts and answering a series of questions.

Speaking: Asking and answering general questions on familiar topics such as home, family, work, studies and interests; introducing oneself and others. **Reading:** Skimming to get the main idea of a text; scanning to look for specific pieces of information.

Reading for Writing: Beginnings and endings of paragraphs - introducing the topic, summarizing the main idea and/or providing a transition to the next paragraph.

Grammar and Vocabulary: Content words and function words; word forms: verbs, nouns, adjectives and adverbs; nouns: countable and uncountable; singular and plural; basic sentence structures; simple question form - wh-questions; word order in sentences.

Non-Detailed Study:

1. "How to Fashion Your Own Brand of Success" by Howard Whitman

2. "How to Recognize Your Failure Symptoms" by Dorothea Brande

Unit-2: 13 HOURS

Detailed Study: An excerpt from The District School as It Was by One Who Went to It by Warren Burton

Theme: On Campus

Listening: Answering a series of questions about main idea and supporting ideas after listening to audio texts.

Speaking: Discussion in pairs/ small groups on specific topics followed by short structured talks.

Reading: Identifying sequence of ideas; recognizing verbal techniques that help to link the ideas in a paragraph together.

Writing: Paragraph writing (specific topics) using suitable cohesive devices; mechanics of writing - punctuation, capital letters.

Grammar and Vocabulary: Cohesive devices - linkers, signposts and transition signals; use of articles and zero article; prepositions.

Non-detailed Study:

3. "How to Conquer the Ten Most Common Causes of Failure" by Louis Binstock

4. "How to Develop Your Strength to Seize Opportunities" by Maxwell Maltz

Unit-3: **13 HOURS**

Detailed Study: The Future of Work?

Theme: Working Together

Listening: Listening for global comprehension and summarizing what is listened to.

Speaking: Discussing specific topics in pairs or small groups and reporting what is discussed

Reading: Reading a text in detail by making basic inferences - recognizing and interpreting specific context clues; strategies to use text clues for comprehension.

Writing: Summarizing - identifying main idea/s and rephrasing what is read; avoiding redundancies and repetitions.

Grammar and Vocabulary: Verbs - tenses; subject-verb agreement; direct and indirect speech, reporting verbs for academic purposes.

Non-Detailed Study:

5. "How to Make the Most of Your Abilities" by Kenneth Hildebrand

6. "How to Raise Your Self-Esteem and Develop Self-confidence" by James W Newman

Unit-4: **13 HOURS**

Detailed Study: H.G Wells and the Uncertainties of Progress by Peter J. Bowler

Theme: Fabric of Change

Listening: Making predictions while listening to conversations/ transactional dialogues without video; listening with video.

Speaking: Role-plays for practice of conversational English in academic contexts (formal and informal) - asking for and giving information/directions.

Reading: Studying the use of graphic elements in texts to convey information, reveal trends/patterns/relationships, communicate processes or display complicated data.

Writing: Information transfer; describe, compare, contrast, identify significance/trends based on information provided in figures/charts/graphs/tables.

Grammar and Vocabulary: Quantifying expressions - adjectives and adverbs; comparing and contrasting; degrees of comparison; use of antonyms

Non-Detailed Study

7. "How to Win Your War against Negative Feelings" by Dr Maxwell Maltz

8. "How to Find the Courage to Take Risks" by Drs. Tom Rusk and Randy Read

Unit-5: **13 HOURS**

Detailed Study: Leaves from the Mental Portfolio of a Eurasian by Sui Sin Far

Theme: Tools for Life

Listening: Identifying key terms, understanding concepts and answering a series of relevant questions that test comprehension.

Speaking: Formal oral presentations on topics from academic contexts - without the use of PPT slides.

Reading: Reading for comprehension.

Writing: Writing structured essays on specific topics using suitable claims and evidences

Grammar and Vocabulary: Editing short texts – identifying and correcting common errors in grammar and usage (articles, prepositions, tenses, subject verb agreement)

Non-Detailed Study

9. "How to Become a Self-Motivator" by Charles T Jones

10. "How to Eliminate Your Bad Habits" by OgMandino

Course Outcomes: Upon successful completion of the course, the student will be able to

CO1 identify the context, topic, and pieces of specific information from social or transactional dialogues spoken by native speakers of English and formulate sentences using proper grammatical structures and correct word forms **(Describe, relate, tell, find L-3)**

CO2 speak clearly on a specific topic using suitable discourse markers in informal discussions **(Discuss, outline, explain, predict – L3)**

CO3 write summaries based on global comprehension of reading/listening texts **(Use, categorize, complete, solve L-3)**

CO4 produce a coherent paragraph interpreting a figure/graph/chart/table **(Identify, compare, explain, illustrate- L4)**

CO5 take notes while listening to a talk/lecture to answer questions **(explain, relate, outline, complete -L3)**

Text books:

1. English All Round: Communication Skills for Undergraduate Learners-Volume 1, Orient Black Swan, 2019
2. University of Success by OgMandino, Jaico, 2015.

Reference books:

1. Bailey, Stephen. Academic writing: A handbook for international students. Routledge, 2014.
2. Chase, Becky Tarver. Pathways: Listening, Speaking and Critical Thinking. Heinley ELT; 2nd Edition, 2018.
3. Skillful Level 2 Reading & Writing Student's Book Pack (B1) Macmillan Educational.
4. Hewings, Martin. Cambridge Academic English (B2). CUP, 2012.

AICTE Recommended Books

5. Meenakshi Raman and Sangeeta Sharma. Technical Communication. Oxford University Press, 2018.
6. Pushplata and Sanjay Kumar. Communication Skills, Oxford University Press, 2018.
7. Kulbushan Kumar. Effective Communication Skills. Khanna Publishing House, Delhi

Sample Web Resources

Grammar / Listening / Writing

1-language.com

http://www.5minuteenglish.com/

https://www.englishpractice.com/

Grammar/Vocabulary

English Language Learning Online

http://www.bbc.co.uk/learningenglish/

http://www.better-english.com/

http://www.nonstopenglish.com/

https://www.vocabulary.com/

BBC Vocabulary Games

Free Rice Vocabulary Game

Reading

https://www.usingenglish.com/comprehension/
https://www.englishclub.com/reading/short-stories.htm
https://www.english-online.at/
Listening
https://learningenglish.voanews.com/z/3613
http://www.englishmedialab.com/listening.html
Speaking
https://www.talkenglish.com/
BBC Learning English – Pronunciation tips
Merriam-Webster – Perfect pronunciation Exercises
All Skills
https://www.englishclub.com/
http://www.world-english.org/
http://learnenglish.britishcouncil.org/

Course Outcomes

At the end of the course, the learners will be able to

CO1. identify the context, topic, and pieces of specific information from social or transactional dialogues spoken by native speakers of English and formulate sentences using proper grammatical structures and correct word forms **(Describe, relate, tell, find L-3)**

CO2. speak clearly on a specific topic using suitable discourse markers in informal discussions **(Discuss, outline, explain, predict – L3)**

CO3. write summaries based on global comprehension of reading/listening texts **(Use, categorize, complete, solve L-3)**

CO4. produce a coherent paragraph interpreting a figure/graph/chart/table **(Identify, compare, explain, illustrate- L4)**

CO5. take notes while listening to a talk/lecture to answer questions **(explain, relate, outline, complete -L3)**

I-Year-I Semester
BS1101

Mathematics-I

L	T	P	C
3	1	0	3

Preamble: This course illuminates the students in the concepts of calculus.

Course objectives:

The main objectives are

1. To enlighten the learners in the concept of differential equations and multivariable calculus.
2. To equip the students with standard concepts and tools at an intermediate to advanced level mathematics to develop the confidence and ability among the students to handle various real-world problems and their applications.

Unit–1: **13 HOURS**

Differential equations of first order and first degree

Linear differential equations-Bernoulli's equations - Exact equations and equations reducible to exact form.

Applications: Newton's Law of cooling – Law of natural growth and decay – Orthogonal trajectories – Electrical circuits.

Unit–2: **13 HOURS**

Linear differential equations of higher order

Non-homogeneous equations of higher order with constant coefficients – with non-homogeneous term of the type $e^{ax}, \sin ax, \cos ax,$ polynomials in x^n , $e^{ax}V(x)$ and $x^nV(x)$ - Method of Variation of Parameters.

Applications: LCR circuit – Simple harmonic motion

Unit–3: **12 HOURS**

Mean value theorems

Mean value theorems (without proofs): Rolle's Theorem – Lagrange's mean value theorem – Cauchy's mean value theorem – Taylor's and Maclaurin's theorems with remainders.

Unit–4: **14 HOURS**

Partial differentiation

Introduction – Homogeneous function – Euler's theorem - Total derivative – Chain rule – Jacobian – Functional dependence – Taylor's and Mc Laurent's series expansion of functions of two variables.

Applications: Maxima and Minima of functions of two variables without constraints and Lagrange's method (with constraints).

Unit–5: **13 HOURS**

Multiple integrals

Double integrals (Cartesian and Polar) – Change of order of integration – Change of variables (Cartesian to Polar) –Triple integrals.

Applications: Areas by double integrals and Volumes by triple integrals.

Course Outcomes: Upon successful completion of the course, the student will be able to

CO1 solve the differential equations related to various engineering fields.

CO2 utilize mean value theorems to real life problems.

CO3 familiarize with functions of several variables which is useful in optimization.

CO4 apply double integration techniques in evaluating areas bounded by region.

CO5 learn important tools of calculus in higher dimensions. Students will become familiar with 2-dimensional and 3 – dimensional coordinate systems.

Text books:

1. **B.S. Grewal,** Higher Engineering Mathematics, 44th Edition, Khanna Publishers.
2. **B.V. Ramana,** Higher Engineering Mathematics, 2007 Edition, Tata Mc. Graw Hill Education.

Reference books:

1. **H. K. Das,** Advanced Engineering Mathematics, 22nd Edition, S. Chand & Company Ltd.
2. **Erwin Kreyszig**, Advanced Engineering Mathematics, 10th Edition, Wiley-India.

I-Year-I Semester
BS1102

APPLIED PHYSICS

L	T	P	C
3	0	0	3

Course Objectives

Applied Physics curriculum which is re-oriented to the needs of Circuital branches of graduate engineering courses offered by Vasireddy Venkatadri Institute of Technology, which serves as a transit to understand the branch specific advanced topics. The course is designed to:

- Impart Knowledge ofPhysicalOpticsphenomena like Interference and Diffraction required to design instruments with higher resolution.
- Understand the physics of Semiconductors and their working mechanism for their utility in electronic devices.
- Impart the knowledge of materials with characteristic utility in appliances.

Unit-1

Wave Optics:

Interference: PrincipleofSuperposition-Interferenceoflight – Conditionsfor sustainedInterference-Interferencein thin films (reflected geometry) - Newton's Rings (reflected geometry) **Diffraction:**Fraunhofer Diffraction:- Diffraction due to single slit (quantitative), double slit(qualitative), N –slits(qualitative) and circular aperture (qualitative) – Intensity distribution curves - Diffraction grating – Grating spectrum – missing order– resolving power – Rayleigh's criterion – Resolving powers of Microscope(qualitative), Telescope(qualitative) and grating (qualitative).

Unit-2

LASERs and Holography

LASERs: Interaction of radiation with matter – Spontaneous and Stimulated emission of radiation – population inversion – Einstein's coefficients & Relation between them and their significance - Pumping Mechanisms - Ruby laser – Helium-Neon laser – Applications.

Holography: Introduction – principle – differences between photography and holography – construction and reconstruction of hologram – applications of holograms

Unit-3

Magnetism and Dielectrics

Magnetism: Introduction - Magnetic dipole moment - Magnetization-Magnetic susceptibility and permeability- Origin of permanent magnetic moment - Bohr magneton-Classification of magnetic materials: Dia, para & Ferro – Domain concept of Ferromagnetism - Hysteresis – soft and hard magnetic materials – applications of Ferromagnetic material.

Dielectrics: Introduction- Dielectricpolarization-Dielectricpolarizability,SusceptibilityandDielectricconstant- Types of polarizations: Electronic and Ionic (Quantitative), Orientation Polarizations (Qualitative) - Lorentz Internal field-Claussius –Mossotti's equation- Frequency dependence of polarization - Applications of dielectrics.

Unit-4

Quantum Mechanics

Introduction– matter waves – de Broglie's hypothesis – Davisson-Germer experiment – G.P.Thomson experiment – Heisenberg's Uncertainty Principle–Schrödinger time independent and time dependent wave equations – physical significance of Schrödinger wave function – Particle in a potential box (determination of energy).

Unit-5

Semiconductor Physics

Originofenergybands(qualitative) –Classificationofsolidsbasedonenergybands– Intrinsicsemiconductors-densityof charge carriers –Electricalconductivity-Fermi level – extrinsicsemiconductors-P-type&N-type – Densityofchargecarriers-DependenceofFermienergyoncarrierconcentrationandtemperature-Halleffect-Hallcoefficient-ApplicationsofHalleffect- Drift and Diffusion currents - Einstein’s equation.

Course Outcomes: *The students will be able to*

CO1. **Understand** the principles such as interference and diffraction to design and enhance the resolving power of various optical instruments.

CO2. **Learn** the basic concepts of LASER light Sources and Apply them to holography

CO3. **Study** the magnetic and dielectric materials to enhance the utility aspects of materials.

CO4. **Learn** the fundamental concepts of Quantum behaviour of matter.

CO5. **Identify** the type of semiconductors using Hall Effect.

TEXT BOOKS

1. “Engineering Physics” by B. K. Pandey, S. Chaturvedi - Cengage Publications, 2012
2. “A Text book of Engineering Physics” by M.N. Avadhanulu, P.G.Kshirsagar - S.Chand, 2017.
3. “Engineering Physics” by D.K.Bhattacharya and Poonam Tandon, Oxford press (2015).
4. “Engineering Physics” by R.K Gaur. and S.L Gupta., - Dhanpat Rai publishers, 2012.

REFERENCE BOOKS

1. “Engineering Physics” by M.R.Srinivasan, New Age international publishers (2009).
2. “Optics” by AjoyGhatak, 6^{th} Edition McGraw Hill Education, 2017.
3. “Solid State Physics” by A.J.Dekker, Mc Millan Publishers (2011).

I-Year-I Semester
ES1101

PROBLEM SOLVING USING C

L	T	P	C
3	0	0	3

Course Objectives

1. To learn about the computer systems, computing environments, developing of a computer program and Structure of a C Program
2. To gain knowledge of the operators, selection, control statements and repetition in C
3. To learn about the design concepts of arrays, strings, enumerated structure and union types. To learn about their usage.
4. To assimilate about pointers, dynamic memory allocation and know the significance of Pre-processor.
5. To assimilate about File I/O and significance of functions

Unit-1

Introduction to Computers: Creating and running Programs, Computer Numbering System, Storing Integers, Storing Real Numbers

Introduction to the C Language: Background, C Programs, Identifiers, Types, Variable, Constants, Input/output, Programming Examples, Scope, Storage Classes and Type Qualifiers.

Structure of a C Program: Expressions Precedence and Associativity, Side Effects, Evaluating Expressions, Type Conversion Statements, Simple Programs, Command Line Arguments.

Unit-2

Bitwise Operators: Exact Size Integer Types, Logical Bitwise Operators, Shift Operators.

Selection & Making Decisions: Logical Data and Operators, Two Way Selection, Multiway Selection, More Standard Functions

Repetition: Concept of Loop, Pretest and Post-test Loops, Initialization and Updating, Event and Counter Controlled Loops, Loops in C, Other Statements Related to Looping, Looping Applications, Programming Examples

Unit-3

Arrays: Concepts, Using Array in C, Array Application, Two Dimensional Arrays, Multidimensional Arrays, Programming Example – Calculate Averages

Strings: String Concepts, C String, String Input / Output Functions, Arrays of Strings, String Manipulation Functions String/ Data Conversion, A Programming Example – Morse Code

Enumerated, Structure, and Union: The Type Definition (Type def), Enumerated Types, Structure, Unions, and Programming Application

Unit-4

Pointers: Introduction, Pointers to pointers, Compatibility, L value and R value

Pointer Applications: Arrays, and Pointers, Pointer Arithmetic and Arrays, Memory Allocation Function, Array of Pointers, Programming Application,**rocessor Commands**: Processor Commands

Unit-5

Functions: Designing, Structured Programs, Function in C, User Defined Functions, Inter-Function Communication, Standard Functions, Passing Array to Functions, Passing Pointers to Functions, Recursion

Text Input / Output: Files, Streams, Standard Library Input / Output Functions, Formatting Input / Output Functions, Character Input / Output Functions

Binary Input / Output: Text versus Binary Streams, Standard Library, Functions for Files, Converting File Type.

Course Outcomes: Upon successful completion of the course, the student will be able to

CO1 **Understand** algorithms and basic terminology of C
CO2 **Solve** problems using control structures and modular approach
CO3 **Make** use of 1D and 2D arrays along with strings for linear data handling
CO4 **Determine** the use of pointers and structures
CO5 **Implement** various operations on data files.

TEXT BOOKS

1. Programming for Problem Solving, Behrouz A. Forouzan, Richard F.Gilberg, CENGAGE
2. The C Programming Language, Brian W.Kernighan, Dennis M. Ritchie, 2e, Pearson

REFERENCES

1. Computer Fundamentals and Programming, Sumithabha Das, Mc Graw Hill
2. Programming in C, Ashok N. Kamthane, AmitKamthane, Pearson
3. Computer Fundamentals and Programming in C, Pradip Dey, Manas Ghosh, OXFORD

Course Outcomes: Upon successful completion of the course, the student will be able to

CO1 **Understand** algorithms and basic terminology of C
CO2 **Solve** problems using control structures and modular approach
CO3 **Make** use of 1D and 2D arrays along with strings for linear data handling
CO4 **Determine** the use of pointers and structures
CO5 **Implement** various operations on data files.

I-Year-I Semester ES1102	ENGINEERING GRAPHICS	L	T	P	C
		0	0	3	1.5

Course objectives:

The main objectives are

1. Expose the students to use Drafting packages for generating Engineering curves and conventions followed in Preparation of engineering drawings.
2. Make the students to understand the concepts of orthographic projections of Lines and Plane Surfaces.
3. To understand the concepts of orthographic projections of Regular Solids.
4. Develop the ability of understanding sectional views and Development of Solid Surfaces.
5. Enable them to use computer aided drafting packages for Conversion of Isometric view to Orthographic Projection and vice versa.

UNIT-I: INTRODUCTION TO AUTOCAD: 15 HOURS

Basic commands, Customization, ISO and ANSI standards for coordinate dimensioning, Annotations, layering, 2D drawings of various mechanical components, 2D drawings of various electrical and electronic circuits. Creation of engineering models- floor plans that include: windows, doors, and fixtures such as WC, bath, sink, shower, etc. Applying colour coding according to building drawing practice; (Experiments should be Planned According to respective Core Branch Applications)

UNIT-II: THEORY OF PROJECTION: 12 HOURS

Principles of Orthographic Projections-Convention: Projections of Points, Projections of Lines inclined to both planes, Projections of planes inclined to one Plane & Projections of planes inclined to both Planes

UNIT III: PROJECTIONS OF REGULAR SOLIDS: 1 12 HOURS

Projections of Solids –with the axis perpendicular to one of the principal planes, with the axis Inclined to one of the principal planes, Projections of Solids –with the axis Inclined to Both the principal planes

UNIT IV: DEVELOPMENT OF SURFACES & SECTIONAL ORTHOGRAPHIC VIEWS 13 HOURS

Development of surfaces of Right Regular Solids – Prism, Pyramid, Cylinder and, Cone. Draw the sectional orthographic views of geometrical solids

UNIT V: ISOMETRIC PROJECTIONS 13 HOURS

Conversion of isometric views to orthographic views, drawing of isometric views - simple Solids, Conversion of orthographic views to isometric views of simple Drawings

Course Outcomes: Upon successful completion of the course, the student will be able to

CO1 Prepare engineering drawings as per BIS conventions Understand level, KL2}

CO2 Produce computer generated of orthographic projections of Lines and Plane surfaces using CAD software {Apply level, KL3}

CO3 Use the knowledge of orthographic projections of Solids to represent engineering information/concepts and present the same in the form of drawings

{Apply level, KL3}

CO4 Use the knowledge of sectional views and Development of Solid Surfaces in Real time Applications {Apply level, KL3}

CO5 Develop isometric drawings of simple objects reading the orthographic projections of those objects {Analyze level, KL4}

Text books:

1. Engineering Drawing by N.D. Butt, Chariot Publications
2. Engineering Graphics with Autocad by Kulkarni D.M, PHI Publishers
3. Engineering Drawing + AutoCad – K Venugopal, V. Prabhu Raja, New Age
4. Engineering Drawing by Agarwal & Agarwal, Tata McGraw Hill Publishers

Reference books:

1. Engineering Drawing by K.L.Narayana& P. Kannaiah, Scitech Publishers
2. Engineering Graphics for Degree by K.C. John, PHI Publishers
3. Engineering Graphics by PI Varghese, McGrawHill Publishers
4. AutoCAD 2018 Training Guide (English, Paperback, Sagar Linkan) ISBN: 9789386551870, 938655187X RUPAPUBLICATIONS

I-Year-I Semester
HS1101L

COMMUNICATIVE ENGLISH LAB

L	T	P	C
0	0	3	1.5

Course Objective:

The main objective of the course is to adopt activity-based teaching-learning methods to ensure that learners would be engaged in use of language both in the classroom and laboratory sessions and appear confidently for competitive examinations for career development.

The specific objectives of the course are to

1. Facilitate effective listening skills for better comprehension of academic lectures and English spoken by native and non-native speakers
2. Focus on appropriate reading strategies for comprehension of various academic texts and authentic materials like newspapers, magazines, periodicals, journals, etc.
3. Help improve speaking skills through participation in activities such as role plays, discussions and structured talks/oral presentations
4. Impart effective strategies for good writing and demonstrate the same in summarizing, writing well organized essays, record and report useful information
5. Provide knowledge of grammatical structures and vocabulary and encourage their appropriate use in speech and writing

Course Outcomes

At the end of the course, the learners will be able to

CO1: Prioritize information from reading texts after selecting relevant and useful points and paraphrase short academic texts using suitable strategies and conventions (L3)

CO2: Make formal structured presentations on academic topics using PPT slides with relevant graphical elements (L3)

CO3: Participate in group discussions using appropriate conventions and language strategies (L3)

CO4: Prepare a CV with a cover letter to seek internship/ job (L2)

CO5: Collaborate with a partner to make presentations and Project Reports (L2)

Detailed Syllabus

CALL based activity. English course books selected for classroom teaching will be used for practice in thecomputer-based language labs. Watching and listening to Video clips.
Listening Activity: Selected speeches of eminent personalities, audio texts, dialogues and discussions
Speaking: JAM, Oral Presentations, Group Discussions
Writing: Different types of reports
Project: Power point presentation of 5 min on a specific topic
Pair work, Role play, conversational practice and Individual speaking activities based on following essays from ***University of Success***.
1. "How to Get Yourself Organized" by Michael LeBeouf

2. “How to Turn Your Desires into Gold” by Napoleon Hill
3. “How to Look Like a Winner How to Increase Your Value” by OgMandino
4. “How to Swap a Losing Strategy” by Auren Uris and Jack Tarrant
5. “How to Bounce Back from Failure” by OgMandino
6. “How to Prevent Your Success from Turning into Ashes” by Allan Fromme
7. “How to Have a Happy Life” by Louis Binstock
8. “How to Keep the Flame of Success Shining Brightly” by Howard Whitman

Any ten Supplementary Language Activities from ***UN Global Goals***document

1. “Developing children’s understanding of the Global Goals” by Carol Read
2. “End poverty in all its forms everywhere” by SylwiaZabor-Zakowska
3. “End hunger, achieve food security and improved nutrition and promote sustainable agriculture” by Linda Ruas
4. ‘Ensure healthy lives and promote well-being for all at all ages” by Carmen Flores
5. “Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all” by Daniel Xerri
6. “Achieve gender equality and empower all women and girls” by Jemma Prior and Tessa Woodward
7. “Ensure availability and sustainable management of water and sanitation for all” by Wei KeongToo
8. “Ensure access to affordable, reliable, sustainable and modern energy for all” by Phil Wade
9. “Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all” by Nik Peachey
10. “Build resilient infrastructure, promote inclusive and sustainable industrialisation and foster innovation” by MaluSciamarelli
11. “Reduce inequality within and among countries” by Alan Maley
12. “Make cities and human settlements inclusive, safe, resilient and sustainable” by David Brennan
13. “Ensure sustainable consumption and production patterns” by Laszlo Katona and Nora Tartsay
14. “Take urgent action to combat climate change and its impacts” by Maria Theologidou
15. “Conserve and sustainably use the oceans, seas and marine resources for sustainable development” by Jill Hadfield and Charlie Hadfield
16. “Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss” by ChrysaPapalazarou
17. “Promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable and inclusive institutions at all levels” by Rebeca Duriga
18. “Strengthen the means of implementation and revitalise the global partnership for sustainable development” by Jennifer Verschoor and Anna Maria Menezes
19. “Content and the Sustainable Development Goals: going beyond language learning” by AdrianTennant

20. "Using extensive reading creatively to raise awareness of issues of equality and justice" by SueLeather
21. "Storytelling for a better world" by David Heathfield
22. "Using the Sustainable Development Goals in the EAP classroom" by Averil Bolster and PeterLevrai

Text Books

1. Alan Maley and Nik Peachy. *Integrating global issues in the creative English Classroom: Withreference to the United Nations Sustainable Development Goals.* British Council Teaching English, 2018 (Public Domain UN Document)
2. *University of Success* by OgMandino, Jaico, 2015 (Reprint).

Reference Books

1. Bailey, Stephen. *Academic writing: A handbook for international students*. Routledge, 2014.
2. Chase, Becky Tarver. *Pathways: Listening, Speaking and Critical Thinking.* Heinley ELT; 2nd Edition, 2018.
3. Skillful Level 2 Reading & Writing Student's Book Pack (B1) Macmillan Educational.
4. Hewings, Martin. *Cambridge Academic English (B2)*. CUP, 2012.
5. Chaturvedi, P. D. and ChaturvediMukesh. *The Art and Science of Business Communication:Skills, Concepts, Cases and Applications.* 4Ed. Pearson, 2017.

AICTE Recommended Books

1. Meenakshi Raman and Sangeeta Sharma. *Technical Communication.* Oxford University Press,2018.
2. Pushplata and Sanjay Kumar. *Communication Skills*, Oxford University Press, 2018.
3. Kulbushan Kumar. *Effective Communication Skills.* Khanna Publishing House, Delhi

Sample Web Resources

Grammar / Listening / Writing 1-language.com http://www.5minuteenglish.com/ https://www.englishpractice.com/ Grammar/Vocabulary English Language Learning Online http://www.bbc.co.uk/learningenglish/ http://www.better-english.com/ http://www.nonstopenglish.com/ https://www.vocabulary.com/ BBC Vocabulary Games Free Rice Vocabulary Game	Reading https://www.usingenglish.com/comprehension/ https://www.englishclub.com/reading/short stories.htm https://www.english-online.at/ Listening https://learningenglish.voanews.com/z/3613 http://www.englishmedialab.com/listening.html Speaking https://www.talkenglish.com/ BBC Learning English – Pronunciation tips Merriam-Webster – Perfect pronunciation Exercises
All Skills https://www.englishclub.com/ http://www.world-english.org/	

I-Year-I Semester
BS1102L

APPLIED PHYSICS & VIRTUAL LAB

L	T	P	C
0	0	3	1.5

Course Objectives: The Applied Physics Lab is designed to

- **Understand** the concepts of interference and diffraction and their applications.
- **Apply** the concept of LASER in the determination of wavelength.
- **Recognize** the importance of energy gap in the study of conductivity and Hall Effect.
- **Illustrate** the magnetic and dielectric materials applications.
- **Apply** the principles of semiconductors in various electronic devices.

LIST OF EXPERIMENTS(Any 10 of the following listed 15 experiments)

1. Determination of wavelength of a source-Diffraction Grating-Normal incidence.
2. Newton's rings – Radius of Curvature of Plano - Convex Lens.
3. Determination of thickness of a spacer using wedge film and parallel interference fringes.
4. Magnetic field along the axis of a current carrying coil – Stewart and Gee's apparatus.
5. Energy Band gap of a Semiconductor p - n junction.
6. Characteristics of Thermistor – Temperature Coefficients
7. Determination of dielectric constant by charging and discharging method
8. Variation of dielectric constant with temperature
9. Study the variation of B versus H by magnetizing the magnetic material (B-H curve).
10. LASER - Determination of wavelength by plane diffraction grating
11. Determination of resistivity of semiconductor by Four probe method.
12. Determine the radius of gyration using compound pendulum
13. Rigidity modulus of material by wire-dynamic method (torsional pendulum)
14. Dispersive power of diffraction grating.
15. Determination of Hall voltage and Hall coefficients of a given semiconductor using Hall Effect.

Course Outcomes: The students will be able to:

CO1. **Operate** optical instruments like microscope and spectrometer
CO2. **Determine** thickness of a paper with the concept of interference
CO3. **Estimate** the wavelength of differentcolours using diffraction grating and resolving power
CO4. **Plot** the intensity of the magnetic field of circular coil carrying current with distance
CO5. **Calculate** the band gap of a given semiconductor

I-Year-I Semester
ES1101L

PROBLEM SOLVING USING C LAB

L	T	P	C
0	0	3	1.5

Course Objectives

1. Apply the principles of C language in problem solving.
2. To design flowcharts, algorithms and knowing how to debug programs.
3. To design & develop of C programs using arrays, strings pointers & functions.
4. To review the file operations, pre-processor commands.

Exercise 1

1. Write a C program to print a block F using hash (#), where the F has a height of six characters and width of five and four characters.
2. Write a C program to compute the perimeter and area of a rectangle with a height of 7 inches and width of 5 inches.
3. Write a C program to display multiple variables.

Exercise 2

1. Write a C program to calculate the distance between the two points.
2. Write a C program that accepts 4 integers p, q, r, s from the user where r and s are positive and p is even. If q is greater than r and s is greater than p and if the sum of r and s is greater than the sum of p and q print "Correct values", otherwise print "Wrong values".

Exercise 3

1. Write a C program to convert a string to a long integer.
2. Write a program in C which is a Menu-Driven Program to compute the area of the various geometrical shape.
3. Write a C program to calculate the factorial of a given number.

Exercise 4

1 .Write a program in C to display the n terms of even natural number and their sum.
2. Write a program in C to display the n terms of harmonic series and their sum.
1 + 1/2 + 1/3 + 1/4 + 1/5 ... 1/n terms.
3. Write a C program to check whether a given number is an Armstrong number or not.

Exercise 5

1. Write a program in C to print all unique elements in an array.
2. Write a program in C to separate odd and even integers in separate arrays.
3. Write a program in C to sort elements of array in ascending order.

Exercise 6

1. Write a program in C for multiplication of two square Matrices.

2. Write a program in C to find transpose of a given matrix.

Exercise 7
1. Write a program in C to search an element in a row wise and column wise sorted matrix.
2. Write a program in C to print individual characters of string in reverse order.

Exercise 8
1. Write a program in C to compare two strings without using string library functions.
2. Write a program in C to copy one string to another string.

Exercise 9
1. Write a C Program to Store Information Using Structures with Dynamically Memory Allocation
2. Write a program in C to demonstrate how to handle the pointers in the program.

Exercise 10
1. Write a program in C to demonstrate the use of & (address of) and *(value at address) operator.
2. Write a program in C to add two numbers using pointers.

Exercise 11
1. Write a program in C to add numbers using call by reference.
2. Write a program in C to find the largest element using Dynamic Memory Allocation.

Exercise 12
1. Write a program in C to swap elements using call by reference.
2. Write a program in C to count the number of vowels and consonants in a string using a pointer.

Exercise 13
1. Write a program in C to show how a function returning pointer.
2. Write a C program to find sum of n elements entered by user. To perform this program, allocate memory dynamically using malloc( ) function.

Exercise 14
1. Write a C program to find sum of n elements entered by user. To perform this program, allocate memory dynamically using calloc( ) function. Understand & write the difference.
2. Write a program in C to convert decimal number to binary number using the function.

Exercise 15
1. Write a program in C to check whether a number is a prime number or not using the function.
2. Write a program in C to get the largest element of an array using the function.

Exercise 16

1. Write a program in C to append multiple lines at the end of a text file.
2. Write a program in C to copy a file in another name.
3. Write a program in C to remove a file from the disk.

Course Outcomes: By the end of the Lab, the student able to

CO1. **Comprehend** the various concepts of a C language

CO2. **Develop** algorithms and flowcharts

CO3. **Design** and development of C problem solving skills.

CO4. **Acquire** modular programming skills.

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I-Year-II Semester
BS1201

MATHEMATICS-II

L	T	P	C
3	1	0	3

Course objectives:

The main objectives are

1. To elucidate the different numerical methods to solve nonlinear algebraic equations
2. To disseminate the use of different numerical techniques for carrying out numerical integration
3. To equip the students with standard concepts and tools at an intermediate to advanced level mathematics to develop the confidence and ability among the students to handle various real-world problems and their applications

UNIT-1: Iterative methods **11 HOURS**

Introduction–Bisection method–Method of false position–Iteration method–Newton-Raphson method (one variable)–Jacobi and Gauss-Seidel methods for solving system of equations.

UNIT-2: Interpolation **14 HOURS**

Introduction–Errors in polynomial interpolation–Finite differences–Forward differences–Backward differences–Central differences –Relations between operators–Newton's forward and backward formulae for interpolation–Gauss's forward and backward formulae for

Interpolation – Interpolation with unequal intervals–Lagrange's interpolation formula–Newton's divide difference formula.

UNIT-3: Numerical integration and solution of ordinary difference equations **12 HOURS**

Trapezoidal rule–Simpson's $1/3^{rd}$ and $3/8^{th}$ rule–Solution of ordinary differential equations by Taylor's series–Picard's method of successive approximations–Euler's method–Modified Euler's method–Runge-Kutta method (second and fourth order).

UNIT–4: Laplace Transforms: **14 HOURS**

Laplace transforms of standard functions – Shifting theorems – Transforms of derivatives and integrals – Unit step function – Dirac's delta function –Periodic function - Inverse Laplace transforms – Convolution theorem (without proof)

Applications: Evaluation of integrals using Laplace transforms - Solving ordinary differential equations (Initial value problems) using Laplace transforms.

UNIT 5: Fourier series and Fourier Transforms: **14 HOURS**

Fourier series: Introduction – Periodic functions – Fourier series of periodic function – Dirichlet's conditions – Even and odd functions – Change of interval – Half-range sine and cosine series.

Fourier Transforms: Fourier integral theorem (without proof) - Fourier sine and cosine integrals – Sine and cosine transforms – Properties – Inverse transforms – Finite Fourier transforms.

Course Outcomes: Upon successful completion of the course, the student will be able to

CO1 Evaluate approximate in the roots of polynomial and transcendental equations by different algorithms (EVALUATE)

CO2 Solve system of linear algebraic equations using Gauss Jacobi, Gauss Seidel and apply Newton's forward and backward interpolation and Lagrange's formulae for equal and unequal intervals (SOLVE,APPLY, FIND)

CO3 Apply different algorithms for approximating the solutions of ordinary differential equations to its analytical computations and also by Laplace the transforms for solving differential equations (SOLVE,APPLY, FIND)

CO4 Find or compute the Fourier series of periodic signals (SOLVE, APPLY, FIND, ANALYSE)

CO5 Know and be able to apply integral expressions for the forwards and inverse Fourier transform to range of non-periodic waveforms (SOLVE, APPLY, FIND)

Text books:

1. B.S. Grewal, Higher Engineering Mathematics, 44th Edition, Khanna Publishers

Reference books:

1. **B.V. Ramana,** Higher Engineering Mathematics, 2007 Edition, Tata Mc. Graw Hill Education.
2. **H.K.Das,** Advanced Engineering Mathematics, 22nd Edition, S. Chand & Company Ltd.
3. **Erwin Kreyszig**, Advanced Engineering Mathematics, 10th Edition, Wiley-India.

I-Year-II Semester
BS1202

APPLIED CHEMISTRY

L	T	P	C
3	0	0	3

Knowledge of basic concepts of chemistry for Engineering students will help them as professional engineers later in design and material selection as well as utilizing the available resources.

Course Objectives

1. Significance of various types of plastic materials in household appliances and composites (FRP) in aerospace and automotive industries.
2. Understand the basic concepts of electrochemistry, which are useful to construct the electrochemical cells, batteries and fuel cells.
   Illustrate the theories and mechanism of corrosion and its prevention.
3. Importance of advanced materials and their engineering applications.
4. Make use of molecular machines in supramolecular chemistry and need of green chemistry.
5. Design and construction of advanced instrumental techniques and recall their importance.

Unit-1
POLYMER TECHNOLOGY
***Polymerisation**:* Introduction-Methods of polymerisation-(emulsion and suspension)-Physical and mechanical properties.
***Plastics**:* Compounding-Fabrication (compression, injection, blown film, extrusion)-Preparation, properties and applications of PVC, ploycarbonates and Bakelite-Mention some examples of plastic materials used in electronic gadgets, recycling of e-plastic waste.
***Elastomers**:* Natural rubber-Drawbacks-Vulcanization-Preparation-Properties and applications of synthetic rubbers (Buna S, thiokol and polyurethanes)
Composite Materials: Fiber reinforced plastics-CFRP and GFRP
Conducting polymers: Polyacetylene, doped conducting polymers -p-type and n-type doping.
Bio degradable polymers: Biopolymers and biomedical polymers
Unit-2
ELECTROCHEMICAL CELLS AND CORROSION
Single electrode potential-Electrochemical series and uses of series-Standard hydrogen electrode, calomel electrode, concentration cell, construction of glass electrode, Batteries: Dry cell, Ni-Cd cells, Ni-Metal hydride cells, Li-ion battery, Zinc air cells, Fuel cells-H_2 –O_2, CH_3OH-O_2, phosphoric acid, molten carbonate.
***Corrosion**:* Definition-theories of corrosion (chemical and electrochemical)-galvanic corrosion, differential aeration corrosion, stress corrosion, water-line corrosion- passivity of metals-galvanic series-factors influencing rate of corrosion-corrosion control: (proper designing, cathodic protection)-protective coatings: cathodic and anodic coatings, electroplating, electroless plating (nickel), paints (constituents and its functions).
Unit-3
MATERIAL CHEMISTRY
Non-elemental semiconducting materails: Stoichiometric, controlled valency & chalcogen photo/semiconductors-preparation of semiconductors (distillation, zone refining, Czochralski crystal pulling technique) – Semiconductor devices (p-n junction diode as rectifier, junction

transistor)
Nano materials: Introduction, sol-gel method, characterization by BET, SEM and TEM methods, applications of graphene-carbon nanotubes and fullerenes: Types, preparation of carbon nanomaterials by carbon-arc, laser abalation methods.
Liquid crystals: Introduction-types-applications.
Superconductors: Meissner effect, type- I and type- II superconductors, characteristics and applications.

Unit-4

ADVANCED CONCEPTS AND GREEEN CHEMISTRY

Molecular switches and machines: Introduction to supramolecular chemistry, characteristics of molecular motors and machines. Rotaxanes and Catenanes as artificial molecular machines. Protypes linear motions in Rotaxanes, and acid-base controlled molecular shuttle, a molecular elevator, an autonomous light –powered molecular motors, natural molecular motors and machine.
Green chemistry: Principles of green chemistry, green synthesis – aqueous phase, microwave assisted chemical reactions and phase transfer catalysis (PTC).

Unit-5

SPECTROSCOPIC TECHNIQUES & NON-CONVENTIONAL ENERGY SOURCES

Spectroscopic Techniques: Electromagneticspectrum-types of molecular spectra and their absorption criteria.
UV-visible spectroscopy (electronic spectroscopy), Frank-Condon principle, Beer-Lambert's law and its limitations, chromophores and auxochromes – *applications of UV visible spectroscopy.
IR spectroscopy – functional group and finger print region – molecular vibrations – stretching and bending vibrations – *applications of IR.
NMR (Nuclear magnetic resonance): Working principle and instrumentation of NMR – chemical shift(δ) – *applications of NMR.
(*only general applications – without any spectroscopic problems regarding quantitative and qualitative analysis.)
Non-conventional energy sources: Design, working, schematic diagram, advantages and disadvantages of photovoltaic cell, organic photo-voltaic, hydropower, geothermal power, tidal, ocean thermal energy conversion (OTEC) – open cycle OTEC, closed cycle OTEC and hybrid cycle OTEC.

REFERENCE BOOKS

1. A text book of Engineering Chemistry by S.S. Dara, S. S. Umare; S. Chand & Co., Ltd., Latest Edition.
2. Engineering Chemistry by Shashi Chawla; Dhanpat Rai Publicating Co., Latest Edition.

TEXT BOOKS

1. Engineering Chemistry by Jain & Jain; Dhanpat Rai Publicating Co., Latest Edition
2. Engineering Chemistry by Shikha Agarwal; Cambridge University Press, 2019 Edition.
3. Engineering Chemistry by Prasanth Rath, B. Ramadevi, Ch. Venkata Ramana Reddy, Subendu Chakravarthy; Cengage Publications, 2019 Edition.

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

CO1. **explain** the preparation, properties and applications of thermoplastics, thermosettings, elastomers and conducting polymers.

CO2. **know** the importance of various materials and their uses in the construction of batteries and fuel cells.

CO3. **know** the applications of advanced materials in various industries.

CO4. **apply** the principles of supramolecular chemistry in the applications of molecular machines, need of green chemistry.

CO5. **explain** the principles of spectrometry such as UV, IR, and NMR.

I-Year-II Semester ES1201	BASICELECTRONIC DEVICES &CIRCUITS	L	T	P	C
		3	0	0	3

Course objectives:

1. To Understand the Diode operation and switching characteristics,
2. To understand the implementation of various diode applications
3. To Understand the Operation of BJT, FET, MOSFET metal semiconductor rectifying and ohmic contacts.
4. To learn the various biasing methods and small-signal models of Transistors
5. To learn the feedback topology of amplifier and applications of transistors.

Unit-1

Junction Diode Characteristics

P-N Junction Diode Qualitative Theory of P-N Junction, P-N Junction as a Diode, Diode Equation(Qualitative), Volt-Ampere Characteristics, Temperature dependence of VI characteristic, Ideal versus Practical – Resistance levels (Static and Dynamic), Transition and Diffusion Capacitances, Diode Equivalent Circuits, Load Line Analysis, Breakdown Mechanisms in Semiconductor Diodes.

Special Diodes, Zener Diode Characteristics, Principle of Operation LED and Photo Diode.

Unit-2

Diode Applications

Rectifiers: Half wave rectifier, ripple factor, full wave rectifier, Harmonic components in a rectifier circuit Rectifier with Filters(Qualitative Treatment only): Inductor filter, Capacitor filter, Qualitative Treatment of L - section filter, Pi - section filter, Multiple L and pi -section and filter, and comparison of various filter circuits in terms of ripple factors

Voltage Regulators: Simple circuit of a regulator using zener diode.

Unit-3

Transistor Characteristics

Bi-polar Junction Transistors(BJT): Formation of N-P-N and P-N-P transistors, Transistor current components, Operation of BJT, BJT characteristics (CE, CB configurations), Early effect, Current equations, Relation between Alpha and Beta, typical transistor junction voltage values and Limits of Operation, Transistor as an amplifier. (6 Hrs)

Junction Field Effect Transistors (JFET): Junction Field Effect Transistor (JFET) structure, Drain and Transfer Characteristics, Significance of Pinch-Off Voltage, JFET as an amplifier and switch, Comparison of BJT and JFET.

Unit-4

Transistor Amplifiers

Biasing and Stabilisation: Need for Proper Biasing, Q-point stability, Fixed and Voltage Divider biasing for BJT, Emitter Degeneration, Design of Self Biasing circuit, Thermal Stability considerations. Fixed, Voltage Divider biasing for JFET.

Small Signal Low frequency analysis of BJT and FET amplifiers: Small signal low frequency h-parameter model of BJT. Approximate model, Analysis of BJT amplifiers using Approximate model for CB,CC and CE configurations, Analysis of JFET Amplifiers, Analysis of CS, CD Amplifiers. (06 Hrs)

Unit-5

Feedback Amplifiers

Negative Feedback Amplifiers: Concept of feedback, Classification of feedback amplifiers, General characteristics of negative feedback amplifiers, Effect of Feedback on input and output characteristics, Voltage series, voltage shunt, current series, and current shunt feedback amplifiers with discrete components and their analysis (05 Hrs)

Oscillators: Condition for oscillations. RC-phase shift oscillators with Transistor and FET, Hartley and Colpitts oscillators, Wein bridge oscillator, Crystal oscillators, Frequency and amplitude stability of oscillators.

Advanced Topics in this Subject: The historical background of MOS devices and their fabrication will be briefly reviewed, as well as the basic MOS structure for accumulation, depletion and inversion. Advanced issues such as work function, trapped charge, interface traps, non-equilibrium operation and re-equilibration processes will be covered.

Text books

1. Jacob Millman and Halkias , ‘ Integrated Electronics’, Tata-Mcgraw Hill International.
2. Donald A. Neaman,”Semiconductor Physics and Devices”, Times Mirror High Education Group, Chicago.

Reference books

1. Robert L.Boylestead and Louis Nashelsky,”Electronic Devices and Circuit Theory”,Pearson Education.
2. Adel S. Sedra and Kenneth C. Smith, “ Microelectronic Circuits”, Oxford University Press.
3. D. Chattopadhyay and P.C. Rakshit Electronics: Fundamentals and Applications

e- Resources & other digital material

1. https://nptel.ac.in/courses/117/102/117102061/
2. https://nptel.ac.in/courses/117/106/117106091/
3. https://nptel.ac.in/courses/108/107/108107142/

Course Outcomes: Upon successful completion of the course, the student will be able to

CO1: Develop through basic knowledge on the behaviour and the characteristics of semiconductor junction. **(Understand)**

CO2: Demonstratethe usage of diodes in various applications **(Apply)**

CO3: Acquire knowledge on the operations of BJT, FET, and MOSFET. **(Understand)**

CO4: Learn the art of biasing of BJTs and FETs, small signal low frequency models of BJTs and FETS in amplifier analysis **(Apply, Analyze)**

CO5: Learn the feedback topology of amplifier and applications of transistors **(Apply, Analyze)**

I-Year-II Semester
ES1202

PROBLEM SOLVING USING PYTHON

L	T	P	C
3	0	0	3

Course Objectives

- To learn about Python programming language syntax, semantics, and the runtime environment
- To be familiarized with universal computer programming concepts like data types, containers
- To be familiarized with general computer programming concepts like conditional execution, loops & functions
- To be familiarized with general coding techniques and object-oriented programming

Unit-1

Introduction: Introduction to Python, Program Development Cycle, Input, Processing, and Output, Displaying Output with the Print Function, Comments, Variables, Reading Input from the Keyboard, Performing Calculations, Operators. Type conversions, Expressions, More about Data Output.

Data Types, and Expression: Strings Assignment, and Comment, Numeric Data Types and Character Sets, Using functions and Modules.

Decision Structures and Boolean Logic: if, if-else, if-elif-else Statements, Nested Decision Structures, Comparing Strings, Logical Operators, Boolean Variables. Repetition Structures: Introduction, while loop, for loop, Calculating a Running Total, Input Validation Loops, Nested Loops.

Unit-2

Control Statement: Definite iteration for Loop Formatting Text for output, Selection if and if else Statement Conditional Iteration, While Loop

Strings and Text Files: Accessing Character and Substring in Strings, Data Encryption, Strings and Number Systems, String Methods Text Files.

Unit-3

List and Dictionaries: Lists, Defining Simple Functions, Dictionaries

Design with Function: Functions as Abstraction Mechanisms, Problem Solving with Top Down Design, Design with Recursive Functions, Case Study Gathering Information from a File System, Managing a Program’s Namespace, Higher Order Function.

Modules: Modules, Standard Modules, Packages.

Unit-4

File Operations: Reading config files in python, Writing log files in python, Understanding read functions, read(), readline() and readlines(), Understanding write functions, write() and writelines(), Manipulating file pointer using seek, Programming using file operations

Object Oriented Programming: Concept of class, object and instances, Constructor, class attributes and destructors, Real time use of class in live projects, Inheritance , overlapping and overloading operators, Adding and retrieving dynamic attributes of classes, Programming using Oops support

Design with Classes: Objects and Classes, Data modeling Examples, Case Study An ATM, Structuring Classes with Inheritance and Polymorphism

Unit-5

Errors and Exceptions: Syntax Errors, Exceptions, Handling Exceptions, Raising Exceptions, User-defined Exceptions, Defining Clean-up Actions, Redefined Clean-up Actions.

Graphical User Interfaces: The Behavior of Terminal Based Programs and GUI -Based, Programs, Coding Simple GUI-Based Programs, Other Useful GUI Resources.
Programming: Introduction to Programming Concepts with Scratch.

TEXT BOOKS:

1. Fundamentals of Python First Programs, Kenneth. A. Lambert, Cengage.
2. Python Programming: A Modern Approach, VamsiKurama, Pearson.

REFERENCES:

1. Introduction to Python Programming, Gowrishankar.S, Veena A, CRC Press.
2. Introduction to Programming Using Python, Y. Daniel Liang, Pearson.

Course Outcomes: After completing this course, Students will be able to-

CO1: Develop essential programming skills in computer programming concepts like data types, containers

CO2: Solve coding tasks related to conditions, loops and String processing

CO3: Experiment with various Data structures in interpreted Language and to build modules and packages for real software needs.

CO4: Implement Files and object oriented principles in Python

CO5: Identify solutions using GUI in Python.

I-Year-II Semester PC1201	BASIC CIRCUIT ANALYSIS	L	T	P	C
		3	1	0	3

Course objectives

- To study the concepts of network elements and network reduction techniques.
- To understand the behavior of RLC networks for sinusoidal excitations.
- To study the performance of different circuits and to understand the concept of resonance.
- To understand the applications of network theorems.
- To study the concept of magnetic coupled circuits.

Unit-1

Introduction to Electrical Circuits

Passive components and their V-I relations. Sources (dependent and independent, Ideal and Practical) -Kirchhoff's laws, Network reduction techniques, source transformation techniques, Nodal analysis and Mesh analysis with DC excitation.

Unit-2

Single Phase A.C Systems

RMS, average value, form factor and Peak factor for Periodic waveforms, Concept of phase, phase angle and phase difference, 'j' operator, waveforms and phasor diagrams for lagging and leading networks. Concept of Impedance and admittance- steady state analysis of R, L and C circuits with sinusoidal excitation, real, reactive power, apparent power and power triangle.

Unit-3

Analysis of AC Networks

Nodal and Mesh analysis with AC excitation, resonance and anti-resonance, selectivity, band width and Quality factor, voltage and current magnification factor, locus diagrams.

Unit-4

Network theorems (DC & AC Excitations)

Superposition theorem, Thevenin's theorem, Norton's theorem, Maximum Power Transfer theorem, Reciprocity theorem, Millman's theorem, Compensation theorem and Telligen's theorem.

Unit-5

Magnetic Circuit

MMF, flux, reluctance, flux density, field intensity and its relations. Analogy between electrical and magnetic circuits. Faraday's laws of electromagnetic induction, Concept of self and mutual inductance, Dot convention, coefficient of coupling and composite magnetic circuit.

Text Books

1. "Fundamentals of Electric Circuits "Charles K.Alexander, Mathew N.O.Sadiku, Tata McGraw-Hill.

2. Engineering Circuit Analysis by William Hayt and Jack E.Kemmerley,Mc Graw Hill Company,6th edition

3. Network Analysis: Van Valkenburg; Prentice-Hall of India Private Ltd.

4. 3000 Solved Problems in Electrical Circuit by Schaum's solved problem series Tata McGraw- Hill.

Reference Books

1. Circuits & Networks Analysis & Synthesis by A. Sudhakar and Shyammohan S Palli, Tata McGraw- Hill.
2. Network Analysis by N.C.Jagan, C.Lakshmi Narayana BS publications 2nd edition
3. Circuit Theory by A.ChakrabartiDanapat Rai & Co publisher.

e- Resources & other digital material:

1. https://www.youtube.com/watch?v=8gMuLr_0-TI&t=7s
2. https://www.youtube.com/watch?v=pO9qgzzRWaA&t=337s
3. https://www.youtube.com/watch?v=HcgDoL9YtMM&t=15s
4. https://www.youtube.com/watch?v=MdPLQFFeQ30&t=74s
5. https://www.youtube.com/watch?v=Q-qKhjXYFPQ

Course Outcomes: Upon successful completion of the course, the student will be able to analyse

CO1 Various electrical networks in presence of active and passive elements. **{Apply level, KL3}**

CO2 Any R, L, C network with sinusoidal excitation.. **{Apply level, KL3&Analyse level, KL4}**

CO3 Any R, L, C network with variation of any one of the parameters i.e R, L, C. and f.**{Apply level, KL3&Analyse level, KL4}**

CO4 Electrical networks by using principles of network theorems.**{Apply level, KL3}**

CO5 Any magnetic circuit with various dot conventions. **{Apply level, KL3}**

I-Year-II Semester BS1202L	APPLIED CHEMISTRY LAB	L	T	P	C
		0	0	3	1.5

Introduction to chemistry laboratory – Molarity, Normality, Primary, Secondary standard solutions, Volumetric titrations quantitative analysis .

Course Objectives

1. To furnish the students with a solid foundation in Chemistry Laboratory required to solve the Engineering problems.
2. To expose the students in practical aspects of the theoritical concepts like pH, hardness of water etc.
3. To guide the students on how to handle the instruments like UV-visible spectrophotometer, potentiometer and conductometer.

List of Experiments: (Students should do any 10 experiments listed below)

1. Determination of HCl using standard Na_2CO_3 solution.
2. Determination of alkalinity of a sample containing Na_2CO_3 and NaOH.
3. Determination of Mn (II) using standard oxalic acid solution.
4. Determination of ferrous iron using standard $K_2Cr_2O_7$ solution.
5. Determination of Copper (II) using standard EDTA solution.
6. Determination of temporary and permanent hardness of water using standard EDTA solution.
7. Determination of Iron (III) by colorimetric method.
8. Determination of the concentration of acetic acid using sodium hydroxide (pH-metric method).
9. Determination of concentration of strong acid vs strong base (by conductometric method).
10. Determination of strong acid vs strong base (by potentiometric method).
11. Determination of Mg^{+2} present in an antacid.
12. Determination of $CaCO_3$ presence in an egg shell.
13. Estimation of vitamin- C.
14. Determination of phosphoric content in soft drinks.
15. Adsorption of acetic acid by charcoal.
16. Prepatation of nylon-6, 6 and Bakelite (demonstration only)

Reference Books:

A Text Book of Quantitative Analysis, Arthur J. Vogel.

Course Outcomes: At the end of the course, the students will be able

CO1. To estimate the amount of metal ions present in different solutions (L4 & L3)

CO2. To analyze the quality parameters of water (L4)

CO3. To determine the strength of different solutions by using different instrumentation techniques (L3)

I-Year-II Semester
ES1201L

BASIC ELECTRONIC DEVICES & CIRCUITS LAB

L	T	P	C
0	0	3	1.5

Course Objectives

1. To study basic electronic components
2. To observe characteristics of electronic devices

Electronic Workshop Practice:

1. Identification, Specifications and Testing of active devices, Diodes, BJTs, JFETs, LEDs, LCDs, SCR, UJT.
2. Soldering Practice- Simple circuits using active and passive components.
3. Study and operation of Ammeters, Voltmeters, Transformers, Analog and Digital Millimeter, Function
4. Regulated Power Supply and CRO.

List of Experiments(Any 10 of the following experiments are to be conducted)

1. P.N Junction Diode Characteristics
   Part A: Germanium Diode (Forward bias& Reverse bias)
   Part B: Silicon Diode (Forward Bias only)
2. Zener Diode Characteristics
   Part A: V-I Characteristic
   Part B: Zener Diode as Voltage Regulator
3. Rectifiers (without and with c-filter)
   Part A: Half-wave Rectifier
   Part B : Full-wave Rectifier
4. BJT Characteristics (CE Configuration)
   Part A: Input Characteristics
   Part B: output Characteristics
5. FET Characteristics
   Part A: Drain Characteristics
   Part B: Transfer Characteristics
6. SCR Characteristics
7. UJT Characteristics
8. Transistor Biasing
9. CRO Operation and its Measurement
10. BJT-CE Amplifier
11. Emitter Follower –CC Amplifier
12. Design any oscillator and measure frequency (RC PHASE SHIFT, WEIN BRIDGE, HARTLEY, and COLPITT’S)
13. Design of variable DC power supply (application).

Learning Outcomes: At the end of the course the students can able to

1. Measure voltage, frequency and phase of any waveform using CRO.
2. Generate sine, square and triangular waveforms with required frequency and amplitude using function generator.
3. Analyze the characteristics of different electronic devices such as diodes, transistors etc.
4. Analyze and design simple circuits like rectifiers, power supplies and amplifiers etc.,

I-Year-II Semester ES1202L	PROBLEM SOLVING USING PYTHON LAB	L	T	P	C
		0	0	3	1.5

Course Objectives

- To acquire programming skills in core Python.
- To acquire Object Oriented Skills in Python
- To develop the skill of designing Graphical user Interfaces in Python
- To develop the ability to write database applications in Python

List of Problems

1. Write a program that asks the user for a weight in kilograms and converts it to pounds. There are 2.2 pounds in a kilogram.
2. Write a program that asks the user to enter three numbers (use three separate input statements). Create variables called total and average that hold the sum and average of the three numbers and print out the values of total and average.
3. Write a program that uses a *for* loop to print the numbers 8, 11, 14, 17, 20, . . . , 83, 86, 89.
4. Write a program that asks the user for their name and how many times to print it. The program should print out the user's name the specified number of times.
5. Use a *for* loop to print a triangle like the one below. Allow the user to specify how high the triangle should be.
   ```
   *
   **
   ***
   ****
   ```
6. Generate a random number between 1 and 10. Ask the user to guess the number and print a message based on whether they get it right or not.
7. Write a program that asks the user for two numbers and prints *Close* if the numbers are within .001 of each other and Not close otherwise.
8. Write a program that asks the user to enter a word and prints out whether that word contains any vowels.
9. Write a program that asks the user to enter two strings of the same length. The program should then check to see if the strings are of the same length. If they are not, the program should print an appropriate message and exit. If they are of the same length, the program should alternate the characters of the two strings. For example, if the user enters *abcde* and *ABCDE* the program should print out *AaBbCcDdEe*.Write a program that asks the user for a large integer and inserts commas into it according to the standard American convention for commas in large numbers. For instance, if the user enters 1000000, the output should be 1,000,000.
10. In algebraic expressions, the symbol for multiplication is often left out, as in 3x+4y or 3(x+5). Computers prefer those expressions to include the multiplication symbol, like

3*x+4*y or 3*(x+5). Write a program that asks the user for an algebraic expression and then inserts multiplication symbols where appropriate.

11. Write a program that generates a list of 20 random numbers between 1 and 100.
    a) Print the list.
    b) Print the average of the elements in the list.
    c) Print the largest and smallest values in the list.
    d) Print the second largest and second smallest entries in the list
    e) Print how many even numbers are in the list.
12. Write a program that asks the user for an integer and creates a list that consists of the factors of that integer.
13. Write a program that generates 100 random integers that are either 0 or 1. Then find the longest run of zeros, the largest number of zeros in a row. For instance, the longest run of zeros in [1,0,1,1,0,0,0,0,1,0,0] is 4.
14. Write a program that removes any repeated items from a list so that each item appears at most once. For instance, the list [1,1,2,3,4,3,0,0] would become [1,2,3,4,0].
15. Write a program that asks the user to enter a length in feet. The program should then give the user the option to convert from feet into inches, yards, miles, millimeters, centimeters, meters, or kilometers. Say if the user enters a 1, then the program converts to inches, if they enter a 2, then the program converts to yards, etc. While this can be done with if statements,it is much shorter with lists and it is also easier to add new conversions if you use lists.
16. Write a function called *sum_digits* that is given an integer num and returns the sum of the digits of num.
17. Write a function called *first_diff* that is given two strings and returns the first location in which the strings differ. If the strings are identical, it should return -1.
18. Write a function called *number_of_factors* that takes an integer and returns how many factors the number has.
19. Write a function called *is_sorted* that is given a list and returns True if the list is sorted and False otherwise
20. Write a function called root that is given a number x and an integer n and returns $x^{1/n}$. In the function definition, set the default value of n to 2.
21. Write a function called primes that is given a number n and returns a list of the first n primes. Let the default value of n be 100.
22. Write a function called merge that takes two already sorted lists of possibly different lengths, and merges them into a single sorted list.
    a) Do this using the sort method. b) Do this without using the sort method.
23. Write a program that asks the user for a word and finds all the smaller words that can be made from the letters of that word. The number of occurrences of a letter in a smaller word can't exceed the number of occurrences of the letter in the user's word.
24. Write a program that reads a file consisting of email addresses, each on its own line. Your program should print out a string consisting of those email addresses separated by semicolons.

25. Write a program that reads a list of temperatures from a file called *temps.txt*, converts those temperatures to Fahrenheit, and writes the results to a file called ftemps.txt.
26. Write a class called Product. The class should have fields called name, amount, and price, holding the product's name, the number of items of that product in stock, and the regular price of the product. There should be a method *get_price* that receives the number of items to be bought and returns a the cost of buying that many items, where the regular price is charged for orders of less than 10 items, a 10% discount is applied for orders of between 10 and 99 items, and a 20% discount is applied for orders of 100 or more items. There should also be a method called *make_purchase* that receives the number of items to be bought and decreases amount by that much.
27. Write a class called Time whose only field is a time in seconds. It should have a method called *convert_to_minutes* that returns a string of minutes and seconds formatted as in the following example: if seconds is 230, the method should return '5:50'. It should also have a method called *convert_to_hours* that returns a string of hours, minutes, and seconds formatted analogously to the previous method.
28. Write a class called Converter. The user will pass a length and a unit when declaring an object from the class—for example, c = Converter(9,'inches'). The possible units are inches, feet, yards, miles, kilometers, meters, centimeters, and millimeters. For each of these units there should be a method that returns the length converted into those units. For example, using the Converter object created above, the user could call c.feet() and should get 0.75 as the result.
29. Write a Python class to implement pow(x, n).
30. Write a Python class to reverse a string word by word.
31. Write a program that opens a file dialog that allows you to select a text file. The program then displays the contents of the file in a textbox.
32. Write a program to demonstrate Try/except/else.
33. Write a program to demonstrate try/finally and with/as.

Course Outcomes: After completing this course, Students will be able to-

CO1: Comprehend how software easily to build right out of the box.

CO2: Demonstrates the use of an interpreted language for problem solving through control statements including loops and conditionals.

CO3: Practice with data structures for quick programming solutions.

CO4: Demonstrates software building for real needs by breaking out code into reusable functions and modules.

CO5: Comprehend the software reliability through exception handling.

I-Year-II Semester
MC1201

Indian Constitution

L	T	P	C
2	0	0	0

Course objectives:

The main objectives are

1. To Enable the student to understand the importance of constitution
2. To understand the structure of executive, legislature and judiciary
3. To understand philosophy of fundamental rights and duties
4. To understand the autonomous nature of constitutional bodies like Supreme Court and high court controller and auditor general of India and election commission of India.
5. To understand the central and state relation financial and administrative.

UNIT-I

Introduction to Indian Constitution: Constitution' meaning of the term, Indian Constitution - Sources and constitutional history, Features - Citizenship, Preamble, Fundamental Rights and Duties, Directive Principles of State Policy.

UNIT-II

Union Government and its Administration Structure of the Indian Union: Federalism, Centre-State relationship, President: Role, power and position, PM and Council of ministers, Cabinet and Central Secretariat, Lok Sabha, Rajya Sabha, The Supreme Court and High Court: Powers and Functions;

UNIT-III

State Government and its Administration Governor - Role and Position - CM and Council of ministers, State Secretariat: Organisation, Structure and Functions

UNIT-IV

Local Administration - District's Administration Head - Role and Importance, Municipalities - Mayor and role of Elected Representative - CEO of Municipal Corporation Panchayati: Functions PRI: Zila Panchayat, Elected officials and their roles, CEO Zila Panchayat: Block level Organizational Hierarchy - (Different departments), Village level - Role of Elected and Appointed officials - Importance of grass root democracy

UNIT-V

Election Commission: Election Commission- Role of Chief Election Commissioner and Election Commissionerate State Election Commission: Functions of Commissions for the welfare of SC/ST/OBC and women

Course Outcomes: Upon successful completion of the course, the student will be able to

CO1 Know the sources, features and principles of Indian Constitution.

CO2 Learn about Union Government, State government and its administration.

CO3 Get acquainted with Local administration and Pachayati Raj.

CO4 Be aware of basic concepts and developments of Human Rights.

CO5 Gain knowledge on roles and functioning of Election Commission

Reference books:

1. Durga Das Basu, Introduction to the Constitution of India, Prentice – Hall of India Pvt. Ltd.. New Delhi
2. Subash Kashyap, Indian Constitution, National Book Trust
3. J.A. Siwach, Dynamics of Indian Government & Politics
4. D.C. Gupta, Indian Government and Politics
5. H.M.Sreevai, Constitutional Law of India, 4th edition in 3 volumes (Universal Law Publication)
6. J.C. Johari, Indian Government and Politics Hans
7. J. Raj Indian Government and Politics
8. M.V. Pylee, Indian Constitution Durga Das Basu, Human Rights in Constitutional Law, Prentice – Hall of India Pvt. Ltd.. New Delhi
9. Noorani, A.G., (South Asia Human Rights Documentation Centre), Challenges to Civil Right), Challenges to Civil Rights Guarantees in India, Oxford University Press 2012

II-Year-I Semester
BS2101

Mathematics-III

L	T	P	C
3	1	0	3

Pre-Requisites:

1. Basics of Matrix Algebra
2. Partial Differentiation
3. Multiple Integrals
4. Ordinary Differential Equations

Course Objectives: To learn

1. The concept of rank of a matrix which is used to know the consistency of system of linear equations and also to find the eigenvectors of a given matrix.
2. Cayley-Hamilton theorem to find the inverse and power of a matrix and determine the nature of the quadratic form.
3. The gradient of a scalar function, divergence and curl of a vector function
4. To evaluate line, surface and volume integrals and construct relation between line, surface and volume integrals using vector integral theorems.
5. To familiarize the techniques in solutions of partial differential equations.

Unit I:Solving system of linear equations, Eigen values and Eigenvectors: (12 hrs)
Rank of a matrix by Echelon form and normal form–solving system of homogeneous and non-homogeneous linear equations–Gauss elimination, Gauss Jordan for solving system of equations-Eigen values and Eigen vectors and their properties.

Unit II Cayley-Hamilton theorem and quadratic forms: (12 hrs)
Cayley-Hamilton theorem (without proof)–Finding inverse and power of a matrix by Cayley-Hamilton theorem–Reduction to Diagonal form–Quadratic forms and nature of the quadratic forms–Reduction of quadratic form to canonical forms by orthogonal transformation.
Application: Free vibration of two mass systems.

Unit III Vector Differentiation:(10 hrs)
Scalar and Vector point functions-Vector Differential operator- Gradient – Directional derivatives – Divergence – Curl – Laplacian second order operator- Vector identities- Scalar Potential.

Unit IV Vector Integration: (12 hrs)
Line integral – Work done – Circulation- Surface integral- Volume integral
Vector integral theorems (without proof): Green’s theorem in a plane- Stoke’s theorem- Gauss Divergence theorem.

Unit V Solutions of Partial differential Equations: (14 hrs)
Formation of partial differential equations by elimination of arbitrary constants and arbitrary functions – Solutions of first order linear (Lagrange) equation and nonlinear (standard types) equations.
Second order PDE: Solutions of linear partial differential equations with constant coefficients – RHS term of the type e^{ax+by}, $\sin(ax+by)$, $\cos(ax+by)$, $x^m y^n$.

Course Outcomes

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

CO1 **Analyze** the solution of the system of linear equations and to find the Eigenvalues and Eigen vectors of a matrix. (L4)

CO2 **Apply** Cayley-Hamilton theorem to determine inverse and power of a matrix and **identify** the nature of the quadratic form (L3)

CO3 **Interpret** the physical meaning of different operators such as gradient, curl and divergence. (L5)

CO4 **Determine** line, surface and volume integrals. **Apply** Green's, Stoke's and Gauss divergence theorems to calculate line, surface and volume integrals. (L5& L3)

CO5 **Identify** the solution methods for partial differential equation that model physical processes. (L3)

Text books:

1. **B.S. Grewal,** Higher Engineering Mathematics, 44th Edition, Khanna Publishers.
2. **B.V. Ramana,** Higher Engineering Mathematics, 2007 Edition, Tata Mc. Graw Hill Education.

Reference books

1. **Erwin Kreyszig,** Advanced Engineering Mathematics, 10th Edition, Wiley-India.
2. **H. K. Das,** Advanced Engineering Mathematics, 22ndEdition,S. Chand & Company Ltd.
3. **David Poole**, Linear Algebra- A modern introduction, 4th edition, Cengage.
4. **Peter O' Neil**, Advanced Engineering Mathematics, Cengage
5. **Srimantha Pal, S C Bhunia**, Engineering Mathematics, Oxford University Press.

e- Resources & other digital material

1. https://www.youtube.com/watch?v=LJ-LoJhbBA4&list=PLbMVogVj5nJQ2vsW_hmyvVfO4GYWaaPp7
2. (For Unit-I, Mod1 :1-7 lectures, Mod 6: 25th lecture, Mod 6: 26thlecture&For Unit-II Mod 7: 25th -27th lectures)
3. https://www.youtube.com/watch?v=9MCjyQSRmR8&list=PLFW6lRTa1g80fZ1giRbqbe_XdXPdkkyqY&ab_channel=NPTEL-NOCIITMNPTEL-NOCIITM
4. (For Unit-I 1-17 lectures)
5. https://www.youtube.com/watch?v=ksS_yOK1vtk&list=PLbRMhDVUMngfIrZCNOyPZwHUU1pP66vQW&ab_channel=IITKharagpurJuly2018IITKharagpurJuly2018
6. (For Unit-III 33-52 lectures, For Unit-IV 53-56 lectures)
7. http://www.infocobuild.com/education/audio-video-courses/mathematics/Mathematics-III-IIT-Roorkee/lecture-16.html
8. (For Unit-V lectures: 30-32)
9. https://www.youtube.com/watch?v=PDUHeFyq6sA&list=PLoVRJrAl0FT0oYJJQbchL1hiAUjlJ4y4O&index=42&ab_channel=AKTUDigitalEducationAKTUDigitalEducation (For Unit-V lectures: 41-44)

II- Year I- Semester	Name of the Course	L	T	P	C
	Data Structures	3	0	0	3

Prerequisites: Programming in C.

Course Objectives:

- To make students learn the basic concepts of Data Structures and Algorithms.
- To solve problems using data structures such as linear lists, stacks, queues.
- To explore advanced data structures such as balanced search trees.
- To be familiar with Graphs and their applications.
- To analyze various sorting techniques.

Unit-1 Linear Lists (12 hrs)

Introduction to Data Structures, Definition, Need & Types of Data Structures

Algorithms: Introduction, Time complexity and Space complexity, Performance and Analysis

Linear lists (Arrays) – Introduction, Operations, Searching.

Sorting - Insertion Sort, Quick Sort, Merge Sort and Radix Sort.

Unit-2 Stack & Queue (10 hrs)

Stacks: Introduction, Operations, implementation, Applications.

Queues: Introduction, Operations, implementation, Applications, Circular Queue

Unit-3 Linked Lists (10 hrs)

Single Linked List: Introduction, Representation, Operations, Applications.

Circular Lists: Introduction, Representation, Operations.

Double linked lists – Representation, operations.

Unit-4 TREES (8 hrs)

Trees: Introduction, Terminology, Representation of Trees

Binary Trees: Properties, Representations, Traversals, Types of Trees

Binary Search Trees: Definition, Operations.

Unit-5 GRAPHS (12 hrs)

Graphs: Introduction, Definition, Representation, Degree of vertex, Types of graphs, Elementary Graph Operations, Graph Traversals – Depth First Search, Breadth First Search, Spanning trees-Prim's algorithm, Krushkal's algorithm

Course Outcomes

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

CO1	**Implement** various operations on linear lists. (L2)
CO2	**Apply** data structure strategies like stacks and queues for exploring complex data structures. (L3)
CO3	**Identify** performance and trade-offs of static and dynamic data structures. (L3)
CO4	**Incorporate** data structures into the applications such as binary trees, binary search trees. (L3)

CO5 **Identify** appropriate data structure algorithms for graphs. (L3)

Text Books:

1. Data structures, Algorithms and Applications in C, S. Sahni, University Press (India) Pvt. Ltd, 2nd edition, Universities Press, Pvt. Ltd.
2. Data structures and Algorithm Analysis in C, Mark Allen Weiss, Pearson Education. Ltd, Second Edition.
3. Data Structures, Schaum's Outline, Seymour Lipschutz, Kindle Edition

Reference Books

1. Introduction to Algorithms, by Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, and Clifford Stein, MIT Press.
2. Classical Data Structures, Second Edition, DebasisSamanta, PHI

e- Resources & other digital material

Data Structures Visualizations :https://www.cs.usfca.edu/~galles/visualization/Algorithms.html
Code Archery Youtube Channel:
https://www.youtube.com/playlist?list=PLrKBFf87Cy9CNZpzi3poq8BFWc0h4f0vL

Course Outcomes

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

CO1 **Implement** various operations on linear lists. (L2)

CO2 **Apply** data structure strategies like stacks and queues for exploring complex data structures. (L3)

CO3 **Identify** performance and trade-offs of static and dynamic data structures. (L3)

CO4 **Incorporate** data structures into the applications such as binary trees, binary search trees. (L3)

CO5 **Identify** appropriate data structure algorithms for graphs. (L3)

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2. Data structures and Algorithm Analysis in C, Mark Allen Weiss, Pearson Education. Ltd, Second Edition.
3. Data Structures, Schaum's Outline, Seymour Lipschutz, Kindle Edition

Reference Books

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2. Classical Data Structures, Second Edition, DebasisSamanta, PHI

e- Resources & other digital material

Data Structures Visualizations :https://www.cs.usfca.edu/~galles/visualization/Algorithms.html
Code Archery Youtube Channel:
https://www.youtube.com/playlist?list=PLrKBFf87Cy9CNZpzi3poq8BFWc0h4f0vL

II-Year-I Semester
PC2101

Electrical Machines-1

L	T	P	C
3	0	0	3

PRE-REQUISITES: 1) Basic Circuit Analysis

Course objectives: The student should be able to

1. To understand the unifying principles of energy conversion and DC Generator.
2. To Understand the significance of Back EMF and Production of Torque in DC Motor.
3. To learn the characteristics, performance, methods of speed control and testing methods of DC motors.
4. To predetermine the performance of single phase transformers with equivalent circuit models.
5. To understand the parallel operation of transformers and three-phase totwophase Conversion.

Unit-1 Electromechanical Energy Conversion and introduction to DC machines (13 hrs)

Electromechanical Energy Conversion (06 hrs)

Principles of electromechanical energy conversion – singly excited system – concept of Co-Energy- force and torque derivation- multi excited system (qualitative treatment).

Construction and principle of operation of DC machine(07 hrs)

EMF equation for generator – Classification of DC machines based on excitation – OCC of DCShunt generator- Determination of Critical resistance and critical speed- Armature reaction and Commutation -Numerical problems.

Unit-2 Performance of D.C. Machines (10 hrs)

Torque and back-EMF equation of dc motor– characteristics of shunt, series and compound motors - losses and efficiency- applications of dc motors- Numerical problems.

Unit-3 Starting, Speed Control and Testing of D.C. Machines (15 hrs)

Starting, Speed Control of D.C. Machines (05 hrs)

Necessity of starter –3 point and 4 point starters – Speed control of Shunt motor by armature voltage and field control.

Testing of D.CMachines(10 hrs)

Testing methods - Swinburne's Test – Hopkinson'sTest -Brake Test on Shunt Motor–Load test on shunt generator- Numerical problems.

Unit-4 Single-phase Transformers (06 hrs)

Principle of operation- Constructional details - EMF equation - operation on no load and on load - phasor diagrams.

Equivalent Circuit and Performance (08 hrs)

Equivalent circuit –Voltage regulation – losses and efficiency – effect of variation of frequency and supply voltage on losses – All day efficiency-Numerical problems.

Unit-5 Transformers Testing and Three Phase Transformers (12 hrs)

Single phase Transformer Testing(08 hrs)

Tests on single phase transformers – open circuit and short circuit tests – Sumpner's test - Separation of losses – parallel operation with equal voltage ratios- Auto Transformer-comparison with two winding transformers-Numerical problems.

Three Phase Transformers(04hrs)

Poly phase connections - Y/Y, Y/Δ, Δ/Y, Δ/Δ and open Δ-Scott connection.

Course Outcomes

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

CO1 **Understand** the concepts of energy conversion and principle operation of DC Generator. **(Remember and Understand)**

CO2 **Examine** the significance of Back EMF and Production of Torque in DC Motor. (**Apply**)

CO3 **Analyze** the speed control methods and performance of DC Machine. (**Analyze**).

CO4 **Quantify** the performance of single phase transformers. (**Evaluate**)

CO5 Empathies parallel operation of transformers and three-Phase to two- phase Conversion. (**Understand, Apply and Analyze**).

Text books:

1. Theory & Performance of Electrical Machines by J.B.Guptha. S.K.Kataria& Sons.
2. Electrical Machines – P.S. Bhimbra, Khanna Publishers.

Reference books:

1. Electrical Machines by D. P.Kothari, I .J .Nagarth, Mc Graw Hill Publications, 4th edition.
2. Electrical Machinery by AbijithChakrabarthi and Sudhipta Debnath, Mc Graw Hill education 2015.
3. Electrical Machinery Fundamentals by Stephen J Chapman McGraw Hill education 2010.
4. Electric Machinery by A.E. Fitzgerald, Charleskingsley, Stephen D.Umans, TMH.

e- Resources & other digital material

1. https://nptel.ac.in/courses/108/105/108105017
2. https://nptel.ac.in/courses/103/102/108102146
3. www.nptelvideos.in/2012/11/electrical-machines-i.html
4. https://www.electrical4u.com/losses-in-dc-machine

II-Year-I Semester
PC2102

Electrical Circuit Analysis

L	T	P	C
3	1	0	3

Prerequisites: Basic Circuit Analysis,
Integrations,
Laplace transforms and
Differential equations

Course Objectives: The student should be able to

1. To study the concepts of balanced and unbalanced three-phase systems.
2. To study the transient behaviour of electrical circuits with DC excitation
3. To study the transient behaviour of electrical circuits with AC excitation.
4. To study the analysis of two port network.
5. To understand the concept of Network synthesis.

Unit-1Three Phase Systems(10hrs)
Types of three phase systems - Phase sequence- relation between line and phase voltages and currents - analysis of balanced three phase systems - Analysis of three phase unbalanced systems: Loop method – Milliman’s method

Unit-2 Analysis in DC circuits(11hrs)
Transient response of R-L, R-C, R-L-C circuits for DC excitation, Solution using differential equations and Laplace transforms

Unit-3 Transient Analysis in AC circuits(11hrs)
Transient response of R-L, R-C, R-L-C circuits for pulse and AC excitations, Solution using differential equations and Laplace transforms.

Unit-4 Two port Networks(10hrs)
Two port network parameters – Z, Y, ABCD and Hybrid parameters and their relations, Cascaded networks

Unit-5 Network Synthesis(10hrs)
Positive real function - basic synthesis procedure - LC immittance functions - RC impedance functions and RL admittance function - RL impedance function and RC admittance function - Foster and Cauer methods

Course Outcomes

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

CO1 Various three phase balanced and unbalanced systems **{Apply level, KL3}**

CO2 Transient response of electrical networks for DC excitation. **{Apply level, KL3&Analyse level, KL4}**

CO3 Transient response of electrical networks for AC excitations**{Apply level, KL3&Analyse level, KL4}**

CO4 Two port network parameters **{Apply level, KL3}**

CO5 Equivalent electrical network for a given transfer function. **{Apply level, KL3}**

Text books:

1. Circuits & Networks Analysis & Synthesis by A. Sudhakar and Shyammohan S Palli, Tata McGraw- Hill.
2. Circuit Theory by A.ChakrabartiDanapat Rai & Co publisher.

Reference books

1. Fundamentals of Electric Circuits” Charles K.Alexander, Mathew N.O.Sadiku, Tata McGraw-Hill.
2. Engineering Circuit Analysis by William Hayt and Jack E.Kemmerley,Mc Graw Hill Company,6th edition
3. Network synthesis: Van Valkenburg; Prentice-Hall of India Private Ltd
4. 3000 Solved Problems in Electrical Circuit by Schaum’s solved problem series Tata McGraw- Hill.
5. Network Analysis by N.C.Jagan, C.Lakshmi Narayana BS publications 2nd edition

e- Resources & other digital material

1. https://www.youtube.com/watch?v=MHwM1C1zUz4
2. https://www.youtube.com/watch?v=xaeob9lTXS0
3. https://www.youtube.com/watch?v=GasWAlIvvD8&list=PL16EE39765482C57F
4. https://www.youtube.com/watch?v=2D_eGLGcUXQ&list=PL16EE39765482C57F&index=5
5. https://www.youtube.com/watch?v=UltkCsoh6Bw&list=PL16EE39765482C57F&index=7

II-Year-I Semester
PC2102

Electromagnetic Fields

L	T	P	C
3	1	0	3

PRE-REQUISITES: Co-Ordinate systems, Differential equations, Integration, vector algebra

Course Objectives: The student should be able to

1. Study the electric field and potentials due to different configurations of static charge and Maxwell's first equation
2. Study the behavior of conductors and dielectrics, evaluation of capacitance for different configurations.
3. Study the Biot Savart's Law, Ampere Circuital Law and applications
4. Study the Lorentz force equation
5. Understand the concept inductance and time varying fields

Unit-1: Electrostatic Fields (16 hrs)

Coulomb's Law, Electric Field Intensity (EFI),EFI due to a line, surface and volume charge, Work done in moving a point charge in an electrostatic field, Electric Potential, Properties of potential function, Potential gradient, Gauss's law, Application of Gauss's Law, Maxwell's first law, Laplace's and Poison's equations, Solution of Laplace's equation in one variable.

Unit-2: Dielectrics and Capacitance (12 hrs)

Electric dipole, Dipole moment, Potential and EFI due to an electric dipole, Torque on an Electric dipole in an electric field, Behavior of conductors in an electric field, Electric field inside a dielectric material, Polarization, Dielectric – Conductor and Dielectric – Dielectric boundary conditions, Capacitance, Capacitance of parallel plate and spherical and co-axial capacitors with composite dielectrics, Energy stored and energy density in a static electric field, Current density, Conduction and Convection current densities, Ohm's law in point form – Equation of continuity.

Unit-3: Static magnetic fields (12 hrs)

Biot-Savart's law, Magnetic field intensity (MFI), MFI due to a straight current carrying filament, MFI due to circular, rectangular, square and solenoid current Carrying wire, Maxwell's second Equation, Ampere's circuital law and its applications, MFI due to an infinite sheet of current and a long current carrying filament, Differential form of Ampere's circuital law (Maxwell's third equation).

Unit-4: Force in Magnetic fields (12 hrs)

Magnetic force on Moving charges in a Magnetic field, Lorentz force equation, Force on a current element in a magnetic field, Force on a straight and a long current carrying conductor in a magnetic field, Force between two straight long and parallel current carrying conductors, Magnetic dipole and dipole moment, A differential current loop as a magnetic dipole, Torque on a current loop placed in a magnetic field.

Unit-5: Electromagnetic Induction(12 hrs)

Inductance: Self and Mutual inductance, Determination of self-inductance of a solenoid and toroid, Mutual inductance between a straight long wire and a square loop wire in the same plane, Energy stored and density in a magnetic field.

Time varying fields: Faraday's laws of electromagnetic induction, Integral and point forms, Maxwell's fourth equation, statically and dynamically induced EMFs, Modification of Maxwell's equations for time varying fields, Displacement current, Poynting theorem and Poynting vector.

Course Outcomes

Upon successful completion of the course

CO1 The student will be able to calculate the electric field and potentials using Gauss's law and Laplace equation **(Remember, Understand, and Apply)**

CO2 The student will be able to evaluate capacitance for different configurations **(Understand, Apply, Analyze and valuate)**

CO3 The student will be able to find magnetic field intensity of different configurations using Biot-Savart's law and Ampere's law (**Apply, Analyze, valuate, and create)**

CO4 The student will be able to calculate magnetic forces and torque produced by currents in magnetic fields **(Understand, Apply, and Analyze)**

CO5 The student will be able to quantify inductance and evaluation of induced EMF in time varying fields **(Apply, Analyze and create)**

Text books:

1. "Elements of Electro Magnetics" by Matthew N.O.Sadiku, 7th edition, Oxford Publications
2. "Engineering Electro Magnetics" by William H. Hayt& John. A. Buck, 7th Editon Mc. Graw-Hill Companies,.2006.

Reference books:

1. "Electro Magnetic Fields" by Dr.Y.Mallikarjuna Reddy, 2nd edition , Universities Press.
2. "Introduction to Electro Dynamics" by D J Griffiths, 2nd edition, PHI Pvt. Ltd.
3. "Electro Magnetics" by J. D Kraus , 4th edition ,Mc Graw-Hill Inc. 1992.
4. "Electro Magnetic Theory" by U.A. Bakshi and A.V.Bakshi, Technical Publications

e- Resources & other digital material

1. https://www.sciencedirect.com/topics/medicine-and-dentistry/electromagnetic-field
2. https://phys.libretexts.org/
3. https://nptel.ac.in/courses/108/106/108106073/
4. https://nptel.ac.in/courses/117/103/117103065/
5. https://nptel.ac.in/courses/108/104/108104087/
6. https://nptel.ac.in/courses/115/101/115101005/

II-Year-I Semester
PC2101L

ELECTRICAL MACHINES-1 LAB

L	T	P	C
0	0	3	1.5

PRE-REQUISITES: 1) Electrical Machines-1 Theory

Preamble: Electrical Machines-1 Lab provides the essential facilities to the students to augment their concepts about the fundamentals of rotating machines and Transformers. The lab is equipped with DC Shunt, Series, Compound machines**,** Single phase and three phase Transformers. The lab covers the determination of characteristics, speed control methods of DC rotating machines. Performance calculations of dc rotating machines and Static device.

Course Objectives: The student should be able to

1. To plot the magnetizing characteristics and understand the load characteristics of DC shunt generator.
2. Learn the methods of speed control of DC shunt motors.
3. To determine the performance of DC machines by direct and indirect loading methods.
4. To predetermine the efficiency and regulation of single-phase transformer and assess their performance.
5. To study the conversion of three phase to two-phase by Scott connection.

LIST OF EXPERIMENTS

Any Ten of the following experiments are to be conducted:

1. Magnetization characteristics of DC shunt generator-critical Resistance and critical speed.
2. Load test on DC shunt generator. Determination of characteristics.
3. Load test on DC Compound generator. Determination of characteristics.
4. Brake test on DC Shunt motor. Determination of performance characteristics.
5. Separation of losses in DC Shunt Motor.
6. Hopkinson’s test on DC shunt machines (Predetermination of efficiency).
7. Swinburne’s test on DC shunt motor.
8. Speed control of DC shunt motor.
9. OC& SC test on single phase transformer.
10. Sumpner’s test on single phase transformers.
11. Scott connection of transformers
12. Separation of core losses of a single-phase transformer.

List of Additional Experiments: Any of the two experiments are to be conducted

13. Load test on DC shunt generator. Determination of characteristics.
14. Field test on DC series machines. Determination of efficiency.
15. Brake test on DC compound motor. Determination of performance characteristics.

Course Outcomes: Upon successful completion of the course, the student will be able to

Course Outcomes

CO1 Analyze the characteristics and performance of DC generator. (**Analyze**)

CO2 Analyze the speed control and testing methods of DC motors. (**Analyze**)

CO3 Determine the performance of DC machines by direct and indirect loading methods. (**Remember and Understand**).

CO4 Perform various types of tests on transformers for assessing losses. (**Evaluate**)

CO5 Three-phase to two phase transformation. (**Understand, Apply and Analyze**)

Text books:

1. Theory & Performance of Electrical Machines by J.B.Guptha. S.K.Kataria& Sons.
2. Electrical Machines – P.S. Bhimbra, Khanna Publishers.

Reference books:

1. Electrical Machines by D. P.Kothari, I .J .Nagarth, Mc Graw Hill Publications, 4th edition.
2. Electrical Machinery by AbijithChakrabarthi and Sudhipta Debnath, Mc Graw Hill education 2015.
3. Electrical Machinery Fundamentals by Stephen J Chapman McGraw Hill education 2010.
4. Electric Machinery by A.E. Fitzgerald, Charles kingsley, Stephen D.Umans, TMH.

e- Resources & other digital material

1.https://nptel.ac.in/courses/108/105/108105017

2.https://nptel.ac.in/courses/103/102/108102146

3.www.nptelvideos.in/2012/11/electrical-machines-i.html

4. https://www.electrical4u.com/losses-in-dc-machine

II-Year-I Semester **PC2102L**

ELECTRICAL CIRCUIT ANALYSIS LAB

L	T	P	C
0	0	3	1.5

Course Objectives:

1. Familiarity with DC and AC circuit analysis techniques.
2. Analyze complicated circuits using different network theorems.
3. Analyse the resonance condition of ac circuits
4. Determine the self and mutual inductance of coupled coils.
5. Acquire skills of using MATLAB software for electrical circuit studies.

LIST OF EXPERIMENTS

1. Verification of Thevenin’s and Norton’s theorem
2. Verification of maximum power transfer theorem
3. Verification of super position theorem
4. Verification of compensation theorem
5. Verification of Milliman’s theorem using hard ware
6. Verification of series resonance of Ac circuit
7. Verification of Kirchhoff’s current law and voltage law using Matlab Simulink.
8. Verification of mesh analysis using Matlab Simulink.
9. Verification of nodal analysis using Matlab Simulink.
10. Determination of average value, rms value, form factor, peak factor of sinusoidal wave, square wave using Matlab Simulink.
11. Verification of parallel resonance of Ac circuit using Matlab Simulink
12. Verification of self inductanceand mutual inductance using Matlab Simulink
13. Determination of Choke coil parameters
14. Determination of Z and Y Parameters of a network
15. Determination of Transmission and hybrid parameters of a network

Course Outcomes:

Upon the completion of Electrical Circuit and simulation practical course, the student will be able to attain the Following:

1. Familiarity with DC and AC circuit analysis techniques.
2. Analyze complicated circuits using different network theorems.
3. Analyse the resonance condition of ac circuits
4. Determine the self and mutual inductance of coupled coils.
5. Acquire skills of using MATLAB software for electrical circuit studies.

Text Books:

1. Fundamentals of Electric Circuits by CHARLES K.ALEXANDER, Matthew N.O.SADIKU
2. Engineering Circuit Analysis by William H. Hayt and E.Kemmerly

Reference books:

1.Circuit Theory by CHAKRABARTI
2. Network Analysis by M.E.VanValkenburg

II-Year-I Semester **SOC2101**

FUNDAMENTALS OF INTERNET OF THINGS

L	T	P	C
1	0	2	2

PRE-REQUISITES: 1) Basic programming knowledge

Preamble: The Internet of Things (IoT) is a course about the new paradigm of objects interacting with people, with information systems, and with other objects. The course will focus on creative thinking and on hands-on project development.

Course objectives: The main objectives are

1. Describe what IoT is and how it works today as well as recognise the factors that contributed to the emergence of IoT.
2. To give a fundamental knowledge on the basic phenomena on which operation of sensor transformation of energy is based.
3. Design an IoT platforms design methodology.
4. To train the students to build IoT systems using Raspberry pi for IoT platforms.
5. To train the students to build IoT systems using Arduino for IoT platforms.

Unit-1 Introduction to IoT (12 hrs)

Definition and characteristics of IoT, Physical Design and Logical Design of IoT, IoT Architecture and Protocols. IoT Enabling Technologies, IoT levels. (Basic concepts only). Difference between IoTand M2M.

Unit-2 Sensors and actuators:(11 hrs)

Definition of sensor, Classifications of sensors and actuators, Principle of sensors, Selection of sensors, Generation of sensors.

Unit-3 IoT Platforms Design Methodology (10 hrs)

Introduction, Step by step procedure of IoT Design Methodology, Challenges in IoT Design, IoT System Management.

Unit-4 Interfacing with Arduino (13 hrs)

Introduction, Types of Arduinos, Arduino IDE, Basic Commands for Arduino, Interfacing Arduino with LED, Interfacing Arduino with LCD. Controlling Arduino with python.

Unit-5 Interfacing with Raspberry Pi (10 hrs)

Basic building blocks of an IoT device, Introduction to Raspberry Pi, hardware & software requirements for Raspberry Pi, Raspberry interfaces, Programming Raspberry Pi with python-Controlling LED with Raspberry Pi - Interfacing an LED and switch with Raspberry Pi-Interfacing a Light Sensor (LDR) with Raspberry Pi- Interfacing of a DC motor with Raspberry Pi.

Course Outcomes

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

CO1 Explain the emergence and challenges in IoT. **{Explain level, KL2}**

CO2 Understand the importance of sensors and actuators. **{understand level, KL3}**

CO3 Understand the design methodologies and application areas of IoT.**{ Evaluate level, KL4}**

CO4 Design and develop programs in Raspberry Pi for sensor applications. **{Analyze level, KL4}**

CO5 Interface and deploy sensors with Arduino **{ Evaluate level, KL5}**

Text books:

1. "Internet of Things A Hands-On- Approach", VijayMadisetti, Arshdeep Bahga1st edition, University press, 2014.
2. "Internet of things with Raspberry Pi and arduino" Rajesh Singh, Anita Gehlot, Lovi Raj Gupta,Bhupendra Singh, and Mahendra Swain, 1st edition, CRC Press, 2020.

Reference books:

1. "Internet of Things A to Z: Technologies and Applications" Qusay F. Hassan,1st edition, Wiley Publishers, 2018.
2. "Introduction to IoT" Sudip Misra, Anandarup Mukherjee, Arijit Roy, 1st edition, Cambridge University Press, 2021.

e- Resources & other digital material

1. https://nptel.ac.in/courses/106/105/106105166/
2. https://nptel.ac.in/courses/108/108/108108098/
3. https://www.classcentral.com/course/iot-4338
4. https://www.coursera.org/learn/interface-with-arduino?specialization=iot

II-Year-I Semester SOC2101	INDUSTRIAL SAFETY ,CODES AND STANDARDS	L	T	P	C
		1	0	2	2

PRE-REQUISITES:

Course objectives: The student should be able to

1. Study the concept and importance of safety in industries.
2. Study the basic hazards in chemical industry and their control methods.
3. Study the various hazards in engineering industry and their safety methods.
4. Know the major electrical hazards and their safety control schemes.
5. Study the causes of fire accidents and their controlling schemes and also know the importance of machine guarding

Unit-1 Introduction to safety (08 hrs)

The Concept of Safety, Derivation of the Concept of Safety, Nature of the Concept of Safety, Philosophy of Safety, Safety Terminology, Basic safety requirements, Message of the work “SAFETY, Safety Psychology, Need of Safety Psychology, Behaviour Based Safety (BBS).

Unit-2 Safety in Chemical Industry(10 hrs)

Need of Safety in Chemical Industry, Types of Chemical Industry ,Statutory Provisions & Indian Standards, Types of Chemical Hazards & Controls,Material (Property) Hazards and Controls,Storage &, ProcessHazards & their Controls, Utility& Pollution Hazards & Controls.

Instrumentation for Safe Plant Operations, Safe Transfer of Chemicals, Safe Transportation of Chemicals, Indian Standards & National Building Code for industries.

Unit-3 Safety in Engineering Industry(9hrs)

Need of Safety in Engineering Industry , Indian Standards ,Introduction to Hot & Cold Processes, Hot Working of Metals, Safety in Other Operations, Heat Treatment Operations, General Health Hazards & Control Measures in Engineering Industry, Safety in Use of Machine Tools, Selection and Care of Cutting Tools, Safe Operations &Maintenance of Machines, safety in other operation like welding &fire. Heat Treatment operations, GeneralHealth Hazards & Control Measures in Engineering Industry.

Unit-4 Electrical Safety(8 hrs)

Electricity, its Usefulness and Hazards, Statutory Provisions & Indian Standards, Effects of Electrical Parameters on Human Body ,Safety Measures for Electric work , Different types of Protections , Portable Electrical Apparatus, Earthing standards ,Electric Work in Hazardous Atmosphere , Static Electricity ,Energy Conservation and Safety.

Unit-5 Fire Hazards &Machine Guarding (09 hrs)

Fire Hazards: Fire Phenomena, Classification of Fire and Extinguishers, Statutory and other standards, Design for Fire Safety, Fire Prevention and Protection System.**(06 hrs)**

Machine Guarding: Requirements of Machine Guarding ,Indian Standards , Principles of Machine Guarding ,Types and Selection of Guards ,Materials for Guard Construction**(03 hrs)**

Content Beyond the syllabus:

Accident Causation and Prevention: Causation or Occurrence, Reasons for Accident Prevention, Factors Impeding Safety, Basic Terms in Accident Prevention.

Safety Management: The Concept of Management, Management Principles, Safety Management and its Responsibilities, Safety environment.
Chemical industry: Inspection, Testing &Maintenance, Work Permits of Hazardous Work, Reports of Some Expert Committees,
Fire explosion and Guarding importance: Explosion Phenomena ,Inspection, Maintenance and Training for Fire Protection ,Ergonomics of Machine Guarding ,Maintenance and Repairs of Guards,
Personal Protective Equipment: Need and Limitation, Selection and Classification, Training, PPE Testing Procedures & Standards

Course Outcomes

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

CO1 **Understand** the Basics &importance of safety in industries.**{Understand level, KL2}**

CO2 **Explain** the hazards in chemical industry and their control methods.**{Apply level, KL3}**

CO3 **Analyze** chemical industry hazards and their control methods.**{Analyze level, KL4}**

CO4 **Evaluate the major electrical hazards and their safety schemes**. **{Evaluate level, KL5}**

CO5 **Analyze** fire safety methods and machine guarding. **{Apply level, KL4}**

Text books:

1. Dr. K U. Mistry- Fundamentals of Industrial Safety and Health, SiddharthPrakashan, Ahmadabad.
1. 2. Industrial Hazards and Safety Handbook, King and Magid, Butterworth

Reference books:

1. Fundamentals of Electrical Safety, V. Manoilov, Mir Publishers, Moscow.
2. Occupational Safety Management and Engineering, Willie Hammer, Prentice-Hall.
3. Chemical Hazards in the Workplace, Measurement & Control, Gangadhar Choudhary, American Chemical Society
4. Accident Prevention Manual for Industrial Operations, National safety Council, Chicago, Illinois.
5. The Factories Act 1948 and the Gujarat Factories Rules 1963.

II-Year-I Semester
SOC2101

DC DRIVES

L	T	P	C
1	0	2	2

PRE-REQUISITES: 1) DC Drives

Course objectives: The student should be able to

6. Study the fundamentals of Drives .
7. Study the principle and working of DC motors.
8. Studies the parameterization, Wiring and its Application .
9. Study the principle and working of DC Drives.
10. Study Features of DC Drives.

Unit-1 Basic of Power Electronic ,Concept of Drive & Expectation from Drive , Starters (6 hrs)

Basic principles of Diodes, Thyristors, IGBT, BJT, Comparison of powerelectronics, Application **(02 hrs)**

Basic fundamentals of Drives **(02 hrs)**

Basic concept, Wiring **(02 hrs)**

Unit-2 DC MOTOR (08 hrs)

Basic on DC motors-working, principle, **(02 hrs)**

types of DC motors **(02 hrs)**

Parameterization **(04 hrs)**

Unit-3 Features of SINAMIC DCM DC Drive (06 hrs)

Introduction, parameterization, Wiring, Application

Unit-4 Concept ofDC DRIVE (06hrs)

Concept of DC Drive in details **(02 hrs)**

types of dc drives **(02 hrs)**

working, principle **(02 hrs)**

Unit-5 Features of DC Drive (06 hrs)

Important features .**(02 hrs)**

Selection of DC Drive and its applications .**(02 hrs)**

Design and protection for DC Drives **(02hrs)**

Content Beyond the syllabus:

Induction motor drives: Volts/Hertz Control, Vector or Field oriented control.

Industrial application: Drive consideration for Textile mills, Steel rolling mills, Cement mills, Paper mills, Machine tools. Cranes & hoist drives.

<u>LIST OF EXPERIMENTS</u>

1. To obtain speed control of Switched Reluctance Motor using DSP controller TMS320F2812.
2. To obtain speed control of Permanent magnet synchronous Motor using SPARTAN 6 FPGA controller.

3. To obtain speed control of three phase induction motor using dsPIC controller MICRO-4011.
4. To visualize the speed and position control of servo motor by various inputs of DSP CONTROLLER kit.
5. To study the operation of speed control of dc motor fed from four quadrant chopper using FPGA controller
6. To simulate the three phase voltage source inverter with resistive load using SPWM.
7. To simulate the chopper fed dc motor (matlab)
8. To study the simulation of Z source inverter using matlab - simulink.

Course Outcomes

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

CO1 **Understand** the fundamentals of Drives .**{Understand level, KL2}**

CO2 **Explain** the principle and working of DC motors.**{Apply level, KL3}**

CO3 **Analyze** parameterization, Wiring and its Application **{Analyze level, KL4}**

CO4 **Evaluate** the working of DC Drives **{Evaluate level, KL5}**

CO5 **Analyze** the Design and protection for DCDrives.**{Apply level, KL4}**

Text books:

1. "Electric Drive: Control of DC and AC Drives" by Srinivas Vemula and Ramaiah Veerlapati.
2. VEDAM SUBRAMANIAM "Electric drives (concepts and applications)", Tata McGraw-Hill.2001.
3. "Electric motor drives", R. Krishnan, PHI.
4. "Electric Motor & Drives". Austin Hughes, Newnes.
5. "Modern Power Electronics & Ac drives", B.K. Bose, Pearson Education.

Reference books:

1. PILLAI.S.K, "A first course on Electric drives", Wiley Eastern Limited, 1998
2. M.D. SINGH, K.B.KHANCHANDANI, "Power electronics", Tata McGraw-Hill.1998

e- Resources & other digital material

1. http://www.hccl.ie/uploads/1/4/7/3/1473854/ha472742_iss4a_ac-dc_catalog.pdf
2. https://www.industrial-electronics.com/MDPTG_4.html
3. http://freetutorials.name/Reference1/Electrical_Engineering.html

II-Year-I Semester
SOC2101

PYTHON LIBRARY TOOLS

L	T	P	C
1	0	2	2

PRE-REQUISITES: Python Programming

Matplotlib is written in Python and makes use of NumPy, the numerical mathematics extension of Python. We assume that the readers of this tutorial have basic knowledge of Python.

Course objectives: The student should be able to

- Learn how to use Jupyter notebooks
- Learn how to work with NumPy data types
- Be proficient in pandas Series
- Be proficient in pandas Data Frames
- Understand how to use data visualization
- Know how to import and clean data
- Introduce statistical tools for working with data sets
- An introduction to the problems of working with PDF data sources

Unit I:NUMPY:

Introduction, Installation of numpy, Features, Uses, Ndarray object, Data types, array attributes, Array creation, indexing and slicing. Binary operations, matrix operations, numpy functions, numpy sorting and searching, Numpy copy Vs view, linear algebra, I/O with numpy.

UNIT:2 : SCIPY:

Introduction, basic functionality, cluster, constants, Fftpack, Integrate, Interpolate, I/O, linalg, Image Processing, optimizers, matlab arrays.

Unit 3: PANDAS:

Introduction, data structures, pandas- series, data frame, panel, basic functionality, Function applications. Reindexing, Iteration, sorting, indexing and satical functions, window function, cleaning data.

Unit:4 MATPOLTLIB:

Introduction , Environment Setup, Anaconda distribution, Jupyter Notebook , Pyplot API, Simple Plot , PyLab module , Object-oriented Interface , Figure Class, Axes Class , Multiplots .

Unit: 5 PLOTLY :

Introduction,EnvironmentSetup,Online and Offline Plotting ,Package Structure, Exporting to Static Images,Legends ,Format Axis and Ticks,Subplots and Inset Plots ,Bar Chart and Pie Chart .

Course Outcomes

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

CO1 **Understand** the operation Introduction, Installation of numpy **{Understand level, KL2}**

CO2 **Explain** the operation of Environment Setup, Anaconda distribution.**{Apply level, KL3}**

CO3 **Analyze**data structures, pandas- series **{Analyze level, KL4}**

CO4 **Evaluate**Environment Setup, Anaconda distribution, Jupyter Notebook in maypoltlib. **{Evaluate level, KL5}**

CO5 **Analyze**EnvironmentSetup,Online and Offline Plotting. **{Apply level, KL4}**

Text books:

The Python Language Reference Manual (version 3.2)

1. Guido van Rossum, and Fred L. Drake, Jr. (Editor),ISBN: 1906966141,Network Theory Ltd, 120 pages (Revised November 2006).

Reference books:

e- Resources & other digital material

1. https://nptel.ac.in/courses/108/102/108102047/
2. https://www.coursera.org/learn/electric-power-systems
3. https://www.classcentral.com/course/electric-power-systems-12053#
4. https://pdhonline.com/courses/e104a/e104a_new.htm
5. https://emp.lbl.gov/sites/all/files/advanced-transmission-technologies.pdf
6. https://www.hitachi.com/rev/pdf/2002/r2002_04_106.pdf
7. http://regulationbodyofknowledge.org/wp-content/uploads/2013/03/NERA_Structure.pdf

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II-Year-I Semester MC2101	ESSENCE OF INDIAN TRADITIONAL KNOWLEDGE

L	T	P	C
2	0	0	0

Pre-Requisites:

1. Basics of General Science
2. Basics of Social Studies

Course Objectives: The objectives of the course are to impart:

To facilitate the students with the concepts of Indian traditional knowledge and to make them understand the Importance of roots of knowledge system.

- The course aim of the imparting basic principle of third process reasoning and inference sustainability is at the course of Indian traditional knowledge system
- To understand the legal framework and traditional knowledge and biological diversity act 2002 and geographical indication act 2003.
- The courses focus on traditional knowledge and intellectual property mechanism of traditional knowledge and protection.
- To know the student traditional knowledge in different sector.

Unit-I: (10 hrs)

Introduction to traditional knowledge: Define traditional knowledge, nature and characteristics, scope and importance, kinds of traditional knowledge, the physical and social contexts in which traditional knowledge develop, the historical impact of social change on traditional knowledge systems. Indigenous Knowledge (IK), characteristics, traditional knowledge vis-à-vis indigenous knowledge, traditional knowledge Vs western knowledge traditional knowledge vis-à-vis formal knowledge

Unit-II: (8 hrs)

Protection of traditional knowledge: the need for protecting traditional knowledge Significance of TK Protection, value of TK in global economy, Role of Government to harness TK.

Unit-III:(8 hrs)

Legal framework and TK: A: The Scheduled Tribes and Other Traditional Forest Dwellers (Recognition of Forest Rights) Act, 2006, Plant Varieties Protection and Farmers Rights Act, 2001 (PPVFR Act);B:The Biological Diversity Act 2002 and Rules 2004, the protection of traditional knowledge bill, 2016. Geographical indications act 2003.

Unit-IV:(10 hrs)

Traditional knowledge and intellectual property: Systems of traditional knowledge protection, Legal concepts for the protection of traditional knowledge, Certain non IPR mechanisms of traditional knowledge protection, Patents and traditional knowledge, Strategies to increase protection of traditional knowledge, global legal FORA for increasing protection of Indian Traditional Knowledge.

Unit-V:(8 hrs)

Traditional knowledge in different sectors: Traditional knowledge and engineering, Traditional medicine system, TK and biotechnology, TK in agriculture, Traditional societies depend on it for their food and healthcare needs, Importance of conservation and sustainable development of environment, Management of biodiversity, Food security of the country and protection of TK.

Course Outcomes

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

CO1	Able to U**nderstand**traditional knowledge, nature and characteristics, scope and importance, kinds of traditional knowledge
CO2	Able to U**nderstand**Protection of traditional knowledge
CO3	Able to understand and apply Legal framework and Traditional Knowledge
CO4	Able to U**nderstand**Traditional knowledge and intellectual property
CO5	Able to Understand Traditional knowledge in different sectors

Text books:

1. Traditional Knowledge System in India, by Amit Jha, 2009.

Reference books

1. Traditional Knowledge System in India, by Amit Jha, 2009.
2. Traditional Knowledge System and Technology in India by Basanta Kumar Mohanta and Vipin Kumar Singh, Pratibha Prakashan 2012.
3. Traditional Knowledge System in India by Amit Jha Atlantic publishers, 2002
4. "Knowledge Traditions and Practices of India" Kapil Kapoor, Michel Danino

e- Resources & other digital material

1.http://moef.gov.in/en/resource/e-books/

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

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II-Year-II Semester BS2201	COMPLEX VARIABLES AND STATISTICAL METHODS	L	T	P	C
		3	1	0	3

Pre-Requisites:

1. Calculus
2. Partial Differentiation
3. Multiple Integrals
4. Basics of Probability

Course objectives: To learn

1. Differentiation and integration of complex functions.
2. Expansion of complex functions using Taylor's and Laurent's series and residue of complex functions.
3. The ideas of probability and random variables and various discrete and continuous probability distributions and their properties.
4. The statistical methods of studying data samples using test of hypothesis.
5. The basic ideas of statistical measures like correlation and regression.

Unit-1 Functions of complex variable and complex integration:

Introduction – Continuity – Differentiability – Analyticity – Properties – Cauchy-Riemann equations in cartesian and polar coordinates – Harmonic and conjugate harmonic functions – Milne-Thompson method. **(05hrs)**

Complex integration: Line integral – Cauchy's integral theorem – Cauchy's integral formula (all without proofs). **(05 hrs)**

Unit-2 Series expansions and Residue Theorem:

Radius of convergence –Expansion in Taylor's series, Maclaurin's series - Laurent's series.**(05 hrs)**

Types of singularities: Isolated – pole of order m – Essential – Residues – Residue theorem (without proof).**(05hrs)**

Unit-3 Probability, Distributions and Sampling Theory:

Probability-Baye'stheorem-Random variables-Discrete and Continuous random variables-Distribution function-Mathematical Expectation and Variance-

Application approach: Binomial, Poisson and Normal distributions.**(07 hrs)**

Population and samples-Sampling distribution of Means -Point and Interval estimations.

Applications: Maximum error of estimate Bayesian estimate**.(07 hrs)**

Unit-4 Test of Hypothesis:

Introduction–Hypothesis-Null and Alternative Hypothesis-Type I and Type II errors-Level of significance-One tail and two-tail tests-Tests concerning one mean and two means (Large and Small samples)-Tests on proportions.

Applications: Chi-square test and F-test on small samples. **(14 hrs)**

Unit-5 Curve fitting and Correlation:

Method of least squares-Straight line-Parabola-Exponential-Powercurves-Correlation-Correlation coefficient-Rank correlation-Regression coefficient and properties-Regression lines-Multiple regression.(**12 hrs)**

Content Beyond the Syllabus:

Unit-3: Maximum error of estimate – Bayesian estimate.

Unit-4: Chi-square test and F-test on small samples.

Unit-5: Multiple regressions.

Course Outcomes

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

CO1 **Apply** Cauchy-Riemann equations to complex function in order to determine whether a given continuous function is analytic. (L3)

CO2 **Find** the differentiation, integration of complex functions used in engineering problems and make use of Cauchy residue theorem to evaluate certain integrals. (L3)

CO3 **Apply** discrete and continuous probability distributions and **Design** the components of a classical hypothesis test. (L3 &L6)

CO4 **Infer** the statistical inferential methods (hypothesis testing) based on small and large sampling tests. (L4)

CO5 **Interpret** the association of characteristics and through correlation and regression tools. (L4)

Text books:

1. **B.S. Grewal,** Higher Engineering Mathematics, 44th Edition, Khanna Publishers.
2. **S. C. Gupta and V. K. Kapoor,** Fundamentals of Mathematical Statistics, 11/e (Reprint) 2019, Sultan Chand & Sons Publications.
3. **B.V. Ramana,** Higher Engineering Mathematics, 2007 Edition, Tata Mc. Graw Hill Education.

Reference books

1. **Miller and Freund's,**Probability and Statistics for Engineers, 7/e, Pearson, 2008.
2. **T. K. V. Iyenger**, Probability and Statistics, S. Chand & Company Ltd, 2015.
3. **Jay I. Devore,** Probability and Statistics for Engineering and the Sciences, 8th Edition, Cengage.
4. **Erwin Kreyszig,** Advanced Engineering Mathematics, 10th Edition, Wiley-India.
5. **H. K. Das,** Advanced Engineering Mathematics, 22ndEdition,S. Chand & Company Ltd.

e- Resources & other digital material

1. https://www.youtube.com/watch?v=Mwpz1zjPlzI&list=PLbMVogVj5nJS_i8vfVWJG16mPcoEKMuWT (For Complex Variables)
2. https://www.youtube.com/playlist?list=PLiUVvsKxTUr66oLF6Pzirc1EgSstMbRZR (For Complex Variables from 1-13)
3. https://www.youtube.com/watch?v=COI0BUmNHT8&list=PLyqSpQzTE6M_JcleDbrVyPnE0PixKs2JE (For Probability and Statistics)

II-Year-II Semester ES2201	THERMAL AND HYDRO PRIME MOVERS	L	T	P	C
		3	0	0	3

Prerequisites: Engineering Mathematics, Engineering Physics, Engineering Thermodynamics

Course Objectives:The student should be able to

1. Identify the unique vocabulary associated with thermodynamics through the precise definition of basic concepts and also apply the laws of thermodynamics to cycles, cyclic devices.
2. Familiarize with the various I.C.Engine systems along with their function and necessity, also performance analysis of I.C. Engines and Gas turbine Power plants.
3. Provide the basic knowledge of components being used in steam power plant cycles and to analyze the energy transfers and transformations in steam turbine.
4. Describe briefly the concepts of different fluid properties, present numerous examples related to variation of pressure in a fluid and measurement of pressure and flow rate.
5. Illustrate briefly impact of jets, hydraulic pumps and also evaluate the performance of hydraulic turbines.

Unit-1 BASIC CONCEPTS OF THERMODYNAMICS: Thermodynamic System, Surrounding, Boundary, Universe, Control Volume, Control Surface, Classes of Systems, State, Thermodynamic Properties, Process and Cycles, Thermodynamic Equilibrium, Reversibility, Quasi static Process.

ZEROTH LAW OF THERMODYNAMICS: Equality of temperature.

FIRST OF THERMODYNAMICS: Statement, Internal energy, Flow work, The Steady Flow Process-Steady Flow Energy Equation, simple Problems.

SECOND LAW OF THERMODYNAMICS: Kelvin-Planck & Clausius Statements of Second law of Thermodynamics, Differences between reversible and Irreversible Process, Carnot Cycle and its specialties. **(13 hrs)**

Unit-2 AIR STANDARD CYCLES: Otto, Diesel and Dual cycles, its comparisons, Brayton Cycle.

I. C. ENGINES : Classification, Working principles, Valve and Port Timing Diagrams, Engine systems- fuel injection, carburetion, ignition, cooling and lubrication – Parameters of performance, Determination of Frictional Power & Indicated Power, Engine performance evaluation.

GAS TURBINES: Simple gas turbine plant, Classification, Analysis of closed and open cycle plants, Applications, Performance parameters, Basic Problems.

(13 hrs)

Unit-3 STEAM TURBINES: Working Principle, Classification, Simple Impulse Turbine, Vector diagrams of velocities, Combined Velocity diagram, Work done on the blade, Axial Thrust, Blade efficiency, stage efficiency, overall efficiency, Effect of blade friction on velocity diagram, simple problems on Impulse turbine, Compounding of Impulse Turbine, Reaction

Turbine, Velocity Diagram for Reaction Turbine, Degree of Reaction (only theory Part on reaction Turbines). **(13 hrs)**

Unit-4 FUNDAMENTALS OF FLUID MECHANICS: Definition of fluid, differences between a solid and fluid, physical properties of fluids- Density, Specific Weight, Specific gravity, viscosity, Types of Fluids and Fluid flows, Continuity and Bernoulli's equations.

MEASUREMENT OF PRESSURE AND FLOW: Pascal's law for pressure at a point, pressure variation in a fluid at rest, Absolute, gauge, Atmospheric and vacuum pressures, Simple Manometers- Piezometer, U-tube and Differential manometers, Venture meter and Orifice meter. **(13 hrs)**

Unit-5 IMPACT OF JETS: Impulse momentum equation, Impact of Jet on stationary and moving vanes (flat and curved).

HYDRAULIC TURBINES: Essential elements of a hydroelectric power plant, head and efficiencies of hydraulic turbines, Classification of turbines, Working principle, Efficiency calculation and Design principles for Pelton Wheel, Francis and for Kaplan turbines.

PUMPS: Types of pumps, main components and working principle of centrifugal and reciprocating type pumps (theory part only), Submersible pump working.

(13 hrs)

Course Outcomes

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

CO1 **Explain** the fundamental concepts of Thermodynamics and also **apply** the laws of thermodynamics to cycles, cyclic devices. **{Apply level, KL3}**

CO2 **Understand** about the working of IC engines and gas turbine plants including its performance **evaluation.** **{Apply level, KL3}**

CO3 **Analyze** the energy transfers and transformations while steam is flowing through the blades of steam turbine. **{Analyze level, KL4}**

CO4 **Understand** about fluid properties and also **apply** the Bernoulli's theorem for flowing fluids. **{Apply level, KL3}**

CO5 **Compute** the performance of hydraulic turbines and also **understand** working of the hydraulic pumps. **{Apply level, KL3}**

Text books:

1. Thermal Engineering by Mahesh Rathore, McGraw- Hill,2010.

2. Hydraulics and Fluid mechanics including Hydraulic machinery by MODI and SETH, Standard Book House Publications,2019.

Reference books

1. I.C. Engines by V. Ganesan, McGraw- Hill,4th edition.

2. Thermal Engineering by RK Rajput, Lakshmi Publications,2010.

3. Fluid Mechanics and Hydraulic Machines by R.K.Rajput, Lakshmi Publications, Sixth Edition

4. "Fluid Mechanics" by Victor. L. Streeter &E.Benjamin Wylie, McGraw- Hill, Indian edition.

II-Year-II Semester
PC2201

POWER SYSTEMS-1

L	T	P	C
3	0	0	3

PRE-REQUISITES: 1) Basic Circuit Analysis

Course objectives: The student should be able to

1. study the principle of operation of hydro and thermal power stations.
2. study the principle of operation of nuclear, gas, diesel power stations and non-conventional energy sources.
3. compute transmission line parameters and understand the concepts of GMD/GMR.
4. know the working of substation equipment and to calculate voltage and power loss in distribution systems.
5. study different types of load curves and tariffs applicable to consumers.

Unit-1 Hydel and Thermal Power Plants

Hydro Electric Power Station: Principle of operation, Schematic arrangement & its components, Selection of site, Advantages and Disadvantages. **(05 hrs)**

Thermal Power Station (Steam): Principle of operation, Schematic arrangement & its components, Selection of site, Efficiency, Advantages and Disadvantages. **(06 hrs)**

Unit-2 Nuclear, Gas, Diesel Power Plants and Non-conventional Energy Sources

Nuclear Power Station: Principle of operation, Schematic arrangement & its components, Selection of site, working of BWR, PWR, FBR. **(07 hrs)**

Gas and Diesel Power Stations: Principle of operation and Equipment (Block diagram approach only). **(02 hrs)**

Non-conventional Energy Sources: Working principle of solar, wind, geo thermal and tidal power stations (Elementary treatment only). **(04 hrs)**

Unit-3 Transmission Line Parameters

Types of conductors, calculation of resistance, inductance and capacitance of single phase and three phase lines with symmetrical and unsymmetrical spacing, transposition, bundled conductors, concept of GMD and GMR, effect of earth on capacitance, skin and proximity effects, Numerical Problems. **(12 hrs)**

Unit-4 Substations and Distribution Systems

Substations: Classification, Equipment and its location, Layout of 33/11 kV substation. **(06 hrs)**

Distribution Systems: Classification, Design features, Voltage drop and power loss calculations, Comparison between DC and AC distribution systems, Numerical Problems. **(06 hrs)**

Unit-5 Economics aspects of Power Generation and Tariff

Economic aspects of Power Generation: Loadcurve, load duration, integrated load duration curves and mass curve, connected load, maximum demand, demand factor, load factor, diversity factor, plant capacity factor, plant use factor, utilization factor, base and peak load plants, Numerical problems. **(06 hrs)**

Tariff: Costs of generation and its division, objectives, characteristics, classification, Numerical problems. **(06 hrs)**

Course Outcomes

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

CO1 **Understand** the working of hydro and thermal power plants**{Understand level, KL2}**

CO2 **Explain** the working of nuclear, gas, diesel power plants and non-conventional energy sources.**{Apply level, KL3}**

CO3 **Analyze** transmission lines parameters **{Analyze level, KL4}**

CO4 **Evaluate** the performance of AC and DC distribution systems. **{Evaluate level, KL5}**

CO5 **Analyze** the different load curves and tariff methods. **{Apply level, KL4}**

Text books:

1. A text book on Power System Engineering by M.L. Soni, P.V.Gupta, U.S. Bhatnagar and A. Chakrabarti, Dhanpat Rai & Co Pvt. Ltd.
2. Generation, Distribution and Utilization of Electric Energy by C.L.Wadhawa, New Age International Private Limited.

Reference books

1. Electrical power systems by C.L.Wadhwa, New Age International (P) Ltd, Publishers, 1998.
2. Electrical Power Distribution Systems by V. Kamaraju, TMH.
3. Elements of Electrical Power Station Design by M.V. Deshpande, PHI.
4. Modern Power System Analysis by I.J.Nagarath and D.P.Kothari, Tata McGraw Hill, 2ndEdition

e- Resources & other digital material

1. https://nptel.ac.in/courses/108/102/108102047/
2. https://www.coursera.org/learn/electric-power-systems
3. https://www.classcentral.com/course/electric-power-systems-12053#
4. https://pdhonline.com/courses/e104a/e104a_new.htm
5. https://emp.lbl.gov/sites/all/files/advanced-transmission-technologies.pdf
6. https://www.hitachi.com/rev/pdf/2002/r2002_04_106.pdf
7. http://regulationbodyofknowledge.org/wp-content/uploads/2013/03/NERA_Electricity_Tariff_Structure.pdf

II-Year-II Semester
PC2202

ELECTRICAL MACHINES-II

L	T	P	C
3	1	0	3

PRE-REQUISITES: 1) Electrical Machines-I

Course objectives: The student should be able to

1. Understand the principle of operation and performance of 3-phase induction motor.
2. Quantify the starting and speed control of induction motor.
3. Study the mechanism of torque producing and starting methods of a single-phase Induction Motor.
4. Understand the Principle, Voltage Regulation and Parallel operation of synchronous generator.
5. Understand the operation, performance and starting methods of synchronous motor.

Unit-1 3-phase Induction Motors (14 hrs)

Constructional details of cage and wound rotor machines- production of rotating magnetic field - principle of operation -rotor EMF and rotor frequency - rotor current and pf at standstill and during running conditions - rotor power input, rotor copper loss and mechanical power developed and their interrelationship – equivalent circuit – phasor diagram- Numerical Problems.

Unit-2 Characteristics of Induction Motors (06 hrs)

Torque equation -expressions for maximum torque and starting torque - torque slip characteristics - crawling and cogging.

Starting and testing methods of Induction Motors(08 hrs)

No load and blocked rotor tests - circle diagram for predetermination of performance–Numerical Problems-Methods of starting (Auto-Transformer and DOL Starters)-Speed control using V/f method.

Unit-3 Single Phase Motors (08 hrs)

Single phase induction motors– Constructional features-Problem of starting–Double revolving field theory–Equivalent circuit.

Starting methods of single phase Induction motor – shaded pole motors-A.C Series Motor.

Unit-4 Synchronous generator (10 hrs)

Constructional features of non–salient and salient pole type–E.M.F equation—Voltage regulation by synchronous impedance method(EMF)– MMF method and Potier triangle method–phasor diagrams– Two reaction analysis of salient pole machines and phasor diagram.

Parallel operation of synchronous Generators (07 hrs)

Parallel operation with infinite bus and other alternators-Synchronizing power– Load sharing-Numerical problems.

Unit-5 Synchronous motor operation, starting and performance (10 hrs)

Principle operation– Phasor diagram –Variation of current and power factor with excitation – Methods of starting –Hunting and its suppression methods-Synchronous condenser-Applications-Numerical problems.

Course Outcomes

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

CO1 **Explain** the operation and performance of three phase induction motor. **{Knowledge level, KL1}**

CO2 **Analyse**the torque-speed relation, starting and speed control of induction motor. **{ Analyze level, KL4}**

CO3 **Describe** the torque production and starting methods of single-Phase induction motor. **{Knowledge level, KL1}**

CO4 **Empathise**the Principle, Voltage Regulation and Parallel operation of synchronous generator. **{Understand level, KL2}**

CO5 **Realize** the operation, performance and starting methods of synchronous motor. **{ Analyze level, KL4}**

Text books:

1. Theory & Performance of Electrical Machines by J.B.Guptha. S.K.Kataria& Sons.
2. Electrical Machines – P.S. Bhimbra, Khanna Publishers.

Reference books:

1. Electrical Machines by D. P.Kothari, I .J .Nagarth, Mc Graw Hill Publications, 4th edition.
2. Electrical Machinery by AbijithChakrabarthi and Sudhipta Debnath, Mc Graw Hill education 2015.
3. Electrical Machinery Fundamentals by Stephen J Chapman McGraw Hill education 2010.
4. Electric Machinery by A.E. Fitzgerald, Charles kingsley, Stephen D.Umans, TMH.

e- Resources & other digital material

5. https://nptel.ac.in/courses/108/106/108106072/
6. https://nptel.ac.in/courses/108/105/108105131/
7. www.nptelvideos.in/2012/11/electrical-machines-ii.html
8. https://nptel.ac.in/courses/108/106/108106023/

II-Year-II Semester
PC2203

CONTROL SYSTEMS

L	T	P	C
3	1	0	3

PRE-REQUISITES: LaplaceTransforms,Differentialequations,MatrixAlgebra, BasicCircuitAnalysis.

Course Objectives: The student should be able to

1. To learn the mathematical modelling of electrical and mechanical systems
2. To analyze the time response of first and second order systems
3. To investigate the stability using Routh's stability criterion and Root locus
4. To investigate the stability using Bode plot and Nyquist plot
5. To formulate the state models and the concepts of Controllability and Observability

Unit-1 Mathematical Modelling of Control Systems (12 hrs)

Introduction tocontrol systems, Classifications - Open Loop and closed loop,transferfunction,MathematicalModelling ofelectricalnetworks,TranslationalandRotationalsystems,analogoussystems,Transfer Function of DC & AC Servo motor- Synchros, Blockdiagramalgebra–Signalflowgraph-Mason'sgainformula

Unit-2 TimeResponseAnalysis (12 hrs)

Standardtestsignals-Timeresponseoffirstandsecondordersystems-Timedomainspecifications - Steady state errors and error constants – EffectsofFeedback-DominantClosedlooppoles- P-PD-PI-PID controllers.

Unit-3 StabilityandRootlocusTechnique:(13 hrs)

The concept ofstability -Routh'sstabilitycriterionProcedureandproblems–limitationsofRouth'sstability–Rootlocusconcept-construction of root loci –Effect of Adding open loop poles andZerosonRootLoci

Unit-4 Frequency Response Analysis (16 hrs)

Introduction - Frequency domain specifications- Bode diagrams- transfer function from theBodeDiagram-PolarPlots,NyquistStabilitycriterion-relativestabilityanalysis-PhasemarginandGainmargin-CharacteristicsofLag,LeadandLag-Leadcompensators.

Unit-5 State Space Analysis (12 hrs)

Concepts of state, state variables, stateequationandstatemodel,statespacemodelingofcontrolsystems,Solutionofthestate equation-StateTransitionMatrixanditsProperties-Transferfunctionfromstatemodel.

Content Beyond the syllabus:

- The principle of argument which is useful for applications where we want to know the location of zeros and poles.
- Design procedure of Lead and Lag compensator

- MATLAB for control systems: Time domain analysis, stability analysis and state space analysis

Course Outcomes

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

CO1 Derivethetransferfunctionusingblockdiagramalgebraandsignalflowgraph **(Remember, Understand, and Apply)**

CO2 DeterminetimeresponsespecificationsofsecondordersystemsandErrorconstants **(Understand, Apply and Analyze)**

CO3 AnalyzestabilityusingRouth'sstabilitycriterionandtherootlocusmethod (**Apply, Analyze)**

CO4 AnalyzethestabilityusingBodeplotandNyquistcriterion **(Understand, Apply, and Analyze)**

CO5 Obtain the state models and understanding the concepts of controllability and observability **(Understand, Apply)**

Text books:

1. "Control Systems Engineering" by I.J.Nagarath and M.Gopal, 5thEdition , New ageInternationalPublications.
2. "Automatic control systems" by Benjamin C.Kuo, 2ndEdition, Prentice HallofIndia.

Reference books:

1. "ControlSystemsprinciplesanddesign" by M.Gopal,4thEdition , TataMcGrawHilleducationPvtLtd.
2. "ModernControlEngineering" byKotsuhikoOgata,PrenticeHallofIndia.
3. "ControlSystems" byManikDhaneshN,Cengage publications.
4. "ControlSystemsEngineering" byS.Palani,TataMcGrawHillPublications.

e- Resources & other digital material

1. https://nptel.ac.in/noc/courses/noc20/SEM2/noc20-ee84/
2. https://nptel.ac.in/noc/courses/noc18/SEM2/noc18-ee25/
3. https://nptel.ac.in/noc/courses/noc19/SEM2/noc19-ee45/

II-Year-II Semester **ES2201L**

THERMAL AND HYDRO PRIME MOVERS LAB

L	T	P	C
0	0	3	1.5

Prerequisite: -Nil-

COURSE OBJECTIVE: To impart practical knowledge on the performance evaluation methods of various internal combustion engines, flow measuring equipment and hydraulic turbines and pumps.

Note: To Conduct A Minimum Of 10 Experiments By Conducting A Minimum Of Five From Each Section.

LIST OF EXPERIMENTS:

SECTION A - THERMAL ENGINEERING LAB

1. I.C. Engines valve / port timing diagrams.
2. I.C. Engines performance test on 4 -stroke Diesel engine.
3. I.C. Engines performance test on 2-stroke petrol engine.
4. Evaluation of engine friction by conducting Morse test on 4-stroke multi cylinder petrol engine
5. Determination of FHP by retardation and motoring test on IC engine.
6. I.C. Engines heat balance on petrol / Diesel engines.
7. Study of boilers.

SECTION B – HYDRAULIC MACHINES LAB

1. Calibration of Venturimeter.
2. Calibration of Orifice meter.
3. Impact of jets on Vanes.
4. Performance Test on Pelton Wheel.
5. Performance Test on Francis Turbine.
6. Performance Test on Centrifugal Pump.
7. Performance Test on Reciprocating Pump.

COURSE OUTCOMES: After completion of the course , students are able to:

CO1:Compute the performance of the IC Engines for a given conditions and also draw the valve and port timing diagrams. **(Apply Level)**

CO2:Determine the frictional power by using the Morse test, retardation test and motoring test. **(Apply Level)**

CO3: Calibrate discharge measuring devices and **finding** discharge through the venture meter and the orifice meter. **(Apply Level)**

CO4:Analyze the performance of hydraulic machines. **(Analyze Level)**

II-Year-II Semester
PC2202L

ELECTRICAL MACHINES-II LAB

L	T	P	C
0	0	3	1.5

PRE-REQUISITES: 1) Electrical Machines-1 Theory

Preamble: Electrical Machines-II Lab provides the essential facilities to the students to augment their concepts about the fundamentals of rotating Asynchronous and Synchronous machines. The lab is equipped with three phase induction motors, synchronous generators, synchronous motorandSingle-phase induction motor. The lab covers the determination of performance characteristics, speed control method of induction motor, voltage regulation of synchronous generator and v and inverted v curves of synchronous motor.

Course Objectives: The student should be able to

1. To control the speed of three phase induction motors.
2. To determine /predetermine the performance of three phase induction.
3. To determine /predetermine the performance of single phase induction.
4. To improve the power factor of single phase induction motor.
5. To predetermine the regulation of three–phase alternator by various methods, find Xd/ Xq ratio of alternator and asses the performance of three–phase synchronous motor.

LIST OF EXPERIMENTS: Any Ten of the following experiments are to be conducted:

1. Brake test on three phase Slip ring Induction Motor
2. No–load & Blocked rotor tests on three phase Slip ring Induction motor
3. Load test on single phase induction motor.
4. Equivalent circuit of single phase induction motor
5. Regulation of a three –phase alternator by synchronous impedance method
6. Regulation of a three –phase alternator by M.M.F method
7. Regulation of three–phase alternator by Potier triangle method
8. Determination of Xd and Xq of a salient pole synchronous machine
9. V and Inverted V curves of a three—phase synchronous motor.
10. Determination of efficiency of three phase alternator by loading with three phase induction motor.
11. Determination of sub transient direct axis (Xd'') and quadrature axis (Xq") synchronous reactance of an alternator.
12. To perform parallel operation of two alternators.

List of Additional Experiments: Any of the two experiments are to be conducted

16. Brake test on three phase Squirrel cage Induction Motor.
17. Determination of the symmetrical impedances of a synchronous machine.
18. Speed control of induction motor by V/f method.

Course Outcomes: Upon successful completion of the course, the student will be able to

Course Outcomes

CO1 Able to assess the performance of three phase induction motor. (**Analyze**)

CO2 Able to control the speed of three phase induction motor. (**Remember and Understand**)

CO3 Able to assess the performance of single phase induction motor. (**Analyze**)

CO4 Able to predetermine the regulation of three–phase alternator by various methods. (**Evaluate**)

CO5 Able to find the Xd / Xq ratio of alternator and asses the performance of three–phase synchronous motor. (**Understand, Apply and Analyze**).

Text books:

1. Theory & Performance of Electrical Machines by J.B.Guptha. S.K.Kataria& Sons.
2. Electrical Machines – P.S. Bhimbra, Khanna Publishers.

Reference books:

1. Electrical Machines by D. P.Kothari, I .J .Nagarth, Mc Graw Hill Publications, 4th edition.
2. Electrical Machinery by AbijithChakrabarthi and Sudhipta Debnath, Mc Graw Hill education 2015.
3. Electrical Machinery Fundamentals by Stephen J Chapman McGraw Hill education 2010.
4. Electric Machinery by A.E. Fitzgerald, Charles kingsley, Stephen D.Umans, TMH.

e- Resources & other digital material

1.https://nptel.ac.in/courses/108/105/108105017

2.https://nptel.ac.in/courses/103/102/108102146

3.www.nptelvideos.in/2012/11/electrical-machines-i.html

*4.*https://www.electrical4u.com/losses-in-dc-machine

II-Year-II Semester
PC2204L

CONTROL SYSTEMS LAB

L	T	P	C
0	0	3	1.5

Pre-Requisites: Control Systems, Electrical Machines

Preamble: Control Systems Lab consists of workstations equipped with an oscilloscope, digital multi-meter, DC,AC servomotor, synchros, DC position control and PID trainers. This lab also covers the computer tools such as MATLAB. The aim of this Control system laboratory is to provide sound knowledge in the basic concepts of design of control system, adequate knowledge in the time response and frequency responses of systems.

Course Objectives:

The main objectives are

1. Toimparthandsonexperiencetounderstandtheperformanceofbasiccontrolsystem componentssuchasmagneticamplifiers,D.Cservo motors and Synchros.
2. To understandtime responses of control system with and without controllers
3. Tounderstandfrequencyresponses ofcontrolsystemwithandwithout compensators.

List of Experiments: Any 10 of the following experiments are to be conducted

1. Time responseofSecondordersystem
2. Characteristics ofSynchros
3. EffectofP, PD,PI,PIDControlleronasecondordersystems
4. StudyofLagandleadcompensation–Magnitudeandphaseplot
5. Effect of feedback on DC servomotor
6. BodePlot, Root locus,Nyquist Plotsforthetransfer functions of systemsupto 5thorder using MATLAB
7. Potentiometer as error detector
8. TemperaturecontrollerusingPID
9. Characteristics ofmagneticamplifiers
10. Characteristics ofDC servomotor
11. State model using MATLAB
12. Transfer function of DC Motor

List of Additional Experiments: Any 2 of the following experiments are to be conducted

13. Programmable logic controller – verification of truth tables of logic gates
14. Characteristics of AC servomotor
15. Determination of steady state error
16. Test for controllability and Observability using MATLAB

CourseOutcomes:

After the completion of the course the student should be:

CO1 Able to analyze the time response of a second order system

CO2 Able to analyze the effect of P, PI,PD, PID controllers and Lag, Lead compensators

CO3 Able to judge the stability in time and frequency domain

Text books:

1. "Control Systems Engineering" by I.J.Nagarath and M.Gopal, 5th Edition, New ageInternationalPublications.
2. "Automatic control systems" by Benjamin C.Kuo, 2nd Edition, Prentice Hall ofIndia.

Reference books:

1. "ControlSystemsprinciplesanddesign" by M.Gopal,4th Edition , TataMcGrawHilleducationPvtLtd.
2. "ModernControlEngineering" byKotsuhikoOgata,PrenticeHallofIndia.

e- Resources & other digital material

1. https://nptel.ac.in/noc/courses/noc20/SEM2/noc20-ee84/
2. https://nptel.ac.in/noc/courses/noc18/SEM2/noc18-ee25/
3. https://nptel.ac.in/noc/courses/noc19/SEM2/noc19-ee45/

II-Year-II Semester FUNDAMENTS OF MATLAB AND PSPICE
SOC2201

L	T	P	C
1	0	2	2

PRE-REQUISITES: Any computer programming (like C, C++ or Java)

Course Objectives: The objective of the course is to

1. Create an environment to work with different software technologies.
2. Build confidence in writing programmes.
3. Make familiar about logical operations.
4. Provide a platform to know about modeling of components.
5. Become aware about the analysis of DC & AC circuits.

Unit-1 Basics: **(8 hrs)**

Overview, Environment, Basic Syntax, variable, Input and Output commands, Basic Data Types, Relational and Logical operators, conditional statements, Loop Types..

Unit-2 Matrices: **(8 hrs)**

Vectors operations, Matrix operations, Multi dimensional and Cell arrays, Colon Notation, Conversion of Numbers, combining Strings into a cell array.

Unit-3 M–file Scripts:(8 hrs)

Creating saving and running an M–file, creating and running of a function, Data import, Data Output, Basic plots , subplots, Bar charts and 3D plots, Algebra:-Solving basic Equation-Expanding, factorization and simplification of algebraic Equations.

Unit-4 PSpice for Circuit Analysis: **(8 hrs)**

Introduction to PSpice, Description of circuit elements, nodes and sources, input and output variables, modeling of the above elements, DC analysis, AC analysis and Transient Analysis.

Unit-5 PSpice for Electronic Devices and Circuits: **(8 hrs)**

Diode model, BJT model, MOSFET model, IGBT model, SCR model, Subroutines, diode rectifiers.

Course Outcomes

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

CO1 Infer various logical operations.**{Apply level, KL3}**
CO2 Recite different matrix and vector operations.**{Understand level, KL5}**
CO3 Draw the graphs for analysis of data.**{Analyze level, KL4}**
CO4 Model circuit elements by distinguishing them AC and DC. **{Understand level, KL3}**
CO5 Simulate the given circuit and validate by conventional means. **{Apply level, KL4}**

Text books:

1. D HanselmanandB little field, “Mastering MATLAB 7”, Pearson Education, 2005.
2. Y Kirani Singh and B BChaudhari,“MATLABProgramming”, Prentice Hall of India,2007.

Reference books:

1. Muhammad H.Rashid,"Spice for Power Electronics and Electric Power", CRC Press 3rd Edition,2012.
2. AGilat,"MATLAB: An Introduction with Applications ",John Wiley and Sons,2004.
3. StevenTKarris,"Introduction to Simulink with Engineering Applications", Orchard Publication, 2nd Edition,2008.

e- Resources & other digital material

5. https://www.mathworks.com/matlabcentral/answers/index
6. www.tutorialspoint.com

II-Year-II Semester
SOC2201

SOLAR PANEL INSTALLATION

L	T	P	C
1	0	2	2

PRE-REQUISITES: 1) Basic Circuit Analysis

Course objectives: The student should be able to

1. Study the Principle of solar energy conversion
2. Study various PV performance measure terminologies,
3. KNOW about manufacturing of PV cells & sizing aspects of PV systems.
4. Know about PV system components and apply them in installation practices,& associated trouble shootings.
5. study PV system applications & associated safety measures

Unit-1 SOLAR CELL FUNDAMENTALS (11 hrs)

Principle of solar energy conversion, Photovoltaic effect, Semiconductor properties, energy levels, basic equations. Solar cell structure, parameters of solar cell.

Unit-2 PV MODULE PERFORMANCE (13 hrs)

Solar PV modules & arrays, I-V &P-V characteristics, maximum power point ,series parallel combination, cell efficiency, fill factor, role of bypass & blocking diode, factors affecting output of a solar cell .

Unit-3 MANUFACTURING OF PV CELLS & DESIGN OF PV SYSTEMS (12 hrs)

Commercial solar cells - Production process of single crystalline silicon cells, multi crystalline silicon cells, amorphous silicon, cadmium telluride, copper indium gallium diselenide cells. Design of solar PV systems, cost estimation, various aspects, system simulation tools.

Unit-4 SOLAR PV SYSTEMS INSTALLATIONS & TROUBLE SHOOTING (12 hrs)

Classification - Central Power Station System, Distributed PV System, Stand alone PV system, grid Interactive PV System, small system for consumer applications, hybrid solar PV system, concentrator solar photovoltaic. System components - PV arrays, inverters, batteries, charge controllers, net metering, PV array installation, operation, costs, reliability. Troubleshooting of PV system components.

Unit-5 PV SYSTEM APPLICATIONS & SAFETY (12 hrs)

Building-integrated photovoltaic units, grid connected central power stations, stand-alone devices for distributed power supply in remote and rural areas, Outlook for the Indian PV industry& challenges, Applications: solar home system, solar cars, Solar Charger, aircraft, space solar power satellites. Socio-economic and environmental merits of photovoltaic systems safety in Installation of solar PV systems.

Text books:

1. Chetan Singh Solanki., Solar Photovoltaic: “Fundamentals, Technologies and Application”, PHI Learning Pvt., Ltd., 2009.
2. Jha A.R., “Solar Cell Technology and Applications”, CRC Press,2010.

3. John R. Balfour, Michael L. Shaw, SharlaveJarosek., “Introduction to Photovoltaics”, Jones & Bartlett Publishers, Burlington, 2011.

Reference books:

1. Chetan Singh Solanki “Solar PV technology and system”, PHI learning private limited, 2015.
2. Luque A. L. and Andreev V.M., “Concentrator Photovoltaic”,Springer, 2007.
3. Partain L.D., Fraas L.M., “Solar Cells and Their Applications”, 2nd ed., Wiley, 2010.
4. S.P. Sukhatme, J.K.Nayak., “Solar Energy”, Tata McGraw Hill Education Private Limited, New Delhi, 2010.
5. R.K Pachauri “From Sun light to Electricity” TERI, 15th Reprint , 2013.

e- Resources & other digital material

https://www.nrel.gov

https://nise.res.in/

http://www.seriius.org/

https://nptel.ac.in/courses/117/108/117108141/#

https://onlinecourses.nptel.ac.in/noc20_ee57/preview

II-Year-II Semester **SENSORS AND ACTUATORS FOR IOT**
SOC2201

L	T	P	C
1	0	2	2

PRE-REQUISITES: 1) IOT

Course objectives: The student should be able to

1. Study the concept on IOT and phenomena on which operation of Sensor transformation of energy is based
2. Know the depth knowledge in physical principles applied in sensing
3. Know the Characteristics, analysis and how measurement systems are designed, calibrated
4. Impart a competence in the design, construction, and execution of mechanical measurements in application point of view

Unit-1 Sensors: **(3 hrs)**
Introduction of IOT, Transducers and definition of sensors.

Unit-2 Classification of Sensors **(3 hrs)**
Active, Analog, Digital, Scalar, Vector, - Inductive Sensors: Sensitivity and Linearity of the Sensor, Types-Capacitive Sensors:– Electrostatic Transducer– Force/Stress Sensors Using Quartz Resonators – Ultrasonic Sensors,-PIR Motion Sensor - Rain Drop Sensor - Moisture Sensor. -Temperature Sensor - Touch Sensor -Infrared Sensor - Servo Motor- RFID Sensor -- Bluetooth Module, Wi-Fi Module.

Unit-3 Characteristics of Sensors **(2hrs)**
Static -Accuracy, Range, Resolution, Error ;**Dynamic**

Unit-4 Actuators **(1hr)**
Classification – Electric, Fluid, Linear, Manual

Unit-5 Application **(6hrs)**
Sensors and actuators,Processors,Transceivers (Mobile Phone Based Sensors., Neural Sensors ,Environmental and Chemical Sensors, Medical Sensors., Radio Frequency Identification (RFID)-Applications on IOT- Arduino, Raspberry Pi.- Smart home, health, logistics, transport, agriculture, social, environment.

Course Outcomes

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

CO1 Understand the concept of IOT

CO2 Explain thephysical parameter into an electrical quantity

CO3 Analyze the Characteristics and develop sensors using different methods with desired properties

CO4 Evaluate the sensor and actuators as an application on industry and /or device type

Text books:

1. Internet of Things : Architecture, Design principles and applications, Rajkamal, McGraw Hill Higher Education.
2. Jon. S. Wilson, “Sensor Technology Hand Book”, 2011, 1st edition, Elsevier, Netherland.

Reference books:

1. Dr. Guillaume Girardin , Antoine Bonnabel, Dr. Eric Mounier, 'Technologies & Sensors for the Internet of Things Businesses & Market Trends 2014 - 2024',Yole Dévelopment Copyrights ,2014
2. Peter Waher, 'Learning Internet of Things', Packt Publishing, 2015
3. N. Ida, Sensors, Actuators and Their Interfaces, Scitech Publishers, 2014.

II-Year-II Semester
SOC2201

AC DRIVES

L	T	P	C
1	0	2	2

PRE-REQUISITES: 1) AC Drives

Course objectives: The student should be able to
1. Study the fundamentals of ACDrives .
2. Study the Typesof AC motorsconstruction & working principle.
3. Study the Concept of AC Drive and construction & working principle.
4. Study the Applications of AC Drives.
5. Study the Design and protection for AC and MV Drives.

Unit-1 Basic principles of AC Drive(6 hrs)
Basic principles of AC Drive and its Application **(02 hrs)**
Benefits of AC Drives **(02 hrs)**
Basic concept, Wiring **(02 hrs)**
Unit-2 Types ofAC MOTOR (08 hrs)
Basic on AC motors-Types of AC motors **(02 hrs)**
construction and working, principle, **(02 hrs)**
Parameterization **(04 hrs)**
Unit-3 Concept ofAC DRIVE (10 hrs)
Concept of AC Drive in details.**(02hrs)**
construction & working principle **(04hrs)**
Selection of AC Drive (**02 hrs)**
Important features .**(02 hrs)**
Unit-4 Applications of AC Drives (06 hrs)
Applications of AC Drives (**02 hrs)**
AC Drive Harmonics(**02 hrs)**
Effects of Harmonics (**02 hrs)**
Unit-5 Features of SINAMIC G-120 AC Drive , MEDIUM VOLTAG (MV) DRIVE (10 hrs)
Introduction, parameterization, Wiring, Application **(06 hrs)**
Introduction, features and application **(02hrs)**
Design and protection for AC and MV Drives **(02hrs)**

Course Outcomes

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

CO1 **Understand** the fundamentals of ACDrives **{Understand level, KL2}**

CO2 **Explain** the principle and working of AC motors.**{Apply level, KL3}**

CO3 **Analyze** the Concept of AC Drive **{Analyze level, KL4}**

CO4 **Evaluate** the Applications of AC Drives.**{Evaluate level, KL5}**

CO5 **Analyze** the Design and protection for AC and MV Drives.**{Apply level, KL4}**

Text books:

1. "Electric Drive: Control of DC and AC Drives" by Srinivas Vemula and Ramaiah Veerlapati.
2. VEDAM SUBRAMANIAM "Electric drives (concepts and applications)", Tata McGraw-Hill.2001.
3. "Electric motor drives", R. Krishnan, PHI.
4. "Electric Motor & Drives". Austin Hughes, Newnes.
5. "Modern Power Electronics & Ac drives", B.K. Bose, Pearson Education.

Reference books:

1. PILLAI.S.K, "A first course on Electric drives", Wiley Eastern Limited, 1998
2. M.D. SINGH, K.B.KHANCHANDANI, "Power electronics", Tata McGraw-Hill.1998

e- Resources & other digital material

1. http://www.hccl.ie/uploads/1/4/7/3/1473854/ha472742_iss4a_ac-dc_catalog.pdf
2. https://www.industrial-electronics.com/MDPTG_4.html
3. http://freetutorials.name/Reference1/Electrical_Engineering.html

II-Year-II Semester
MC2201

ENVIRONMENTAL STUDIES

L	T	P	C
2	0	0	0

Pre-Requisites:

1. Basics of General Science
2. Basics of Social Studies

Course Objectives: The objectives of the course are to impart:

1. Overall understanding of the natural resources
2. Basic understanding of the ecosystem and its diversity.
3. Acquaintance on various environmental challenges induced due to unplanned anthropogenic activities.
4. An understanding of the environmental impact of developmental activities.
5. Awareness on the social issues, environmental legislation and global treaties.

UNIT – I: MULTIDISCIPLINARY NATURE OF ENVIRONMENTAL STUDIES (12 Hrs)

Definition, Scope and Importance – Need for Public Awareness.

NATURAL RESOURCES : Renewable and non-renewable resources – Natural resources and associated problems – Forest resources – Use and over – exploitation, deforestation, case studies – Timber extraction – Mining, dams and other effects on forest and tribal people – Water resources – Use and over utilization of surface and ground water – Floods, drought, conflicts over water, dams – benefits and problems – Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources, case studies – Food resources: World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity, case studies. – Energy resources:

UNIT – II: Ecosystems, Biodiversity, and its Conservation (12 hrs)

ECOSYSTEMS: Concept of an ecosystem. – Structure and function of an ecosystem – Producers, consumers and decomposers – Energy flow in the ecosystem – Ecological succession – Food chains, food webs and ecological pyramids – Introduction, types, characteristic features, structure and function of the following ecosystem:

a. Forest ecosystem.
b. Grassland ecosystem
c. Desert ecosystem
d. Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries)

BIODIVERSITY AND ITS CONSERVATION : Definition: genetic, species and ecosystem diversity – Bio-geographical classification of India – Value of biodiversity: consumptive use, Productive use, social, ethical, aesthetic and option values – Biodiversity at global, National and local levels – India as a mega-diversity nation – Hot-sports of biodiversity – Threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts – Endangered and endemic species of India – Conservation of biodiversity: In-situ and Ex-situ conservation of biodiversity.

UNIT-III: Environmental Pollution and Solid Waste Management (10 hrs)

ENVIRONMENTAL POLLUTION: Definition, Cause, effects and control measures of :

a. Air Pollution.
b. Water pollution
c. Soil pollution
d. Marine pollution
e. Noise pollution
f. Thermal pollution
g. Nuclear hazards

SOLID WASTE MANAGEMENT : Causes**,** effects and control measures of urban and industrial wastes – Role of an individual in prevention of pollution – Pollution case studies – Disaster management: floods, earthquake, cyclone and landslides.

UNIT – IV: Social Issues and the Environment (12 hrs)

SOCIAL ISSUES AND THE ENVIRONMENT: From Unsustainable to Sustainable development – Urban problems related to energy – Water conservation, rain water harvesting, watershed management – Resettlement and rehabilitation of people; its problems and concerns. Case studies – Environmental ethics: Issues and possible solutions – Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust. Case Studies – Wasteland reclamation. – Consumerism and waste products. – Environment Protection Act. – Air (Prevention and Control of Pollution) Act. – Water (Prevention and control of Pollution) Act – Wildlife Protection Act – Forest Conservation Act – Issues involved in enforcement of environmental legislation – Public awareness.

UNIT – V: Human Population and the Environment (14 hrs)

HUMAN POPULATION AND THE ENVIRONMENT: Population growth, variation among nations. Population explosion – Family Welfare Programmed. – Environment and human health – Human Rights – Value Education – HIV/AIDS – Women and Child Welfare – Role of information Technology in Environment and human health – Case studies.

FIELD WORK : Visit to a local area to document environmental assets River/forest grassland/hill/mountain – Visit to a local polluted site-Urban/Rural/Industrial/Agricultural Study of common plants, insects, and birds – river, hill slopes, etc..

Course Outcomes

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

CO1 Able to U**nderstand** Natural resources and their importance

CO2 Able to U**nderstand**TheThe concepts of the ecosystem, learn biodiversity of India and the threats to biodiversity and **Apply** conservation practices

CO3 Able to learn Various attributes of the pollution and their impacts.

CO4 Able to U**nderstand** Social issues both rural and urban environment and Environmental Legislation.

CO5 Able to Understand Popultion Explosion and Apply Structure and Functions of Ecosystem.

Text books:

1. Text book of Environmental Studies for Undergraduate Courses by ErachBharucha for University Grants Commission, Universities Press.
2. Environmental Studies by Palaniswamy – Pearson education
3. Environmental Studies by Dr.S.AzeemUnnisa, Academic Publishing Company.

Reference books

1. Textbook of Environmental Science by Deeksha Dave and E.Sai Baba Reddy, Cengage Publications.
2. Text book of Environmental Sciences and Technology by M.Anji Reddy, BS Publication.
3. Comprehensive Environmental studies byJ.P.Sharma, Laxmi publications.
4. Environmental sciences and engineering – J. Glynn Henry and Gary W. Heinke – Prentice hall of India Private limited.
5. A Text Book of Environmental Studies by G.R.Chatwal, Himalaya Publishing House
6. Introduction to Environmental engineering and science by Gilbert M. Masters and Wendell P. Ela - Prentice hall of India Private limited.

e- Resources & other digital material

1.http://moef.gov.in/en/resource/e-books/

2.https://cpcb.nic.in/

3.https://www.unep.org/

II-Year-II Semester
HO2201

ANALYSIS OF LINEAR SYSTEMS

L	T	P	C
3	0	2	4

PRE-REQUISITES: 1) Basic Circuit Analysis
2) Electrical Circuit Analysis
3) Engineering Mathematics

Course objectives: The student should be able to

1. Formulate state equations for Electrical networks.
2. Study Fourier series and Fourier transform of a periodic function.
3. Compute an Effective value and an average values of non-sinusoidal periodic waves
4. Analyze Response of RL, RC, and RLC Networks to Step, Ramp, and impulse functions.
5. Study the Hurwitz polynomials and Positive Real Functions.

Unit-1 STATE VARIABLE ANALYSIS (10 hrs)

Choice of state variables in Electrical networks-Formulation of state equations for Electrical networks-Equivalent source method. Network topological method - Solution of state equations-Analysis of simple networks with state variable approach.

Unit-2 FOURIER SERIES &FOURIER TRANSFORM REPRESENTATION (15hrs)

Introduction, Trigonometric form of Fourier series, Exponential form of Fourier series, Wave symmetry, Fourier integrals and transforms, Fourier transform of a periodic function , Properties of Fourier Transform , Parseval's theorem , Fourier transform of some common signals, Fourier transform relationship with Laplace Transform.

Unit-3 APPLICATIONS OF FOURIER SERIES AND FOURIER TRANSFORM REPRESENTATION (15hrs)

Introduction, Effective value and average values of non-sinusoidal periodic waves, currents, Power Factor, Effects of harmonics, Application in Circuit Analysis, Circuit Analysis using Fourier Series.

Unit-4 LAPLACE TRANSFORM APPLICATIONS (15hrs)

Application of Laplace transform Methods of Ananlysis – Response of RL, RC, RLC Networks to Step,Ramp, and impulse functions, Shifting Theorem – Convolution Integral – Applications

Unit-5 TESTING OF POLYNOMIALS (10hrs)

Elements of reliability-Hurwitz polynomials, Properties of Hurwitz polynomials -positive real functions-Properties-Testing-Sturm's Test, examples.

Content Beyond the syllabus:

Response of RL network to sinusoidal signals
Response of RC network to sinusoidal signal
Response of RLC network to sinusoidal signal
Properties of LC Immittence
Transfer function of an electrical network

List of Experiments: practice any 5 programs**(10 hrs)**

1. Compute the response of RL Circuit with step input.
2. Compute the response of RC Circuit with step input.

3. Compute the response of RLC Circuit with step input.
4. Compute the response of RL Circuit with impulse input.
5. Compute the response of RL Circuit with impulse input.
6. Compute the response of RC Circuit with impulse input.
7. Compute the response of RL Circuit with impulse input.
8. Study the Effects of harmonics in a RLC Circuit.
9. Obtain the Response of RC network to Non-sinusoidal signal.
10. Obtain the solution of a network using state space analysis.

Course Outcomes

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

CO1 **Understand** the Formulation of state equations for Electrical networks**{Understand level, KL2}**

CO2 **Analyze** Fourier series and Fourier transform of a periodic function.**{ Understand Analyze level, KL2&KL4}**

CO3 **Analyze** Effective value and average values of non-sinusoidal periodic waves**{Analyze level, KL4}**

CO4 **Analyze** Response of RL, RC, RLC Networks to Step, Ramp, and impulse functions**{ Analyze level, KL4}**

CO5 **Analyze** Hurwitz polynomials and Positive Real Functions. **{Apply level, KL4}**

Text books:

1. Network Analysis and Synthesis – UmeshSinha- SatyaPrakashan Publications
2. Linear System Analysis – A N Tripathi, New Age International.

Reference books:

1. Network and Systems – D Roy Chowdhary, New Age International.
2. Engineering Network Analysis and Filter Desgin- Gopal G Bhisk&Umesh.
3. Linear system anlysis by A.Cheng, Oxford publishers.
4. Signals, Systems and Communications by B.P. Lathi, BS Publications 2003.

e- Resources & other digital material

1. https://nptel.ac.in/courses/108/106/108106150/
2. https://onlinecourses.nptel.ac.in/noc20_ee15/preview
3. https://nptel.ac.in/courses/108/104/108104100/
4. https://ocw.mit.edu/courses/mechanical-engineering/2-017j-design-of-electromechanical-robotic-systems-fall-2009/course-text/MIT2_017JF09_ch02.pdf
5. https://www.researchgate.net/publication/301078132_Linear_Systems_Analysis_in_the_Time_Domain

II-Year-II Semester

HO2201

ENERGY STORAGE SYSTEMS

L	T	P	C
3	0	2	4

PRE-REQUISITES: 1) Chemistry

Course objectives: The student should be able to

1. Study the types of various energy storage systems.
2. Study the principle of electro chemical energy storage system and accumulators.
3. Understand flywheel mechanism and energy storage system.
4. Know the production of hydrogen gas, its storage and generation of electricity from hydrogen
5. study the use of super capacitors, its charging and discharging phenomenon and energy storage.

Unit-1 Generalities On Energy Storage: (10hrs)

Energy, Power, Capacity, Depth Of Discharge, State Of Discharge, Round Trip Efficiency, Charge And Discharge Losses, Types Of Energy Storage Systems: Physical And Electrical Storage(Types Only)

Unit-2 Electro Chemical Energy Storage:(10hrs)

Introduction, System Structure, Elementary Principle, Different Types Of Accumulators-Accumulators With Aqueous Electrolyte: Lead–Acid Accumulator, Alkaline Accumulators, The Nickel-Iron , Nickel–Cadmium Accumulator, Ni-MH Accumulator, Accumulators With Non-aqueous Electrolyte: Lithium-Metal Accumulator, Lithium-Ion Accumulator.

Unit-3 Flywheel storage System:(8hrs)

Introduction, Rotor Dynamics, Moment Of Inertia, Specific Energy, Aerodynamic Drag Of A Flywheel, Efficiency, Design Of Flywheel.

Unit-4 Energy Storage Based On Hydrogen:(12hrs)

Introduction, Structure Of Energy storage system, Electrolysis Of Water, Alkaline Electrolysis, High-Temperature Steam Electrolysis.

Storage Of Hydrogen: Liquid Hydrogen Storage, Storage Of Hydrogen By Compression, Formic Acid For Hydrogen Storage, Conversion From Hydrogen To Electricity, Efficiency.

Unit-5 Super Capacitors:(8hrs)

Introduction, types of super capacitors, Electrodes used for super capacitors, Electrical parameters, Life time, Applications of super capacitors, General Characteristics, Modelling, behaviour of super capacitors, charging and discharging of super capacitors.

Course Outcomes

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

CO1 **Understand** the various forms of energy and types of energy storage system **{Understand level, KL2}**

CO2 **Analyze**the working of electro chemical energy storage system and various accumulators**{Analyze level, KL3}**

CO3 **Explain** the performance of flywheel storage mechanism **{Explain level, KL4}**

CO4 **Understand** the Generation phenomenon of electricity from hydrogen gas and storage system**{Understand level, KL2}**

CO5 **Analyze** the working of super capacitors and its performance **{Apply level, KL4}**

Text books:

1. Energy storage systems and components by Alfred Rufer , CRC press.
2. Electro Chemical Energy Storage for Renewable sources and Grid balancing, by Patrick T. Mosely, Jurgen Garche, Elsevier.

Reference books:

1. Energy storage: Fundamentals, materials and applications by RobbertA Huggins, Springer, Second Edition.
2. Supercapacitors: Materials, Systems, and Applications by Max Lu, Francois Beguin, ElzbietaFrackowiak, Wiley VCH.
3. Super capacitors Alternative Energy Storage System by Tripati SK, Jain Amrita, Lambert Academic publishing.
4. Engineering Energy storage by OdnestokkeBurhiem, Elsevier Academic press.

e- Resources & other digital material

1. https://nptel.ac.in/content/storage2/courses/108103009/download/M9.pdf
2. https://www.youtube.com/watch?v=EakRe6ICM-Q&t=54s
3. https://energystorage.org/why-energy-storage/technologies/flywheel-energy-storage-systems-fess/
4. https://en.wikipedia.org/wiki/Supercapacitor
5. https://en.wikipedia.org/wiki/Flywheel_energy_storage

II-Year-II Semester HO2201

SEMICONDUCTOR DEVICES MODELLING

L	T	P	C
3	0	2	4

Pre-Requisites: knowledge of basic Devices

Course objectives: This subject gives knowledge of semiconductor devices

1. The main objectives are Study the principle of operation of basic devices and physics
2. Study the principle of operation of MOSFET and classification of MOSFET
3. Compute the performance factors of CMOS
4. Know the different types of Bipolar devices and its working
5. Design the different modes of Bipolar devices

Unit–1: Basic Devices And Physics(15hrs)

Electrons And Holes In Silicon And Germanium -P-N Junction Diode :Operation, &Its Working,-MOS –Capacitor: Structure And Principle Of Operation-High Field Effects

Unit–2: MOSFET DEVICES(15hrs)

Long-channel MOSFETs-Short-channel MOSFETs- CMOS Device Design : MOSFET Scaling-Threshold voltage-MOSFET channel length

Unit–3: CMOS PERFORMANCE FACTORS(15hrs)

Basic CMOS circuit elements- Parasitic elements-Sensitivity of CMOS delay to device parameters-Performance factors of advanced CMOS devices

Unit–4: BIPOLAR DEVICES(15hrs)

n-p-n Transistors-Ideal current-voltage characteristics-Characteristics of a typical n-p-n transistor-Bipolar device models for circuit and time-dependent analyses- Breakdown voltages

Unit–5: BIPOLAR DEVICE DESIGN (15hrs)

Design of the emitter design- Design of the base region-Design of the collector design- Modern bipolar transistor structures.

Course Outcomes:

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

CO1 **Understand** the working of basic devices and physics**{Understand level, KL2}**

CO2 **Know**the principle of operation of MOSFET and classification of MOSFET**{Apply level, KL3}**

CO3 **Compute** the performance factors of CMOS**{Analyze level, KL4}**

CO4 **Know**the different types of Bipolar devices and its working{**Understand Level,KL2**}

CO5 **Design** the different modes of bipoardevices.**{Apply level, KL4}**

Text books:

1. **“Solid State Electronic Devices “**,B. G. Streetman and S. Banerjee, PHI.
2. “**Physics of Semiconductor Devices”** S. M. Sze, , John Wiley & Sons..
3. **“Semiconductor Devices: Physics and Technology “**S. M. Sze, , John Wiley & Sons**.**
4. **“Physics of Semiconductor Devices**” Michael Shur, PHI.

Reference books:

1. **“Semiconductor Devices** “NanditaDasGupta and AmitavaDasGupta, , PHI.
2. “**Fundamentals of Solid State Electronics**” C. T. Sah, World Scientific.
3. **“Advanced Theory of Semiconductor Devices”,**Karl Hess, , IEEE Press.
4. **“Fundamentals of Semiconductor Devices “.**J.Lindmayer and C. Y. Wringley, , Affiliated East-West Press Pvt. Ltd

e-resource:

1. https://nptel.ac.in/courses/117/106/117106033/
2. https://www.researchgate.net/publication/267261216_Semiconductor_Device_Modeling
3. https://en.wikipedia.org/wiki/Semiconductor_device_modeling
4. https://iitk.ac.in/new/ee616a

II-Year-II Semester
HO2201

RENEWABLE ENERGY SOURCES

L	T	P	C
3	0	2	4

PRE-REQUISITES: 1) Basics of Solar Energy

Preamble: This course gives a flavor of renewable sources and systems to the students. It introduces solar energy its radiation, collection, storage and its applications. This covers generation, design, efficiency and characteristics of various renewable energy sources including solar, wind, hydro, and biomass. Fuel cells and geothermal systems.

Course objectives: The main objectives are

1. To study the solar radiation data, extraterrestrial radiation. Radiation on earth's surface.
2. To study solar thermal collections.
3. To study solar photo voltaic systems.
4. To study maximum power point techniques in solar pv and wind energy
5. To study wind energy conversion systems Betz coefficient systems tip speed ratio.
6. To study basic principle and working of hydro, tidal, biomass, fuel cell and geothermal systems

Unit-1 Fundamentals of Energy Systems And Solar Energy (11 hrs)

Fundamentals of Energy Systems: Energy conversion principle, Energy Scenario, various forms of renewable energy, solar radiation, outside earth's atmosphere, earth surface, analysis of solar radiation data. **(05 hrs)**

Solar Energy: Geometry – radiation of tilted surface, numerical problems. Liquid plate plate collectors, performance analysis – Transmissivity – Absorptivity product collector efficiency factor, collector heat remove factor. **(06 hrs)**

Unit-2 Solar Thermal Systems (13 hrs) Introduction to solar Air heaters, concentrating collectors, solar pond and solar till, Solar thermal plant, numerical problems, solar photovoltaic systems, photovoltaic cell, module, array – construction – efficiency of solar cells, developing technologies cells – I- V characteristics, equivalent circuit of solar cells, series resistance, shunt resistance, applications and systems, balance of system components, maximum power point techniques, pertube and observe technique, hill climbing technique.

Unit-3 Wind Energy (12 hrs) Sources of wind energy – wind patterns, types of turbines, horizontal axis and vertical axis machines, kinetic energy of wind, Betz coefficient, tip speed ratio, Efficiency, power output of wind turbine, selection of generators (synchronous, induction), maximum power point tracking, wind forms, power generators for utility grids.

Unit-4 Hydro And Tidal Power Systems (12 hrs)

HydroPower Systems: Basic working principle, Classification of hydro systems, large, small, micro measurement of head and flow - energy equation - types of turbines , numerical problems. **(06 hrs)**

Tidal Power Systems: Tidal power, basics, kinetic energy equation- turbines for tidal power, numerical problems, wave power basics, kinetic energy equation, wave power devices, linear generators. **(06 hrs)**

Unit-5 Biomass, Fuel Cells And Geothermal Systems (10 hrs) Energy, Fuel classification – Pyrolysis- direct combustion of heat, different digesters and sizing

Course Outcomes

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

CO1 **Analyze solar radiation data,** extraterrestrial radiation. radiation on earth's surface.**{Apply level, KL4}**

CO2 Design solar thermal collectors, solar thermal plants. **{Evaluate level, KL5}**

CO3 Design solar photo voltaic systems. **{Evaluate level, KL5}**

CO4 Develop maximum power point techniques in solar PV and wind energy systems.{**Understand level, KL2}**

CO5 **Explain** wind energy conversion systems, wind generators, power generations.**{Explain level, KL3}**

Text books:

3. "Solar Energy" Principles of thermal collections and storage, S. P. Sukhatme, and J.K. Nayak, TMH ,New Delhi, 3rd edition.
4. "Renewable Energy Resources" Johan Twidell and Tony Weir, Taylor and Fancies 2rd edition, 2013.

Reference books:

3. "Renewable Energy" Edited by Godfrey, Boyle-Oxford University press 3rd edition, 2013.
4. "Renewable Energy Technologies/Ramesh and Kumar Narosa
5. "Renewable Energy Technologies" A Practical Guide For Beginners

e- Resources & other digital material

7. https://nptel.ac.in/courses/112105051
8. https://www.tatapower.com/bussiness/renewable-energy.aspx
9. https://www.cleanlineenergy.com/technology/wind-and-solar
10. https://www. youtube.com/watch?=xokHLFE96h8
11. https://www.youtube.com/watch?v=GZKKWz_tX1c

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III-Year-I Semester **Engineering Economics and Management**

L	T	P	C
3	0	0	3

PRE-REQUISITES: 1) Basic Sciences and Humanities

Course objectives: The student should be able to

CO 1: To understand the concept and nature of Economics and Demand and to familiarize about the Production function, Input Output relationship, Cost-Output relationship and Break Even Analysis.

CO 2: To understand the nature of markets and the concepts of Money and RBI functions.

CO 3: To familiarize with the process of management, principles, and to provide conceptual knowledge on functional management that is on Human resource management and Marketing management.

CO 4: To learn different Accounting Systems, preparation of Financial Statement and to familiarize with the tools of project Management.

CO 5: To understand the concept of Capital, Capital Budgeting and the techniques used to evaluate Capital Budgeting proposals.

Unit-1 Introduction to Economics and Theory of Production 13 Hrs

Introduction to Economics; Definitions, Nature, Scope, Difference between Microeconomics & Macroeconomics –Concept of Demand, Types of Demand, Determinants of Demand-Law of Demand -Elasticity of Demand, Types of Elasticity of Demand.

Theory of production; production function, Law of variable proportions & law of returns to scale, Cost; meaning, short run & long run cost, fixed cost, variable cost, total cost, average cost, marginal cost, opportunity cost. Break even analysis; meaning, explanation, simple problems.

Unit-2 Introduction to Markets and Money12 Hrs

Markets: meaning, types of markets & their characteristics (Perfect Competition, Monopoly, Monopolistic Completion, Oligopoly). National Income, GNP, GDP, NNP, NDP, Personal income and GST (Goods & Service Tax).

Money: meaning, functions, types, Monetary policy- meaning, objectives, tools, fiscal policy-meaning, objectives, tools, Banking; meaning, types, functions, Central Bank- RBI; its functions, concepts; CRR, bank rate, repo rate, reverse repo rate, SLR.

Unit-3 Introduction to Management 12 Hrs

Concept –nature and importance of Management Functions of Management, Principles of Management.

Human Resource Management: Meaning and difference between Personnel Management and Human Resource Management, Functions of Human Resource Management.

Marketing Management: Functions of Marketing - Marketing strategies based on product Life Cycle, Channels of distributions.

Unit-4 Introduction to Accounting & Project Management 15 Hrs

Introduction to Double Entry System, Journal, Ledger, Trail Balance and Preparation of Final Accounts with adjustments – Preparation of Financial Statements.

Project Management: (PERT/CPM): Development of Network – Difference between PERT and CPM Identifying Critical Path (Simple Problems).

Unit-5 Capital and Capital Budgeting: **12 Hrs**

Capital Budgeting: Meaning of Capital-Capitalization-Meaning of Capital Budgeting-Time value of money- Methods of appraising Project profitability: Traditional Methods (payback period, accounting rate of return) and modern methods (Discounted cash flow method, Net Present Value method, Internal Rate of Return Method and Profitability Index).

Course Outcomes

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

CO1 The Learner is equipped with the knowledge of estimating the Demand and demand elasticity's for a product and Input-Output-Cost relationships.

CO2 The Learner is also ready to understand the nature of different markets and also to have the knowledge of Money & Banking.

CO3 The Learner will acquire the knowledge on management, HRM and Marketing.

CO4 The Learner will acquire the knowledge to prepare Financial Statements and the techniques of project management.

CO5 The Learner can able to evaluate various investment project proposals with the help of capital budgeting techniques for decision making.

Text books:

1. Dr. A. R. Aryasri – Managerial Economics and Financial Analysis, TMH 2018, 2e.
2. Dr. N. Appa Rao, Dr. P. Vijay Kumar: 'Managerial Economics and Financial Analysis', Cengage Publications, New Delhi – 2012.
3. Management Science, Aryasri, Tata McGraw Hill, 2014.
4. Dr. P. Vijaya Kumar & Dr. N. Appa Rao, 'Introduction to *Management Science'* Cengage, Delhi, 2012.
5. Engineering Economy and Management 1 Edition Pravin Kumar – Wiley Publication.
6. Engineering Economics & Management- Dr. Vilas Kulkarni & HardikBavishi - Vikas Publishing.

Reference books:

1. R. L Varshney, K.L. Maheshwari : Managerial Economics, Sultan Chand&Sons 2014,22e.
2. Suma Damodaran : Managerial Economics, Oxford 2010,2e.
3. Ambrish Gupta: 'Financial Accounting for Management', Pearson 2015,5e.
4. Dr. S.N. Maheswari: Financial Accounting, Vikas Publications 2018.
5. S. A. Siddiqui & A. S. Siddiqui: Managerial Economics and Financial Analysis, New Age International Publishers, 2017.
6. Principles of Marketing: A South Asian Perspective, Kotler Philip, Gary Armstrong, Prafulla Y. Agnihotri, and Eshan ul Haque , 17th Edition, Pearson Education/ Prentice Hall of India, 2018.
7. Human Resource Management: Gary Dessler, 14^{th} Edition, pearson 2015.

III-Year-I Semester

Power Systems-II

L	T	P	C
3	0	0	3

PRE-Requisites. Electrical circuit Analysis
ii. Power Systems-I

Course objectives: The students should be able to

1. To study the short, medium and long length transmission lines, their models and performance.
2. To study the effect of travelling waves on transmission lines.
3. To study the factors affecting the performance of transmission lines and power factor improvement methods.
4. To discuss sag and tension computation of transmission lines as well as to study the performance of overhead insulators.
5. To discuss computation of Z_{bus} and Y_{bus} of power system

Unit-1 Performance of Transmission Lines

Classification of Transmission Lines – Short, medium, long line and their model representations – Nominal-T–Nominal-Pie and A, B, C, D Constants for symmetrical and Asymmetrical Networks– Numerical Problems– Mathematical Solutions to estimate regulation and efficiency of all types of lines – Numerical Problems.

Performance of Long Transmission Lines–Rigorous Solution – Evaluation of A,B,C,D Constants– Interpretation of the Long Line Equations, regulation and efficiency– Representation of Long Lines – Equivalent-T and Equivalent Pie network models (Numerical Problems).
(10 hrs)

Unit-2 Travelling waves

Incident, Reflected and Refracted Waves –Surge Impedance and SIL of Long Lines–Wavelength and Velocity of Propagation of Waves

Power system Transients

Types of System Transients – Travelling or Propagation of Surges – Attenuation–Distortion– Reflection and Refraction Coefficients – Termination of lines with different types of conditions – Open Circuited Line–Short Circuited Line – T-Junction– Lumped Reactive Junctions. **(10 hrs)**

Unit-3 Various Factors governing the Performance of Transmission line

Skin and Proximity effects – Description and effect on Resistance of Solid Conductors – Ferranti effect – Charging Current –Shunt Compensation –Corona – Description of the phenomenon–Factors affecting corona–Critical voltages and power loss – Radio Interference. **(12 hrs)**

Unit-4 Sag and Tension Calculations and Overhead Line Insulators

Sag and Tension calculations with equal and unequal heights of towers–Effect of Wind and Ice on weight of Conductor–Numerical Problems – Stringing chart and sag template and its applications– Types of Insulators – String efficiency and Methods for improvement– Numerical Problems – Voltage distribution–Calculation of string efficiency–Capacitance grading and Static Shielding. **(10 hrs)**

Unit-5 Bus Admittance Matrix & Bus Impedance Matrix

Bus Admittance Matrix (Ybus):

Per Unit systems, Single line diagram, Impedance diagram of a power system, Primitive network representation, Formation of Ybus matrix by direct inspection method. Numerical Problems.

Bus Impedance Matrix (Zbus):

Formation of Zbus matrix by building algorithm, Modification of Zbus for the changes in network, Numerical Problems (3 bus system only). **(12 hrs)**

Course Outcomes

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

CO1	**Understand** about the performance of various transmission systems**{Understand level, KL2}**
CO2	**Understand**about Travelling waves and transients in power transmission systems **{Understand level, KL2}**
CO3	**Analyze** various factors related to charged transmission lines **{Analyze level, KL4}**
CO4	**Understand**sag/tension of transmission lines and performance of line insulators**{Understand level, KL2}**
CO5	**Analyze** about calculation of Y_{bus} and Z_{bus} matrices **{Apply level, KL4}**

Textbooks:

1. Electrical power systems – by C.L.Wadhwa, New Age International (P) Limited, Publishers, 1998.
2. Modern Power System Analysis by I.J.Nagarath and D.P.Kothari, Tata McGraw Hill, 2nd Edition.

Reference books:

1. Power system Analysis–by John J Grainger William D Stevenson, TMC Companies, 4th edition
2. Power System Analysis and Design by B.R.Gupta, Wheeler Publishing.
3. A Text Book on Power System Engineering by M.L.Soni, P.V.Gupta, U.S.BhatnagarA.Chakrabarthy, DhanpatRai& Co Pvt. Ltd.
4. Electrical Power Systems by P.S.R. Murthy, B.S.Publications.

e- Resources & other digital material

1. https://nptel.ac.in/courses/108105104
2. https://www.vssut.ac.in/lecture_notes/lecture1424265031.pdf
3. https://www.academia.edu/6923342/LECTURE_NOTES_COURSE_POWER_SYSTEMS_II
4. https://www.powertransmission.com/articles/1702
5. https://www.powertransmissionworld.com/

III-Year-I Semester **ELECTRICAL MEASUREMENTS & INSTRUMENTATION**

L	T	P	C
3	0	0	3

PRE-REQUISITES: 1) Basic Circuit Analysis

Course objectives: The student should be able to

1. Study the principle of operation and working of different types of instruments for measurement of electrical quantities.
2. Study the working principle of operation of different types of instruments for measurement of power and power factor, energy and frequency.
3. Understand the principle of operation and working of various types of bridges for measurement of parameters –resistance, inductance, capacitance and frequency.
4. Know the principle of operation and working of transducers.
5. Study the principle of operation and working of DVMs, DMM and other digital instruments

Unit-1 Measuring Instruments & Instrument Transformers: (12 hrs)

Error analysis; Classification – Deflecting, Controlling and Damping torques – PMMC, MI, Electrodynamometer type instruments – Expression for torque. Extension of ranges using Shunts and Multipliers-numerical problems. Instrument transformers: C.T & P.T: Principle of operation and working.

Unit-2 Measurement of Power, Power factor & frequency: (15 hrs)

Single phase and three phase dynamometer wattmeter: LPF and UPF; Expression for deflecting and control torques; Measurement of active and reactive powers in balanced and unbalanced systems-Numerical problems. (09 hrs)

Type of P.F. Meters – Single phase and three phase dynamometer and moving iron type (Elementary treatment only) (02 hrs)

Electrical resonance type frequency meter and Weston typesynchroscope, Phase sequence indicator (Elementary treatment only) (04 hrs)

Unit-3 Potentiometers & Bridges (12 hrs)

Potentiometers: Principle and operation of D.C. Crompton's potentiometer – Standardization – Measurement of unknown resistance – Current – Voltage. AC Potentiometers: polar and coordinate types – Standardization (Elementary treatment only). **(06 hrs)**

Bridges: Kelvin's double bridge, Wheat stone's bridge, Measurement of high resistance by loss of charge methods – Megger; Measurement of Inductance & Capacitance: Maxwell' bridge, Anderson's bridge, Hays bridge, Wien's bridge, Schering's bridge, Wagner's earth device. **(06 hrs)**

Unit-4 Transducers (12 hrs)

Transducers: Q-meters, Definition and Classification of Resistive, Inductive and Capacitive Transducer, LVDT, Strain Gauge,Thermistors, Thermocouples, Piezo electric and Photo Diode Transducers, measurement of non-electrical quantities – Pressure- Angular velocity- liquid level.

Unit-5 Digital Meters: (10 hrs)

Advantages of Digital meters**,** Principle of operation of Ramp, dual–Slope integration continuous balance type DVM's - Successive approximation DVM's, digital multi-meters, digital phase & frequency meters and digital tachometer.

Course Outcomes

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

CO1 Choose suitable instrument for measurement of ac and dc Electrical quantities. **{Understand level, KL2}**

CO2 Understand the concepts used in measurement of power, power factor, and frequency & know the application of synchroscope and sequence indicators. **{Understand level, KL2}**

CO3 Select suitable bridge for measurement of electrical parameters. **{Apply level, KL3}**

CO4 Acquire proper knowledge to use various types of Transducers and able to measure various non-electric quantities. **{Apply level, KL3}**

CO5 Acquire proper knowledge and working principle of various types of digital instruments. **{Understand level, KL2}**

Text books:

1. Electrical & Electronic Measurement & Instruments by A.K.Sawhney, Dhanpat Rai & Co 17th edition 2000.

2. Electronic Instrumentation by H S Kalsi, 2nd Edition, McGraw-Hill Publishing, 2004.

3. Electrical Measurements and measuring Instruments - by E.W. Golding and F.C. Widdis, 5th Edition, Wheeler Publishing, 1999.

Reference books:

1. Electrical and Electronic Measurements and instrumentation by R.K.Rajput, S.Chand

2. Electrical Measurements by Harris John Wiley.

3. Electrical Measurements: Fundamentals, Concepts, Applications – by Reissland, M.U, New Age International (P) Limited, Publishers.

e- Resources & other digital material

1. https://nptel.ac.in/noc/courses/noc19/SEM2/noc19-ee44
2. http://www.facstaff.bucknell.edu/mastascu/elessonshtml/Measurements/MeasIntro.htm
3. http://www.electrical4u.com/electrical-measuring-instruments-types-accuracy-precision-resolutionspeed/

III-Year-I Semester

Power Electronics

L	T	P	C
3	0	0	3

PRE-REQUISITES: 1. Basic Circuit Analysis
2. Basics of Electronics
3. Concepts of Integrations

Preamble: It is very common to use power converters in all the systems of engineering. So it is compulsory for the students to imbibe the concepts of power electronics. This course covers characteristics of semiconductor devices, AC-DC, DC-DC, AC-AC and DC-AC converters.

Course objectives: The main objectives are

1.To study the characteristics of various power semiconductor devices and to design firing circuits for SCR.

2. To understand the operation of single phase full–wave converters and analyse harmonics in the input current.

3. To study the operation of three phase full–wave converters.

4. To understand the operation of choppers and AC-AC converters.

5. To understand the operation of inverters and application of PWM techniques for voltage control and harmonic mitigation.

Unit-1 Power Semi-Conductor Devices (12 hrs)

Static Characteristics of power MOSFET and power IGBT, Silicon controlled rectifier (SCR): Basic theory of operation of SCR–Static characteristics–Dynamic characteristics of SCR - Turn on and turn off methods– Firing circuits of SCR-Snubber circuit design, Single phase diode bridge rectifier.

Unit-2 Single-Phase AC-DC Converters (12 hrs)

Half wave controlled converter, Full wave controlled converters: Half controlled bridge converter with R and RL loads–continuous and discontinuous conduction, Fully controlled bridge converter with R and RL loads–continuous and discontinuous conduction, Effect of source inductance in fully controlled bridge rectifier with continuous conduction.

Unit-3 Three-Phase AC-DC Converters (12 hrs)

Three-phaseHalf controlled bridge converter with R and RL loads: continuous and discontinuous conduction, Three-phaseFully controlled bridge converter with R and RL loads: continuous and discontinuous conduction, 3-phase semi controlled rectifier with R and RL load, Three-phase Dual converter.

Unit-4 DC–DC Converters (12 hrs)

Introduction to Choppers, Classifications of Choppers, Analysis of Buck, Boost and Buck-Boost converters in Continuous Conduction Mode only. (05 hrs)

AC – AC Regulators.

Integral cycle control, Single phase-controlled AC voltage controller with R and RL loads , Single phase bridge Cycloconverters with R-load only. (07 hrs)

Unit-5 DC–AC Converters **(12 hrs)**

Single- phase full bridge inverters with R and RL loads, Unipolar and Bipolar switching, 3-phase inverters: 120^0 and 180^0 conduction modes, PWM Inverters, Sinusoidal pulse width modulation method, Current Source Inverter (CSI).

Real time applications: UPS operation.

Content Beyond the syllabus:

Power diode, Series and parallel operation of SCR's, Three phase uncontrolled Rectifiers, Series inverter.

Course Outcomes

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

CO1 **Design** firing circuits for SCR. **{Apply level, KL4}**

CO2 **Evaluate** the performance of converters and can suggest the converter required for DC drives. **{Evaluate level, KL5}**

CO3 **Analyze** the source current harmonics. **{Analyze level, KL4}**

CO4 **Understand** the operation of different types of DC-DC converters**{Understand level, KL2}**

CO5 **Explain** the operation of inverters and application of PWM techniques for voltage control and harmonic mitigation. **{Explain level, KL3}**

Text books:

5. "Power Electronics" M.D.Singh, K B Khanchandani, 2nd edition, Tata Mc-Graw Hill publishers,2007.
6. "Power Electronics" P.S.Bhimbra, 3rd edition, Khanna Publishers, 2002.
7. "Power Electronics" Daniel W.Hart, 1st edition, Tata Mc-Graw Hill publishers,2011.

Reference books:

6. "Power Electronics: Circuits, Devices and Applications" M. Harnur Rashid, 3rd edition, Pearson, 2009.
7. "Power Electronics: converters, applications & design" Ned Mohan, Tore M. Undeland, W.P. Riobbins 3rdedition,Wiley India Pvt. Ltd,2009.
8. "Thyristorised Power Controllers" G. K. Dubey, S.R.Doradla, A.Joshi, R. M. K.Sinha, 1st edition, New Age International (P) Limited Publishers, 1996

e- Resources & other digital material

1. https://nptel.ac.in/noc/courses/noc21/SEM1/noc21-ee01/
2. https://www.coursera.org/learn/power-electronics
3. https://www.classcentral.com/course/powerelectronics-716
4. https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-334-power-electronics-spring-2007/lecture-notes/

III-Year-I Semester **Object Oriented Programming through JAVA (Open Elective)**

L	T	P	C
2	0	2	3

PRE-Requisites C language and object oriented concepts knowledge

Course objectives: The students should be able to

1. Tounderstandobject-orientedprogrammingconcepts,andapplytheminsolving problems.
2. To make the students to learn the principles of inheritance and polymorphism; and todemonstratehowtheyrelatetothedesignofabstractclasses;tointroducetheimple mentationof packages and interfaces.
3. Tomakethe studentstolearn theconcepts ofexceptionhandling.
4. Tomakethestudentsto learntheconceptsof multithreading.
5. Tomakethestudents todevelopGUIapplications.

Unit-1 IntroductiontoOOPSConcepts,ClassesandStrings

Introduction to Object Oriented Programming, Java buzzwords, Java Programming Basics,Sampleprograms, Data types and operators, Controlstatements.

Classes: Classes, Objects, Methods, Constructors, this and static keywords, Method andConstructor Overloading, Access modifiers, arrays-One Dimensional and multi-dimensionalarrays,Searching, Sorting.

Strings-ExploringtheStringclass, Stringbuffer class, Command-linearguments.

Unit-2 Inheritance, Interfaces, Packages

Inheritance : Need of inheritance, types, super keyword, abstract classes, interfaces, compile time and runtime polymorphism, Packages.

Unit-3 ExceptionHandlingand I/OStreams10 Hrs

Exception Handling: Concepts of Exception handling, Built-in exceptions, creating ownexceptionsub classes,Assertions.

StreambasedI/O(java.io)–TheStreamClasses-BytestreamsandCharacterstreams,readingconsole Input and Writing Console Output, File class, Reading and writing Files, Randomaccessfile operations, Object Serialization, exploringjava.nio

Unit-4 Multithreading

Concepts of Multithreading, differences between process and thread, threadlifecycle,Threadclass,Runnableinterface,creatingmultiplethreads,Synchronization,threadpri orities,inter threadcommunication,daemon threads, threadgroups.

Unit-5 GUI Programming with Swing: Introduction, limitations of AWT, Various swing components & hierarchy.

EventHandling-
eventdelegationmodel,sourcesofevent,EventListeners,adapterclasses,innerclasses.

Course Outcomes

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

CO1 **Comprehend** object-oriented programming concepts for problem solving.

CO2 **Build** classhierarchyandpackages forrealworldproblems.

CO3 **Develop** thread safe Java programs with appropriate Exception handling.

CO4 **Demonstrate** multithreaded application programs through a language

CO5 **Design** GUI applications using swings and multithreading.

Textbooks:

1. Java - The Complete Reference, Herbert Schildt, MC GRAW HILL Education,9th Edition, 2016.

Reference books:

1. Java – How to Program", Paul Deitel, Harvey Deitel, PHI.
2. "Core Java", Nageswar Rao, Wiley Publishers.
3. "Thinking in Java", Bruce Eckel, Pearson Education
4. "A Programmers Guide to Java SCJP", Third Edition, Mughal, Rasmussen, Pearson.

III-Year-I Semester **Electrical Measurements and Instrumentation Lab**

L	T	P	C
0	0	3	1.5

PRE-REQUISITES: 1) Basic Circuit Analysis

Preamble:
This course introduces principle of operation of basic analog and digital measuring instruments for measurement of current, voltage, power, energy etc. Measurement of resistance, inductance and capacitance by using bridge circuits will be discussed in detail. It is expected that student will be thorough with various measuring techniques that are required for an electrical engineer.

Course Objectives: The student should be able
1. To study the principle of operation and working of different types of instruments. Measurement of voltage and current.
2. To study the working principle of operation of different types of instruments for measurement of power and energy
3.To understand the principle of operation and working of dc and ac potentiometers.
4.To understand the principle of operation and working of various types of bridges for measurement of parameters –resistance, inductance, capacitance and frequency.

LIST OF EXPERIMENTS

Any Ten of the following experiments are to be conducted:

1. Calibration and testing of single-phase energy meter.
2. Calibration of dynamo meter type power factor meter.
3. Calibration of PMMC voltmeter and ammeter by dc Crompton's Potentiometer.
4. Measurement of resistance using Kelvin's double bridge.
5. Transformer turns ratio measurement using A.C. bridge.
6. Measurement of capacitance by using Schering bridge.
7. Measurement of inductance by using Anderson's bridge.
8. Measurement of 3 - phase reactive power by using single wattmeter.
9. Measurement of parameters of choke coil using three voltmeter and three ammeter methods.
10. Calibration of LPF wattmeter by phantom testing.
11. Measurement of 3 - phase power by using 1 - phase wattmeter and two current transformers.
12. C.T. testing using mutual inductor – measurement of % ratio error and phase angle of given C.T. by null method.
13. LVDT and capacitance pickup-characteristics and calibration.

List of Additional Experiments: Any of the two experiments are to be conducted

1. Resistance strain gauge- strain measurements and calibration.
2. Dielectric oil testing using h.t. testing kit.

3. Measurement of % ratio error and phase angle of given C.T by comparison.

Course Outcomes: Upon successful completion of the course, the student will be able to

Course Outcomes

CO1	Able to choose right type of instrument for measurement of voltage and current for ac and dc. (**Analyze**)
CO2	Able to choose right type of instrument for measurement of power and energy – able to calibrate energy meter by suitable method (**Remember and Understand**)
CO3	Able to calibrate ammeter, voltmeter and potentiometer. (**Analyze**)
CO4	Able to select suitable bridge for measurement of electrical parameters. (**Evaluate**)

Text books:

1. Electrical Measurements and measuring Instruments – by E.W. Golding and F.C.Widdis, fifth Edition, Wheeler Publishing.
2. Modern Electronic Instrumentation and Measurement Techniques – A.D. Helfrick and W.D. Cooper, PHI, 5th Edition, 2002.

Reference books:

11. Electrical & Electronic Measurement & Instruments by A.K.SawhneyDhanpatRai&Co.Publications.
2. Electrical and Electronic Measurements and instrumentation by R.K.Rajput, S.Chand.
3. Electrical Measurements – by Buckingham and Price, Prentice – Hall
4. Electrical Measurements: Fundamentals, Concepts, Applications – by Reissland, M.U, New Age International (P) Limited, Publishers.
5. Electrical and Electronic Measurements by G.K.Banerjee,PHI Learning Private Ltd,New Delhi–2012

e- Resources & other digital material

1.https://nptel.ac.in/courses/108/105/108105017
2.https://nptel.ac.in/courses/103/102/108102146
3.www.nptelvideos.in/2012/11/electrical measurements and instrumentation.html
*4.*https://www.electrical4u.com/losses-in-dc-machine

III-Year-I Semester **POWER ELECTRONICS LABORATORY**

L	T	P	C
0	0	3	1.5

PRE-REQUISITES: 1) Power Electronics Theory

Preamble: Introduction to power electronics, Various power electronics devices, Pulse width modulation, AC to DC Converters, AC Voltage Regulator, Buck converter, Boost converter and inverters

Course Objectives: The student should be able to

1.Study the characteristics of various power electronic devices and analyze firing circuits and commutation circuits of SCR.
2. Analyze the performance of single–phase and three–phase full–wave bridge converters with both resistive and inductive loads.
3. Understand the operation of AC voltage regulator with resistive and inductive loads.
4. Understand the working of Buck converter, Boost converter and inverters.

LIST OF EXPERIMENTS

Any Ten of the following experiments are to be conducted:

1. Study of Characteristics of Thyristor, MOSFET & IGBT, SCR.
2. Experimentally study of a firing circuit for Thyristor.
3. Experimentally study of gate drive circuits for IGBT.
4. Single -Phase Half controlled converter with R and RL load
5. Single -Phase fully controlled bridge converter with R and RL loads.
6. Single -Phase AC Voltage Regulator with R and RL Loads
7. Single -Phase square wave bridge inverter with R and RL Loads
8. Three- Phase fully controlled converter with RL–load.
9. Design and verification of voltages gain of Boost converter.
10. Design and verification of voltages gain of Buck-Boost converter.
11. Single -phase PWM inverter with sine PWM technique.
12. 3-phase AC-AC voltage regulator with R-load.

List of Additional Experiments: Any of the two experiments are to be conducted

1. Study of Characteristics of NPN Transistor.
2. Design and verification of voltages gain of Buck converter.
3. Three -phase PWM inverter with sine PWM technique.

Course Outcomes: Upon successful completion of the course, the student will be able to

Course Outcomes

CO1	Study the characteristics of various power electronic devices and analyze gate drive circuits of IGBT. (**Analyze**)
CO2	Analyze the performance of single phase and three phase full wave bridge converters with both resistive and inductive loads. (**Remember and Understand**)
CO3	Understand the operation of single phase AC voltage regulator with resistive and inductive loads. (**Analyze**)
CO4	Understand the working of Buck converter, Boost converter, single phase square wave inverter and PWM inverter. (**Evaluate**)

Text books:

1. Elements of Power Electronics–Philip T.Krein.oxford.
2. Power Electronics – by P.S.Bhimbra, Khanna Publishers.

Reference books:

1. Power Electronics by M. D. Singh and K. B. Khanchandani – USA

2. Power Electronics: Converters, Applications And Design, Media Enhanced (With CD) by Ned Mohan, Tore M. Undeland, and William P. Robbins.

3.Principles Of Power Electronics by John G. Kassakian, Martin F. Schlecht, and George C.

e- Resources & other digital material

1. http://vlabs.iitb.ac.in/vlabs-dev/labs/mit_bootcamp/power_electronics/labs/index.php
2. https://www.vlab.co.in/broad-area-electrical-engineering
3. https://www.vlab.co.in/broad-area-electronics-and-communications

III-Year-II Semester MICROPROCESSORS AND MICROCONTROLLERS

L	T	P	C
3	0	0	3

PRE-REQUISITES: The Purpose of the course is to provide students with the Knowledge of Microprocessors and Microcontroller. To solve real world problems in an efficient manner, this course also emphasis on architecture, Programming and system design used in various day to day gadgets.

Course objectives: The student should be able to

To understand the organization and architecture of Micro Processor

2. To understand addressing modes to access memory and modes of operation
3. To interface different devices to 8086.
4. To understand 8051 micro controller architecture
5. To understand the basics of PIC18 architecture and develop programs using C.

Unit-1 Introduction to Microprocessor Architecture(13h)

Introduction and evolution of Microprocessors,8086 Pin diagram- Architecture of 8086, Register Organization of 8086, Memory organization of 8086– General bus operation of 8086–Introduction to 80286–80386 and 80486 and Pentium [Elementary treatment only]

Unit-2 Minimum and Maximum Mode Operations (10h)

Instruction set- Addressing modes, Minimum and Maximum mode operations of 8086- Read and write cycle timing diagrams, 8086 Control signal interfacing

Unit-3 I/O Interface(20h)

8255 PPI– Architecture of 8255–Modes of operation–Interfacing A to D converters– Interfacing D to A converters– Stepper motor interfacing, DMA controller (8257)–Architecture– Modes of operations, Programmable Interrupt Controller (8259)–Modes of Operation- Command words of 8259,Keyboard/display controller (8279)–Architecture–Modes of operation[Elementary treatment only]

Unit-4 Introduction to 8051 Micro Controller (12h)

Introduction to 8051 Micro Controller– Architecture– Register set, I/O ports, Memory Organization– Interrupts, Timers and Counters–Serial Communication.

Unit-5 Introduction to PIC Micro Controller (10h)

Block diagram of basic PIC 18 micro controller, registers I/O ports, Data types, I/O programming, logical operations, data conversion., Numerical problems. **(06 hrs)**

Content Beyond the syllabus:

Powering A Generation: Generating Electricity using Fossil-fuelled plants, Cogeneration, Combined-cycle and Biomass plants, Geothermal plants, and Decentralized generation. (Elementary treatment only)

Advanced Transmission Technologies: High-temperature super conducting technology, Advanced composite conductors.(Elementary treatment only)

New Technologies for Electric power Distribution Systems: Concept of Intelligent Substations (Elementary treatment only).

Tariff structure design process: Identification of tariff structures, tariff constraints (Elementary treatment only)

Course Outcomes

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

CO1	Understand the concepts of 8086 architecture, register and memory organization{Knowledge level, KL1}
CO2	Understand and apply the concepts of the modes of operations and instruction set to develop the Assembly level language programs. {Apply level, KL3}
CO3	Classify the types of interfacing devices and implement to interface with 8086 {Knowledge level, KL1}
CO4	Explain the 8051 architecture and its features. {Knowledge level kL1}
CO5	Understand the PIC18 architecture and Develop the programs using C {Apply level, KL3}

Text books:

1. "Advanced Micro Processors and Interfacing", Ray and Burchandi, Tata McGraw– Hill
2. "The 8051 Micro Controller Architecture, Programming and Applications", Kenneth J Ayala, Thomson Publishers, 2nd Edition.
3. "PIC Microcontroller and Embedded Systems using Assembly and C for PIC 18", Muhammad Ali Mazidi, RolindD.Mckinay, Danny causey, Pearson Publisher 21st Impression..

Reference books:

1. "A Text book of Microprocessors and Micro Controllers", R.S. Kaler, I.K. International Publishing House Pvt. Ltd.
2. "Microcontrollers – Theory and Applications", Ajay V. Deshmukh, Tata McGraw– Hill Companies –2005
4. "Microcontrollers – Principles and Applications", Ajit Pal, PHI Learning Pvt Ltd, 2011.
5. "Microprocessors and Interfacing", Douglas V Hall, Mc–Graw Hill, 2nd Edition.

e- Resources & other digital material

https://nptel.ac.in/courses/108107029

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III-Year-II Semester

POWER SYSTEMS-III

L	T	P	C
3	0	0	3

Pre-Requisites: Power Systems-I and Power Systems-II

Preamble:

The course is designed to give the required knowledge for the calculation of power flow in a power system network using various techniques, short circuit analysis, power system analysis for steady state and transient stability. It also deals with economic operation of power systems, modelling of speed governing system, turbines and generators including single area and two area load frequency control.

Course Objectives:

- To study the Gauss Seidel, Newton Raphson, Decoupled and Fast Decoupled load flow methods.
- To understand the short circuit calculations for symmetrical and unsymmetrical faults.
- To study the stability analysis of power systems.
- To understand optimal dispatch of generation with and without losses.
- To study the load frequency control for single and two area system.

Unit-1 Power Flow Studies (13hrs)

Necessity of power flow studies, Derivation of static power flow equations, Load flow solutions using Gauss Seidel Method, Newton Raphson Method, Decoupled and Fast Decoupled Methods, Numerical problems (3 bus system up to one iteration only).

Unit-2 Short Circuit Analysis

Symmetrical Fault Analysis: (6hrs)

Symmetrical fault analysis-Short circuit current and MVA calculations, Series reactors-Selection and Advantages of reactors, Numerical problems.

Unsymmetrical Fault Analysis: (7hrs)

Symmetrical component theory-Positive, Negative and Zero sequence components, Sequence impedances and networks, Various types of faults-LG, LL and LLG on unloaded alternator, Numerical problems.

Unit-3 Stability Analysis

Steady State Stability: (7hrs)

Classification of power system stability,Transfer Reactance, Synchronizing Power Coefficient ,Power Angle Curve , Determination of Steady State Stability, Methods to improve steady state stability, Numerical Problems.

Transient Stability: (6hrs)

Swing Equation, Determination of Transient Stability by Equal Area Criterion, Application of Equal Area Criterion-Critical Clearing Angle and time,Methods to improve transient stability, Numerical Problems.

Unit-4 Economical Operation of Power Systems:

Different Curves: (6hrs)

Optimal operation of Generators in Thermal power stations, Input–output characteristics, Cost Curve, Heat rate curve, Incremental fuel and Production costs.

Mathematical Analysis: (6hrs)

Optimum generation allocation with and without transmission line losses, Loss Coefficients, General transmission line loss formula, Numerical Problems.

Unit-5 Load Frequency Control

Single Area Control: (7hrs)

Modeling of speed governing system, steam turbine and generator, Control area concept, Single area control-Transfer function and Block diagram representation of an isolated power system, Steady state analysis, Dynamic response, Proportional plus Integral control of single area and its block diagram representation, Numerical Problems.

Two Area Control: (6hrs)

Transfer function and Block diagram representation, Tie-line bias control, Steady state analysis, real time applications of load frequency control and economic load dispatch.

Course Outcomes

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

CO1	Find out the load flow solution of a power system network using different load flow methods.
CO2	Evaluate the fault current for different types of faults with a view to provide data for the design of protective devices.
CO3	Analyze the steady state and transient stability concepts of a power system.
CO4	Calculate optimal scheduling for generators **with and without losses**.
CO5	Acquire the knowledge of load frequency control **for various systems**.

Textbooks:

1. Modern Power System Analysis- I.J.Nagrath&D.P.Kothari: Tata McGraw-Hill Publishing Company, 2^{nd} edition.
2. Electrical Power Systems- C.L. Wadhwa, New Age International Publishers, 7th Edition.

Reference books:

1. Power System Analysis–Grainger and Stevenson, Tata McGraw-Hill
2. Power Systems Operation and Control –Chakravarthi, Prentice Hall, Inc.
3. Power System Analysis -Hadi Saadat, TMH Edition .
4. Power System Stability & Control -PrabhaKundur, TMH.

e- Resources & other digital material

1. https://nptel.ac.in/courses/117105140/
2. https://nptel.ac.in/courses/108/105/108105104
3. https://nptel.ac.in/courses/108/107/108107127/
4. https://nptel.ac.in/courses/108/105/108105060/
5. https://www.coursera.org/learn/electric-power-systems
6. https://www.edx.org/ power-systems
7. https://www.classcentral.com/course/electric-power-systems

III-Year-II Semester **DIGITAL ELECTRONICS**
(Professional Elective I)

L	T	P	C
3	0	0	3

PRE-REQUISITES: NIL

Course objectives: The student should be able to

1. To understand common forms of number representation in digital circuits and Boolean algebra.
2. To learn basic techniques for the design of digital circuits and fundamental concepts used in the design of digital systems and simplify logic expressions using basic theorems, K-map and Tabular methods.
3. To understand the concept of Combinational logic design and realize logic expressions using MUX and Decoder
4. Illustrate the concept of sequential logic design; analyze the operation of flip-flop and conversion from one flip-flop to another, and application of flip-flop.
5. To impart to student the concepts of sequential machines of digital system.

Unit-1 Number Systems and Boolean Algebra 14 Hours

Number systems: Introduction to different number system and their conversions, Complement of number system and subtraction using complement method, Weighted and Non-weighted codes and its Properties, Error detection and correction codes,

Boolean Algebra: Boolean algebra and logic gates, Basic theorems and properties of Boolean Algebra, Boolean functions, canonical and standard forms, Universal Gates.

Unit-2 Minimization Methods of Boolean functions 11 Hours

Minimization of logic expressions by algebraic method, Sum of Products (SOP), Product of Sums (POS), K-Map Method, Don't Care Combinations, Prime and essential Prime Implicants, Tabular Method.

Unit-3 Combinational Circuits 14 Hours

Design procedure, Half/full adders, Half / full subtractors, Carry look ahead adder, Multiplexer/De-Multiplexer, Encoder/Decoder, Priority encoders, Implementation of Higher-Order Device Using Lower Order devices, Implementation of combinational logic using MUX/Decoder, Magnitude Comparator.

Unit-4 Sequential Circuits 12 Hours

Sequential Circuits Fundamentals: Basic Architectural Distinctions between Combinational and Sequential circuits, SR Latch, Flip Flops: SR, JK, JK Master Slave, D and T Type Flip Flops, Excitation Table of all Flip Flops, Timing and Triggering Consideration, Conversion from one type of Flip-Flop to another.

Registers and Counters: Shift Registers Left, Right and Bidirectional Shift Registers, Applications of Shift Registers, Design and Operation of Ring and Twisted Ring Counter, Operation of Asynchronous and Synchronous Counters.

Unit-5 Sequential Machines 8 Hours

Finite State Machines, Synthesis of Synchronous Sequential Circuits, Mealy and Moore models, Serial Binary Adder, Sequence Detector, Parity-bit Generator Synchronous Modulo N – Counters, Finite state machine capabilities and limitations.

Course Outcomes

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

CO1 Distinguish the analog and digital systems, apply positional notations, number systems, computer codes in digital systems. **(Remember, Understand, and Apply)**

CO2 Uunderstand the Boolean Algebra theorems, simplify and design logic circuits. **(Understand, Apply, Analyze and valuate)**

CO3 Implement combinational logic circuit design and modular combinational circuits using encoders, decoders, multiplexers and demultiplexers. (**Apply, Analyze, valuate, and create)**

CO4 Understand the basic elements of sequential logic circuits. **(Understand, Apply, Analyze)**

CO5 Design and analyze sequential circuits. **(Apply, Analyze and create)**

Text books:

1. Digital Design by Mano, PHI
2. Modern Digital Electronics by RP Jain, TMH
3. Switching Theory and Logic Design by A. Anand Kumar, PHI.
4. Switching and Finite Automata Theory- ZviKohavi& Niraj K. Jha, Cambridge.

Reference books:

1. Switching Theory and Logic Design by Hill and Peterson Mc-Graw Hill TMH edition
2. Fundamentals of Logic Design by Charles H. Roth Jr, Jaico Publishers

e- Resources & other digital material

1. https://nptel.ac.in/courses/108/105/108105113/
2. https://www.coursera.org/learn/digital-systems
3. https://swayam.gov.in/nd1_noc20_ee70/preview

III- Year II- Semester	Name of the Course	L	T	P	C
	FLEXIBLE A.C TRANSMISSION SYSTEM (Professional Elective I)	3	0	0	3

PRE-REQUISITES: 1) Power Electronics and Power Systems

Course Objectives: The student should be able to

1. Study the basics of power flow control in transmission lines using FACTS controllers
2. Explain operation and control of voltage source and current source converter.
3. Understand Shunt compensation methods to improve stability and reduce power oscillations of a power system.
4. Know the methods of compensation using Series compensators.
5. Study the operation and control of Unified Power Flow Controller (UPFC) and Interline Power Flow Controller (IPFC).

Syllabus		
Unit No	**Contents**	**Mapped CO**
I	**Introduction to FACTS and High Power Electronic Devices(12 hrs)** **Introduction to FACTS (08 hrs)** Power flow in an AC System – Loading capability limits – Dynamic stability considerations – Importance of controllable parameters – Basic types of FACTS controllers – Benefits from FACTS controllers. **Introduction to High Power Electronic Devices(04 hrs)** Requirements and characteristics of high power devices – Voltage and current rating – Losses and speed of switching – Parameter trade–off devices.	**CO1**
II	**Voltage source and Current source converters (12 hrs)** **Voltage source converters:** Concept of voltage source converter (VSC) – Single phase bridge converter – Square wave voltage harmonics for a single–phase bridge converter – Three–phase full wave bridge converter. **(09 hrs)** **Current source converters**– Concept of current source converter(CSC) -Comparison of current source converter with voltage source converter. **(03 hrs)**	**CO2**
III	**Shunt Compensators (14 hrs)** **Shunt Compensators–1 (07 hrs)** Objectives of shunt compensation – Mid–point voltage regulation for line segmentation – End of line voltage support to prevent voltage instability – improvement of transient stability – Power oscillation damping. **Shunt Compensators–2 (07 hrs)** Thyristor Controlled and Thyristor Switched Reactor (TCR & TSR), Thyristor Switched Capacitor (TSC) – Static VAR compensator (SVC) and Static Compensator (STATCOM)- comparisons between SVC and STATCOM.	**CO3**
IV	**Series Compensators (12 hrs)** Static series compensators**:** Concept of series capacitive compensation – Improvement of transient stability – Power oscillation damping – Functional requirements. GTO thyristor controlled Series Capacitor (GSC) – Thyristor Switched Series Capacitor (TSSC), Thyristor Controlled Series Capacitor (TCSC) and Static Synchronous Series Compensator (SSSC)	**CO4**

V	**Combined Controllers (10 hrs)** Schematic and basic operating principles of Unified Power Flow Controller (UPFC) and Interline Power Flow Controller(IPFC),real time applications of these controllers on transmission lines.	CO5
Content Beyond the syllabus: **Shunt compensators**: Operating point control and summary of compensation control. **Combined Controllers :**Conventional transmission control capabilities,Mathematical modelling of UPFC and IPFC		

Course Outcomes	
Upon successful completion of the course, the student will be able to	
CO1	**Understand** the power flow control in transmission lines using FACTS controllers. **{Understand level, KL2}**
CO2	**Explain** the operation and control of voltage source and current source converters. .**{Apply level, KL3}**
CO3	**Analyze** the compensation methods to improve stability and reduce power oscillations in the transmission lines.**{Analyze level, KL4}**
CO4	**Understand**the methods of compensations using series compensators. . **{Understand level, KL2}**
CO5	**Explain** operation and control of Unified Power Flow Controller (UPFC) and Interline Power Flow Controller(IPFC).**{Apply level, KL3}**

Learning Resources

Text books:

1. "Understanding FACTS" N.G.Hingorani and L.Guygi, IEEE Press.Indian Edition is available:—Standard Publications, 2001.

Reference books:

1 "Flexible AC transmission system (FACTS)" Edited by YONG HUE SONG and ALLAN T JOHNS, Institution of Electrical Engineers, London.
2 Flexible AC Transmission Systems: Modeling and Control by Zhang Rehtanz Bikash Pal, SPRINGER INDIA.
3 Facts Controllers In Power Transmission and Distribution by K.R.Padiyar, New Age International Pvt Ltd; Second edition (1 January 2016)

e- Resources & other digital material

1. https://nptel.ac.in/courses/108/102/108102047/
2. https://www.coursera.org/learn/electric-power-systems
3. http://ieeexplore.ieee.org/stamp/stamp.jsp?arnumber=00634216
4. https://www.electronicshub.org/flexible-ac-transmission-systemfacts/
5. https://www.electrical4u.com/facts-on-facts-theory-and-applications/
6. https://link.springer.com/book/10.1007%2F978-3-642-28241-6

Micro-Syllabus-FACTS

Unit-1: Introduction to FACTS and High Power Electronic Devices(12 hrs)

Introduction to FACTS (08 hrs)

Power flow in an AC System – Loading capability limits – Dynamic stability considerations – Importance of controllable parameters – Basic types of FACTS controllers – Benefits from FACTS controllers.

Introduction to High Power Electronic Devices(04 hrs)

Requirements and characteristics of high power devices – Voltage and current rating – Losses and speed of switching – Parameter trade–off devices.

Unit No	Module	Micro content
1a. Introduction to FACTS	**Introduction to FACTS**	Power flow in an AC System
		Loading capability limits
		Dynamic stability considerations
		Importance of controllable parameters
		Basic types of FACTS controllers and benefits of facts controllers.
1b. Introduction to High Power Electronic Devices	**Introduction to High Power Electronic Devices**	Requirements and characteristics of high power devices
		Voltage and current rating
		Losses and speed of switching
		Parameter trade–off devices.
		Advantages and Disadvantages.

Unit-2:Voltage source and Current source converters (12 hrs)

Voltage source converters: Concept of voltage source converter (VSC) – Single phase bridge converter – Square wave voltage harmonics for a single–phase bridge converter – Three–phase full wave bridge converter. **(09 hrs)**

Current source converters– Concept of Current source converter (CSC) -Comparison of current source converter with voltage source converter. **(03 hrs)**

Unit No	Module	Micro content
2a. Voltage source converters	**Voltage source converters**	Concept of voltage source converter (VSC)
		Single phase bridge converter
		Square wave voltage harmonics for a single–phase bridge converter
		Three–phase full wave bridge converter.
2b. Current source converters	**Current source converter**	Concept of Current source converter (CSC)
		Comparison of current source converter with voltage source converter.

Unit-3:Shunt Compensators (14 hrs)

Shunt Compensators–1 (07 hrs)

Objectives of shunt compensation – Mid–point voltage regulation for line segmentation – End of line voltage support to prevent voltage instability – improvement of transient stability – Power oscillation damping.

Shunt Compensators–2 (07hrs)

Thyristor Controlled and Thyristor Switched Reactor (TCR & TSR), Thyristor Switched Capacitor (TSC) – Static VAR compensator (SVC) and Static Compensator (STATCOM)- comparisons between SVC and STATCOM.

Unit No	Module	Micro content
3a. Shunt Compensators–1	**Shunt Compensators–1**	Objectives of shunt compensation
		Mid–point voltage regulation for line segmentation
		End of line voltage support to prevent voltage instability
		Improvement of transient stability
		Power oscillation damping.
3b. Shunt Compensators–2	**Shunt Compensators–2**	Thyristor Switched & controlled Reactor (TCR & TSR).
		Thyristor Switched Capacitor (TSC)
		Static VAR compensator (SVC)
		Static Compensator(STATCOM)
		Comparisons between SVC and STATCOM.

Unit-4:Series Compensators (12 hrs)

Static series compensators**:** Concept of series capacitive compensation – Improvement of transient stability – Power oscillation damping – Functional requirements. GTO Thyristor controlled Series Capacitor (GSC) – Thyristor Switched Series Capacitor (TSSC), Thyristor Controlled Series Capacitor (TCSC) and Static Synchronous Series Compensator (SSSC)

Unit No	Module	Micro content
4. Series Compensators	**Series Compensators**	Concept of series capacitive compensation
		Improvement of transient stability and Power oscillation damping.
		GTO Thyristor controlled Series Capacitor (GSC).
		Thyristor Switched Series Capacitor (TSSC)
		Thyristor Controlled Series Capacitor (TCSC).
		Static Synchronous Series Compensator (SSSC)

Unit-5: Combined Controllers (10 hrs)

Schematic and basic operating principles of Unified Power Flow Controller (UPFC) and Interline Power Flow Controller(IPFC),real time applications of these controllers on transmission lines.

Unit No	Module	Micro content
5. Combined Controllers	**Combined Controllers**	Schematic and basic operating principle of Unified Power Flow Controller (UPFC)
		Schematic and basic operating principle of Interline Power Flow Controller (IPFC)

		Application of combined controllers on transmission lines

CO-PO mapping Table

Contribution of Course Outcomes towards achievement of Program Outcomes & Strength of correlations **(High: 3, Medium: 2, Low: 1)**														
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO-1	PSO-2
CO1	3													
CO2	3												1	
CO3	2													
CO4	2	2												1
CO5	3													1

III-Year-II Semester

Advance Control Systems
(Professional Elective I)

L	T	P	C
3	0	0	3

PRE-REQUISITES: 1) Control System
2) Analog Circuits -1
3) Engineering Mathematics -1

Course objectives: The student should be able to

1) Tostudythebasictheoryrequiredforsolvingcomplexcontrolproblems.
2) Todoanalysisandmodelingofsystemsandsignals.

Unit-1 **Conceptofstatespace-** statespacerepresentationofsystem,solutionoftimeinvariantstateequation-statetransitionmatrix.Lineartimevarying System.Discretesystemstatespacerepresentationandsolution (7hrs)

Unit-2 **Non-linearsystem**,typesofnon-linearity,singularpoint,non-linearsystemstabilityanalysis-phaseplanetechnique,constructionofphasetrajectories,isoclinemethod. (8Hrs)

Unit-3 **Describingfunctionanalysis** : Basicconcepts,derivationofdescribingfunctionsforcommonnon-linearities Describingfunction analysis of non-linear systems– Conditions for stability–Stabilityofoscillations. (9Hrs)

Unit-4 **Lyapunovstabilityanalysis-** definitionofstability,instabilityandasymptoticstability.Lyapunovstabilitytheorems.Stabilityanalysisof simplelinearsystems. (9Hrs)

Unit-5 **MIMOsystems-controllability**-Observability-Effectofpole-zerocancellation, Practical examples-controllable and uncontrollable systems-observableandunobservablesystems.Optimalcontrolsystem-definition-designusingstatevariablefeedbackanderrorsquaredperformance indices. (9Hrs)

Content Beyond the syllabus:

Z-transfer function- block diagram-signalflowgraph-discreterootlocus.

Course Outcomes

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

CO1 Graduateswillbeabletounderstanddifferent statemodelofasystem,andhavetheknowledgetofinditssolution. **{Knowledge& Understand(1&2) }**

CO2 Graduates will be able to understand nonlinear system models, and analyse its stability. {**Understand & Analyze (2 & 4)}**

CO3 Graduates will be able to analyse the describing function analysis of various nonlinear systems. {**Analyze (4)**}

CO4 Graduates will be able design different systems and analyse its stability using Lyapunov stability analysis.{**Analyze & Design (4 & 6)**}

CO5 Graduates will be industry ready by analysis of controllability and observability of the dissimilar system. {**Analyze (4)**}

Text books:

1. "Discrete Time Control Systems", K. Ogata, PHI, 1996.
2. "Modern Control Engineering", K. Ogata, PHI, 1996.
3. Modern Control Systems, R. C. Dorf and R. H. Bishop, 8th ed., Pearson Education, Delhi, 2004.

Reference books:

1. Process Control Instrumentation Technology, C. D. Johnson, 7th ed., Prentice Hall of India, New Delhi, 2003.
2. "Modern Control System Theory", M. Gopal, New Age International Publishers, 2nd edition,1996.
3. "Digital control and state variables methods", Madangopal, PHI, 1997.
4. Modern control engineering – Katsuhiko Ogata, Pearson Edn.

e- Resources & other digital material

1. http://nptel.iitm.ac.in/courses/108101037/
1. http://nptel.iitm.ac.in/video.php?subjectId=108102043
2. http://nptel.iitm.ac.in/courses/Webcourse-contents/IIT-Delhi/Control%20system%20design%20n%20principles/index.htm

III- Year II- Semester	Name of the Course	L	T	P	C
	Switched Mode Power Conversion **(Professional Elective I)**	3	0	0	3

PRE-REQUISITES: Concepts of Electrical Circuit Analysis and Power Electronics.

Course objectives: The student should be able to

6. To understand various modes of operation of DC-DC Converter
7. To analyze control aspects of converter
8. To design various Switched Mode Power Supply components
9. To understand the control schemes of DC-DC converters and designing of magnetic components.
10. Analyze the switch mode converters using small-signal analysis.

Syllabus		
Unit No	**Contents**	**Mapped CO**
I	**Basic Converter Circuits: 12 Hours** Buck Regulator, Buck- Boost Regulator, Boost Regulator, Cuk Converters and Resonant Converters. Choice of switching frequency.	**CO1**
II	**Isolated SMPS: 11 Hours** Fly back Converter, Forward Converter, Half-Bridge and Full Bridge Converters, Push-Pull Converter and SMPS with multiple outputs. Choice of switching frequency.	**CO2**
III	**Resonant converters: 14 Hours** Basic resonant circuit concepts, series resonant circuits, parallel resonant circuits, zero current switching quasi-resonant buck converter, zero current switching quasi-resonant boost converter, zero voltage switching quasi-resonant buck converter, zero voltage switching quasi-resonant boost converter.	**CO3**
IV	**Control schemes of switching converters: 12 Hours** Voltage control, Current mode control, control scheme for resonant converters. Magnetic design consideration: Transformer design, inductor and capacitor design.	**CO4**
V	**Modeling and Controller design based on linearization: 12 Hours** Formulation of averaged models for buck and boost converters: state space analysis, average circuit models, linearization and small – signal analysis, small-signal models. Control design based on linearization: Transfer function of converters, control design, large signal issues in voltage-mode and current-mode control.	**CO5**

Course Outcomes	
Upon successful completion of the course, the student will be able to	
CO1	Analyze various modes of operation of Dc-Dc converter**(Analyze)**

CO2	Design different controllers for converter **(Apply)**
CO3	Analyze operation and control of resonant converters. (**Analyze)**
CO4	Design various components of dc-dc converter **(Understand)**
CO5	Feedback design of switch mode converters based on linearized models. **(Apply)**

Learning Resources
Text books:
1. Fundamentals of Power Electronics-Erickson, Robert W., Maksimovic, Dragan, Springer, 2011. 2. Power switching converters-Simon Ang, Alejandro Oliva, CRC Press, 2010. 3. Elements of Power Electronics – Philip T. Krein, Oxford University press, 2014. 4. Design of Magnetic Components for Switched Mode Power Converters- Umanand, S.P. Bhat, John Wiley & Sons Australia, 1992.
Reference books:
3. Switching Power Supply Design-Abraham I. Pressman, McGraw-Hill Ryerson, Limited, 1991. 4. Power Electronics: converters Applications & Design – Mohan, Undeland, Robbins-Wiley publications.
e- Resources & other digital material
12. https://archive.nptel.ac.in/courses/108/108/108108036/

Module Coordinator **BOS** **HOD**

III- Year II- Semester	Name of the Course	L	T	P	C
	Power System Protection (Professional Elective II)	3	0	0	3

PRE-REQUISITES: 1) Power Systems

Course objectives: The student should be able to

1. Study the basic aspects of protection system and operation of circuit breakers.
2. Study the classification, operation and application of different types ofelectromagnetic protective relays.
3. Learn about the various protection schemes generators and transformers.
4. Know the various protection schemes applied for transmission lines and neutral grounding
5. Study the reasons for Over voltages, protection schemes and latest trends in Protection schemes

Syllabus		
Unit No	**Contents**	**Mapped CO**
I	**Introduction to Power system protection(12 hrs)** **Power system protection:**Faults in power system, characteristics of short circuit and open circuit faults and harmful effects, necessity of protection system, basic requirements, classification, protection system terminology. **(02 hrs)** **Fuse:** Introduction to fuse, fuse materials, characteristics of fuse and ratings; HRC fuse**(02 hrs)** **Circuit Breakers:** Elementary principles of arc phenomenon -Principle of operation of air, oil, vacuum and SF6 circuit breakers (Elementary treatment only) - Specification of circuit breakers, ratings and auto re-closures**. (08 hrs)**	**CO1**
II	**Fundamentals of Protectiverelays(12 hrs)** Protective Relays:**Relay connection – Principle of operation Balanced beam type attracted armature relay - induction disc andinduction cup relays–Torque equation –PSM, TSM - Relays classification–Instantaneous– DMT andIDMT types (06 hrs)** Applications of relays**:Over current and under voltage relays– Directionalrelays– Differential relays and percentage differential relays– Universal torque equation– Distance relays**: **Impedance– Reactance– Mho and offset mho relays– Characteristics ofdistance relays and comparison (06 hrs)**	**CO2**
III	**Protection of AC generators and Transformer(12 hrs)** **Protection of AC generators**: **Protection of generators against stator faults– Rotor faults and abnormal conditions–restricted earth fault and inter turn fault protection– Numerical example**. **(07 hrs)**	**CO3**

	Protection of transformers: **Percentage differential protection– Design of CT's ratio–Buchholz relay protection–Numerical examples**. **(05 hrs)**	
IV	**Protection of Transmission lines and Neutral grounding(12 hrs)** Protection of lines: **Over current Protection schemes - Numerical examples –** Pilot wire protection - **Carrier current and three zone distance relay using impedance relays–Protection of bus barsby using Differential protection**.**(08 hrs)** **Neutral grounding:** Grounded and ungrounded neutral systems–Effects of ungrounded neutral on system performance– Methods of neutral grounding: Solid–resistance–Reactance–Arcing grounds and grounding Practices **(04 hrs)**	**CO4**
V	**Protection against Over voltages and Advancements in Protection systems (12 hrs)** Over Voltage Protection**: Causes of over voltages in power systems – internal causes - Protection against lightning over voltages: Rod gap and horn gap arrester–Valve type and expulsion type lighting arresters and ground wires (elementary treatment only) – Selection of lightning arresters - Insulation coordination (10 hrs)** **Advancements in Protection systems:** Advancements in protective relays: Static relays, digital relays block diagram - Preliminaries of Synchro Phasor, Phasor measuring units, Wide Area Monitoring **(02 hrs)**	**CO5**
Content Beyond the syllabus: **Advancements in Circuit breakers:**MCB, MCCB, RCCB, ELCB. (Elementary treatment only) **Advancements in relays:** Static, Microprocessor based relays, Numerical relays and applications.(Elementary treatment only) **Recent trends in Protection systems:** AI applications in Power System Protection (Elementary treatment only).		

Course Outcomes	
Upon successful completion of the course, the student will be able to	
CO1	**Acquire** the knowledge of protection systems and operation of circuit breakers **{Understand level, KL2}**
CO2	**Describe** the operating principles of various types of relays.**{ Understand level, KL2}**
CO3	**Select** appropriate protection scheme for AC generator and transformer **{Apply level, KL3}**
CO4	**Choose** appropriate protection scheme for transmission lines and **know** about different neutral grounding techniques**{ Apply level, KL3}**
CO5	**Understand** the reasons behind over voltages and operation of lightning arrester along with latest trends in protection system**{ Understand level, KL2}**

Learning Resources

Text books:
1. A text book on Power System Engineering by M.L. Soni, P.V.Gupta, U.S. Bhatnagar and A. Chakrabarti, DhanpatRai& Co Pvt. Ltd. 2. Electrical power systems by C.L.Wadhwa, New Age International (P) Ltd, Publishers, 1998.
Reference books:
1. Fundamentals of Power System Protection by Paithankar Y.G and Bhide S.R. PHI, 2007 2. Switchgear and protection by Sunil S. Rao Khanna Publications. 3. Switchgear and Protection by J.B.Gupta, S.K.Kataria and sons .Publications, 2nd edition, 2004 4. Power System Protection and Switchgear by B.Ram and D.N.Viswakarma, Tata McGraw Hill, 2ndEdition, 2011 5. A. G. Phadke and J. S. Thorp, “Computer Relaying for Power Systems”, John Wiley &Sons, 1988
e- Resources & other digital material
1. https://nptel.ac.in/courses/108101039
2. https://nptel.ac.in/courses/108105167
3. https://nptel.ac.in/courses/108107167
4. https://nptel.ac.in/courses/117107148
5. https://www.youtube.com/playlist?list=PLBVJZMfxcrJn3p03lxsOP_ivHXzFLysYE

Micro-Syllabus

Unit – 1: Introduction to Power system protection (12 hrs)

Power system protection: Faults in power system, characteristics of short circuit and open circuit faults and harmful effects, necessity of protection system, basic requirements, classification, protection system terminology. **(02 hrs)**

Fuse: Introduction to fuse, fuse materials, characteristics of fuse and ratings; HRC fuse **(02 hrs)**

Circuit Breakers: Elementary principles of arc phenomenon -Principle of operation of air, oil, vacuum and SF6 circuit breakers (Elementary treatment only) - Specification of circuit breakers, ratings and auto re-closures. **(08 hrs)**

Unit No	Module	Micro content
1 Introduction to Power system protection	**Power system protection**	Faults and abnormal conditions
		Classification and characteristics of faults: Short circuit fault and Open circuit fault
		Harmful effects of faults, necessity of protection system
		Basic requirements of relays: Selectivity, speed, sensitivity, reliability, simplicity and economy
		Classification of relaying equipment
		protection system terminology: Definitions of Relay, pickup level, reset level, operating time, reset time, primary and secondary relays, auxiliary relays, Reach, Under reach, over reach, maximum torque angle
	Fuse	Fuse and its desirable characteristics, fuse element materials

		Terms related to fuse: Current rating, fusing current, fusing factor, prospective current, cut off current, pre arcing time, arcing time, operating time, breaking capacity
		HRC fuse construction, operation and its applications
	Circuit Breakers	Circuit Breaker operation
		Arc Phenomenon, principles of arc extinction
		Methods of arc extinction: High Resistance method and Current zero method
		Arc voltage, Re-striking Voltage, Recovery Voltage, RRRV and numerical problems
		Current Chopping and Resistance Switching
		Principle of operation of Air, Oil, Vacuum and SF6 gas circuit breaker and applications (elementary treatment only)
		Circuit breaker ratings: Breaking capacity, Making capacity, Short time rating.

Unit-2: Fundamentals of Protective relays (12 hrs)

Protective Relays: **Relay connection – Principle of operation Balanced beam type attracted armature relay - induction disc andinduction cup relays–Torque equation –PSM, TSM - Relays classification–Instantaneous– DMT andIDMT types(06 hrs)**

Applications of relays**:Over current and under voltage relays– Directionalrelays– Differential relays– Universal torque equation–Distance relays**: **Impedance– Reactance– Mho and offset mho relays– Characteristics ofdistance relays and comparison(06 hrs)**

Unit No	Module	Micro content
2 Fundamentals of Protective relays	**Protective relays**	Basic relays: Electromagnetic attraction and Electromagnetic induction
		Electromagnetic attraction relays: Attracted armature type, solenoid type, balanced beam type
		Electromagnetic induction relays: Shaded pole structure, Watt-hour meter structure and induction cup structure
		Relay classification based on time of operation: Instantaneous OC relay, DMT OC relay, IDMT OC relay
		Pickup current, Current setting, Plug setting multiplier (PSM) and Time setting multiplier (TSM)
	Applications of relays	Functional relay types: Induction type OC relay – directional and non-direction relay
		Induction type directional power relay
		Differential relays: Current differential and Voltage balance differential relay
		Distance relay

<table>
<tr><td rowspan="3"></td><td rowspan="3"></td><td>Universal torque equation of relay</td></tr>
<tr><td>Realization of impedance, reactance and mho relay from universal torque equation</td></tr>
<tr><td>Characteristics of impedance, reactance and mho relay on R-X diagram and applications to various faults</td></tr>
<tr><td colspan="3">Unit-3:Protection of AC generators and Transformer (12 hrs)
Protection of AC generators: Protection of generators against stator faults– Rotor faults and abnormal conditions–restricted earth fault and inter turn fault protection– Numerical example. (07 hrs)
Protection of transformers: Percentage differential protection– Design of CT's ratio–Buchholz relay protection–Numerical examples(05 hrs)</td></tr>
<tr><th>Unit No</th><th>Module</th><th>Micro content</th></tr>
<tr><td rowspan="16">3. Protection of AC generators and Transformer</td><td rowspan="10">Protection of AC generators</td><td>Various types of faults occurs on the generator: Stator faults, Rotor faults and abnormal conditions</td></tr>
<tr><td>Rotor earth fault protection</td></tr>
<tr><td>Protection from unbalanced loading</td></tr>
<tr><td>Overload protection</td></tr>
<tr><td>Over voltage protection</td></tr>
<tr><td>Failure of prime mover protection</td></tr>
<tr><td>Loss of excitation protection</td></tr>
<tr><td>Stator protection: by Differential protection, biased differential protection</td></tr>
<tr><td>Inter turn fault protection</td></tr>
<tr><td>Restricted earth fault protection</td></tr>
<tr><td colspan="1" style="display:none"></td></tr>
</table>

<table>
<tr><td rowspan="7"></td><td></td><td>Numerical problems on protected winding of stator</td></tr>
<tr><td rowspan="6">Protection of Transformer</td><td>Transformer Differential protection</td></tr>
<tr><td>Combined leakage and over load protection</td></tr>
<tr><td>Harmonic restraint relay</td></tr>
<tr><td>Restricted earth fault protection</td></tr>
<tr><td>Buchholz relay</td></tr>
<tr><td>Numerical problems on design of CT ratio for differential protection scheme</td></tr>
<tr><td colspan="3">Unit-4:Protection of Transmission lines and Neutral grounding (12 hrs)
Protection of lines: Over current Protection schemes - Numerical examples – Pilot wire protection - Carrier current and three zone distance relay using impedance relays–Protection of bus barsby using Differential protection.(08 hrs)
Neutral grounding: Grounded and ungrounded neutral systems–Effects of ungrounded neutral on system performance– Methods of neutral grounding: Solid–resistance–Reactance–Arcing grounds and grounding Practices (04 hrs)</td></tr>
<tr><th>Unit No</th><th>Module</th><th>Micro content</th></tr>
</table>

4. Protection of Transmission lines and Neutral grounding	Protection of Transmission lines	Protection of bus bars: differential protection and fault bus protection
		Protection of feeders: Time graded protection, Current graded protection, pilot wire scheme
		Protection of parallel feeders
		3-zone protection scheme for transmission lines
		Carrier current protection scheme for transmission lines
	Neutral grounding	Effectively grounded systems and ungrounded system
		Resonant grounding: Peterson coil
		Methods of neural grounding: solid grounding
		Resistance and reactance grounding-Peterson coil-Numerical problems
		Voltage transformer and zig zag transformer grounding

Unit-5: Protection against Over voltages and Advancements in Protection systems (12 hrs)

Over Voltage Protection**: Causes of over voltages in power systems – internal causes - Protection against lightning over voltages: Rod gap and horn gap arrester–Valve type and expulsion type lighting arresters and ground wires (elementary treatment only) – Selection of lightning arresters - Insulation coordination (10 hrs)**

Advancements in Protection systems: Advancements in protective relays: Static relays, digital relays - Preliminaries of Synchro Phasor, Phasor measuring units, Wide Area Monitoring **(02 hrs)**

Unit No	Module	Micro content
5. Protection against Over voltages and Advancements in Protection systems	Over Voltage Protection	Causes of over voltages in power system
		Internal causes and external causes of over voltage
		Protection against lightning over voltages: ground wires
		Lightning arresters: Rod gap, Horn gap arrester
		Expulsion type and valve type arrester
		Selection of rating of lightning arrester
		Insulation coordination
	Advancements in Protection systems	Developments in relays: electromechanical, static, microprocessor based, Numerical relays
		Static and digital relay: Block diagram approach (Over current relay only)
		Advantages and disadvantages above relays
		Preliminaries of Synchro phasor, Phasor Measuring Unit (PMU)
		Wide Area Monitoring Systems

CO-PO mapping Table

Contribution of Course Outcomes towards achievement of Program Outcomes & Strength of correlations **(High: 3, Medium: 2, Low: 1)**														
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO-1	PSO-2
CO1	2													
CO2	2													
CO3	3	3	1											
CO4	3	3	1											
CO5	2		1									1	1	

Module Coordinator **BOS** **HOD**

III- Year II- Semester	Name of the Course	L	T	P	C
	Renewable Energy Sources **(Professional Elective II)**	3	0	0	3

PRE-REQUISITES: 1) Basics of Solar Energy

Preamble: This course gives a flavor of renewable sources and systems to the students. It introduces solar energy its radiation, collection, storage and its applications. This covers generation, design, efficiency and characteristics of various renewable energy sources including solar, wind, hydro, and biomass. Fuel cells and geothermal systems.

Course objectives: The main objectives are

1. To study the solar radiation data, extraterrestrial radiation. Radiation on earth's surface.
2. To study solar thermal collections.
3. To study solar photo voltaic systems.
4. To study maximum power point techniques in solar pv and wind energy
5. To study wind energy conversion systems Betz coefficient systems tip speed ratio.
6. To study basic principle and working of hydro, tidal, biomass, fuel cell and geothermal systems

Syllabus		
Unit No	**Contents**	**Mapped CO**
I	**Fundamentals of Energy Systems And Solar Energy (11 hrs)** **Fundamentals of Energy Systems:** Energy conversion principle, Energy Scenario, various forms of renewable energy, solar radiation, outside earth's atmosphere, earth surface, analysis of solar radiation data. **(05 hrs)** **Solar Energy:** Geometry – radiation of tilted surface, numerical problems. Liquid plate plate collectors, performance analysis – Transmissivity – Absorptivity product collector efficiency factor, collector heat remove factor. **(06 hrs)**	**CO1**
II	**Solar Thermal Systems (13 hrs)** Introduction to solar Air heaters, concentrating collectors, solar pond and solar till, Solar thermal plant, numerical problems, solar photovoltaic systems, photovoltaic cell, module, array – construction – efficiency of solar cells, developing technologies cells – I- V characteristics, equivalent circuit of solar cells, series resistance, shunt resistance, applications and systems, balance of system components, maximum power point techniques, pertube and observe technique, hill climbing technique.	**CO2**
III	**Wind Energy (12 hrs)** Sources of wind energy – wind patterns, types of turbines, horizontal axis and vertical axis machines, kinetic energy of wind, Betz coefficient, tip speed ratio, Efficiency,	**CO3**

	power output of wind turbine, selection of generators (synchronous, induction), maximum power point tracking, wind forms, power generators for utility grids.	
IV	**Hydro And Tidal Power Systems (12 hrs)** **Hydro Power Systems:** Basic working principle, Classification of hydro systems, large, small, micro measurement of head and flow - energy equation - types of turbines , numerical problems. **(06 hrs)** **Tidal Power Systems:** Tidal power, basics, kinetic energy equation- turbines for tidal power, numerical problems, wave power basics, kinetic energy equation, wave power devices, linear generators. **(06 hrs)**	**CO4**
V	**Biomass, Fuel Cells And Geothermal Systems (10 hrs)** Energy, Fuel classification – Pyrolysis- direct combustion of heat, different digesters and sizing	**CO5**

Content Beyond the syllabus:

Application of non-conventional and renewable energy sources, Estimation of solar radiation.

List of Experiments

1. To conduct the solar retardation test.
2. To conduct its performance and analysis of solar thermal systems.
3. To draw the I-V characteristics of solar photovoltaic system.
4. To draw the equivalent circuit of solar cell.
5. To find the tip – speed – ratio of wind energy and its efficiency.
6. To write the Kinetic Energy Equation for tidal power systems.
7. To write the Kinetic Energy Equation for Hydro power systems.
8. To draw the V-I characteristics of Fuel cell.

Course Outcomes	
Upon successful completion of the course, the student will be able to	
CO1	**Analyze solar radiation data,** extraterrestrial radiation. radiation on earth's surface.**{Apply level, KL4}**
CO2	Design solar thermal collectors, solar thermal plants. **{Evaluate level, KL5}**
CO3	Design solar photo voltaic systems. **{Evaluate level, KL5}**
CO4	Develop maximum power point techniques in solar PV and wind energy systems.{**Understand level, KL2}**
CO5	**Explain** wind energy conversion systems, wind generators, power generations.**{Explain level, KL3}**

Learning Resources

Text books:

8. "Solar Energy" Principles of thermal collections and storage, S. P. Sukhatme, and J.K. Nayak, TMH ,New Delhi, 3rd edition.
9. "Renewable Energy Resources" Johan Twidell and Tony Weir, Taylor and Fancies 2rd edition, 2013.

Reference books:
9. "Renewable Energy" Edited by Godfrey, Boyle-Oxford University press 3rd edition, 2013. 10. "Renewable Energy Technologies/Ramesh and Kumar Narosa 11. "Renewable Energy Technologies" A Practical Guide For Beginners
e- Resources & other digital material
13. https://nptel.ac.in/courses/112105051
14. https://www.tatapower.com/bussiness/renewable-energy.aspx
15. https://www.cleanlineenergy.com/technology/wind-and-solar
16. https://www. youtube.com/watch?=xokHLFE96h8
17. https://www.youtube.com/watch?v=GZKKWz_tX1c

Micro-Syllabus

Unit – 1: Fundamentals of Energy Systems And Solar Energy (13hrs)

Fundamentals of Energy Systems And Solar Energy: Energy conversion principle, Energy Scenario, various forms of renewable energy ,solar radiation, outside earth's atmosphere, earth surface, analysis of solar radiation data, Geometry – radiation of tilted surface, numerical problems. Liquid plate plate collectors, performance analysis – transmissivity – absorptive product collector efficiency factor, collector heat remove factor.

Unit No	Module	Micro content
1.Fundamentals of Energy Systems And Solar Energy	Fundamentals of Energy Systems And Solar Energy	Energy conversion principle
		Energy Scenario
		Various forms of renewable energy
		Solar radiation, outside earth's atmosphere
		Earth surface, analysis of solar radiation data
		Geometry – radiation of tilted surface
		Liquid plate plate collectors, performance analysis
		Transmissivity – Absorptive product collector
		Efficiency factor
		Collector heat remove factor
		Numerical problems.

Unit-2: Solar Thermal Systems (13 hrs)

Solar Thermal Systems: Introduction to solar Air heaters, concentrating collectors, solar pond and solar till, Solar thermal plant, numerical problems, solar photovoltaic systems, photovoltaic cell, module, array – construction – efficiency of solar cells, developing technologies cells - I- V characteristics, equivalent circuit of solar cells, series resistance, shunt resistance, applications and systems, balance of system components, maximum power point, techniques, pertube and observe technique, hill climbing technique.

Unit No	Module	Micro content
2. Solar Thermal Systems	Solar Thermal Systems	Introduction to solar Air heaters
		Concentrating collectors, solar pond and solar till

		Solar thermal plant (Working)
		Solar photovoltaic systems, photovoltaic cell, module
		Array – construction – efficiency of solar cells
		Series resistance, shunt resistance, applications
		Balance of system components
		Maximum power point, techniques
		Pertube and observe technique, hill climbing technique.
		Numerical problems.

Unit-3:**Wind Energy (15hrs)**

Wind Energy: Sources of wind energy – wind patterns, types of turbines, horizontal axis and vertical axis machines, kinetic energy of wind, Betz coefficient, tip speed ratio, Efficiency, power output of wind turbine, selection of generators (synchronous, induction), maximum power point tracking, wind forms, power generators for utility grids.

Unit No	Module	Micro content
3.Wind Energy	Wind Energy	Sources of wind energy
		Wind patterns - wind patterns
		Types of turbines
		Horizontal axis and vertical axis machines
		Kinetic energy of wind
		Betz coefficient, tip speed ratio
		Efficiency, power output of wind turbine
		Selection of generators (synchronous, induction)
		Maximum power point tracking, wind forms
		Power generators for utility grids.

Unit-4: Hydro And Tidal Power Systems (13hrs)

Hydro And Tidal Power Systems: Basic working principle, Classification of hydro systems, large, small, micro measurement of head and flow - energy equation - types of turbines , numerical problems, tidal power, basics, kinetic energy equation- turbines for tidal power, wave power basics, kinetic energy equation, wave power devices, linear generators.

Unit No	Module	Micro content
4. Hydro And Tidal Power Systems Substations	Hydro And Tidal Power Systems Substations	Basic working principle
		Classification of hydro systems, large, small, micro measurement of head and flow
		Energy equation, - types of turbines
		Tidal power, basics

		Basics, kinetic energy equation
		Turbines for tidal power
		Kinetic energy equation
		Turbines for tidal power, wave power basics
		Kinetic energy equation, wave power devices, linear generators
		Numerical problems.
Unit 5:Biomass, Fuel Cells And Geothermal Systems (12 hrs) **Biomass, Fuel Cells And Geothermal Systems:** Biomass Energy, Fuel classification – Pyrolysis - direct combustion of heat, different digesters and sizing.		
Unit No	**Module**	**Micro content**
Biomass, Fuel Cells And Geothermal Systems	Biomass, Fuel Cells And Geothermal Systems	Biomass Energy
		Fuel classification
		Pyrolysis
		Direct combustion of heat
		Different digesters and sizing.

CO-PO mapping Table

Contribution of Course Outcomes towards achievement of Program Outcomes & Strength of correlations **(High: 3, Medium: 2, Low: 1)**														
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO-1	PSO-2
CO1	3													
CO2	3												1	
CO3	3	2												
CO4	3	3												1
CO5	3	1												1

Module Coordinator **BOS** **HOD**

III- Year II- Semester	Name of the Course	L	T	P	C
	Linear System Analysis **(Professional Elective II)**	3	0	0	3

PRE-REQUISITES: 1) Basic Circuit Analysis
2) Electrical Circuit Analysis
3) Engineering Mathematics

Course objectives: The student should be able to

6. Formulate state equations for Electrical networks.
7. Study Fourier series and Fourier transform of a periodic function.
8. Compute an Effective value and an average values of non-sinusoidal periodic waves
9. Analyze Response of RL, RC, and RLC Networks to Step, Ramp, and impulse functions.
10. Study the Hurwitz polynomials and Positive Real Functions.

Syllabus		
Unit No	**Contents**	**Mapped CO**
I	**STATE VARIABLE ANALYSIS (10 hrs)** Choice of state variables in Electrical networks-Formulation of state equations for Electrical networks-Equivalent source method. Network topological method - Solution of state equations-Analysis of simple networks with state variable approach.	**CO1**
II	**FOURIER SERIES &FOURIER TRANSFORM REPRESENTATION (15hrs)** Introduction, Trigonometric form of Fourier series, Exponential form of Fourier series, Wave symmetry, Fourier integrals and transforms, Fourier transform of a periodic function , Properties of Fourier Transform , Parseval's theorem , Fourier transform of some common signals, Fourier transform relationship with Laplace Transform.	**CO2**
III	**APPLICATIONS OF FOURIER SERIES AND FOURIER TRANSFORM REPRESENTATION (15hrs)** Introduction, Effective value and average values of non-sinusoidal periodic waves, currents, Power Factor, Effects of harmonics, Application in Circuit Analysis, Circuit Analysis using Fourier Series.	**CO3**
IV	**LAPLACE TRANSFORM APPLICATIONS (15hrs)** Application of Laplace transform Methods of Ananlysis – Response of RL, RC, RLC Networks to Step,Ramp, and impulse functions, Shifting Theorem – Convolution Integral – Applications	**CO4**
V	**TESTING OF POLYNOMIALS (10hrs)**	**CO5**

	Elements of reliability-Hurwitz polynomials, Properties of Hurwitz polynomials - positive real functions-Properties-Testing-Sturm's Test, examples.	

Content Beyond the syllabus:
Response of RL network to sinusoidal signals
Response of RC network to sinusoidal signal
Response of RLC network to sinusoidal signal
Properties of LC Immittence
Transfer function of an electrical network

List of Experiments: practice any 5 programs**(10 hrs)**

1. Compute the response of RL Circuit with step input.
2. Compute the response of RC Circuit with step input.
3. Compute the response of RLC Circuit with step input.
4. Compute the response of RL Circuit with impulse input.
5. Compute the response of RL Circuit with impulse input.
6. Compute the response of RC Circuit with impulse input.
7. Compute the response of RL Circuit with impulse input.
8. Study the Effects of harmonics in a RLC Circuit.
9. Obtain the Response of RC network to Non-sinusoidal signal.
10. Obtain the solution of a network using state space analysis.

Course Outcomes	
Upon successful completion of the course, the student will be able to	
CO1	**Understand** theFormulation of state equations for Electrical networks**{Understand level, KL2}**
CO2	**Analyze** Fourier series and Fourier transform of a periodic function.**{ Understand Analyze level, KL2&KL4}**
CO3	**Analyze** Effective value and average values of non-sinusoidal periodic waves**{Analyze level, KL4}**
CO4	**Analyze** Response of RL, RC, RLC Networks to Step, Ramp, and impulse functions**{ Analyze level, KL4}**
CO5	**Analyze**Hurwitz polynomials and Positive Real Functions. **{Apply level, KL4}**

Learning Resources
Text books:
10. Network Analysis and Synthesis – UmeshSinha- SatyaPrakashan Publications 11. Linear System Analysis – A N Tripathi, New Age International.
Reference books:

1. Network and Systems – D Roy Chowdhary, New Age International.
2. Engineering Network Analysis and Filter Desgin- Gopal G Bhisk&Umesh.
3. Linear system anlysis by A.Cheng, Oxford publishers.
4. Signals, Systems and Communications by B.P. Lathi, BS Publications 2003.

e- Resources & other digital material

18. https://nptel.ac.in/courses/108/106/108106150/
19. https://onlinecourses.nptel.ac.in/noc20_ee15/preview
20. https://nptel.ac.in/courses/108/104/108104100/
21. https://ocw.mit.edu/courses/mechanical-engineering/2-017j-design-of-electromechanical-robotic-systems-fall-2009/course-text/MIT2_017JF09_ch02.pdf
22. https://www.researchgate.net/publication/301078132_Linear_Systems_Analysis_in_the_Time_Domain

Micro-Syllabus

Unit – 1: State Variable Analysis (10 hrs)

Choice of state variables in Electrical networks-Formulation of state equations for Electrical networks-Equivalent source method. Network topological method - Solution of state equations-Analysis of simple networks with state variable approach.

Unit No	Module	Micro content
1a. State Variable Analysis	Formulation of state equations	Choice of state variables in Electrical networks,
		Formulation of state equations for Electrical networks,
		Equivalent source method,
1b. State Variable Analysis	Solution of state equations-for simple networks	Network topological method,
		Solution of state equations,
		Analysis of simple networks with state variable approach,

Unit – 2: Fourier Series &Fourier Transform Representation (15hrs)

Introduction, Trigonometric form of Fourier series, Exponential form of Fourier series, Wave symmetry, Fourier integrals and transforms, Fourier transform of a periodic function , Properties of Fourier Transform , Parseval's theorem , Fourier transform of some common signals, Fourier transform relationship with Laplace Transform.

Unit No	Module	Micro content
2a. Fourier Series & Fourier Transform Representation	Fourier series	IntroductionFourier series,
		Trigonometric form of Fourier series,
		Exponential form of Fourier series,
		Wave symmetry,
2b. Fourier Series & Fourier Transform	Fourier integrals and Transforms	Fourier transform of a periodic function,
		Properties of Fourier Transform,
		Parseval's theorem

<table>
<tr><td>Representation</td><td></td><td>Fourier transform of some common signals,
Fourier transforms relationship with Laplace Transform.</td></tr>
<tr><td colspan="3">Unit – 3: Applications of Fourier Series And Fourier Transform Representation (15hrs)

Introduction, Effective value and average values of non-sinusoidal periodic waves, currents, Power Factor, Effects of harmonics, Application in Circuit Analysis, Circuit Analysis using Fourier Series.</td></tr>
<tr><td>Unit No</td><td>Module</td><td>Micro content</td></tr>
<tr><td rowspan="7">3a. Applications of Fourier Series And Fourier Transform Representation</td><td rowspan="7">Applications of Fourier Series</td><td>Introduction applications of Fourier series,</td></tr>
<tr><td>Computation of Effective valueof non-sinusoidal periodic waves,</td></tr>
<tr><td>Computation of Average valueof non-sinusoidal periodic waves,</td></tr>
<tr><td>Computation of Effective current value of non-sinusoidal periodic waves,</td></tr>
<tr><td>Computation of Effective voltage value of non-sinusoidal periodic waves,</td></tr>
<tr><td>Computation of Effective current value of non-sinusoidal periodic waves,</td></tr>
<tr><td>Computation of Power Factor value of non-sinusoidal periodic waves,</td></tr>
<tr><td rowspan="3">3b.Applications of Fourier Series And Fourier Transform Representation</td><td rowspan="3">Applications of Fourier Transforms</td><td>Effects of harmonics,</td></tr>
<tr><td>Application in Circuit Analysis,</td></tr>
<tr><td>Circuit Analysis using Fourier Series.</td></tr>
<tr><td colspan="3">Unit-4:Laplace Transform Applications(15hrs)
Applications of Laplace transform Methods of Analysis – Response of RL, RC, RLC Networks to Step, Ramp, and impulse functions, Shifting Theorem – Convolution Integral – Applications.</td></tr>
<tr><td>Unit No</td><td>Module</td><td>Micro content</td></tr>
<tr><td rowspan="4">4a. Laplace Transform Applications</td><td rowspan="4">Application of Laplace transform</td><td>Application of Laplace transform Methods of Analysis,</td></tr>
<tr><td>Response of RL Networks to Step, Ramp, and impulse functions,</td></tr>
<tr><td>Response of RC Networks to Step, Ramp, and impulse functions,</td></tr>
<tr><td>Response of RLC Networks to Step, Ramp, and impulse functions.</td></tr>
<tr><td>4b.Distribution</td><td>Application of Laplace</td><td>Shifting Theorem,</td></tr>
</table>

Systems	transform	Convolution Integral,
		Applications of Convolution Integral.
Unit-5:Testing of Polynomials (10hrs) Elements of reliability-Hurwitz polynomials, Properties of Hurwitz polynomials -positive real functions-Properties-Testing-Sturm’s Test, examples.		
Unit No	**Module**	**Micro content**
5a.Testing of Polynomials	Hurwitz polynomials	Elements of reliability,
		Introduction to Hurwitz polynomials,
		Properties of Hurwitz polynomials
		problemsto check Hurwitz polynomials
5b.Testing of Polynomials	Positive Real Functions	Introduction to Positive Real Functions,
		Properties of Positive Real Functions,
		Testing-Sturm’s Test,
		Simple Problems on Positive real Functions

CO-PO mapping Table

Contribution of Course Outcomes towards achievement of Program Outcomes & Strength of correlations **(High: 3, Medium: 2, Low: 1)**														
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO-1	PSO-2
CO1	3	2				1							1	
CO2	2	2											1	
CO3	2	1				1							1	
CO4	3	2											1	
CO5	2	1											1	

Module Coordinator **BOS** **HOD**

III-Year-II Semester	MICROPROCESSORS AND MICROCONTROLERS LAB	L	T	P	C
		0	0	3	1.5

PRE-REQUISITES: 1) MICROPROCESSORS AND MICROCONTROLERS Theory

Preamble: Microprocessors and Microcontrollers laboratory course helps the students to develop their knowledge on processor architecture and the programming skills. This laboratory course provides hands-on experience to interface I/O devices, perform stepper motor rotation and writing assembly level language programs etc. The skills acquired through the experiments help the students to dotheir projects and enhance their knowledge on the latest trends and technologies.

Course objectives:

The main objectives are

1. To perform arithmetic, logical, string and port operations using 8086 emulator software.
2. To implement timer and serial data operations using 8051microcontroller.
3. To interface 8255 and 8279 using8086Objective.

List of Experiments: Any 10 of the following experiments are to be conducted

1. ARITHMETICOPERATIONS
   a. Multi byte addition and subtraction, multiplication and division
   b. ASCII – addition and subtraction, multiplication and division.
2. LOGICOPERATIONS
   a. Packed BCD to UnpackedBCD
   b. BCD toASCII
   c. Find the number of elements in the array having “1” in their 5thposition.
3. STRINGOPERATIONS
   a. Change position of word in a given string
   b. Reverse the given string
   c. Insert a word into given string
   d. Remove a word from given string
   e. Find length of the string.
4. PORTOPERATIONS
   a. Read data from port 1 and increment it by 1 and transfer it to port2.
   b. Transfer 1 to 10 continuously port1.
5. TIMER IN DIFFERENT MODES USING8051
   a. Produce 1khz square wave with 50% duty cycle using timer 0 in mode0.
   b. Produce 1khz square wave with 50% duty cycle using timer 0 in mode1
   c. Produce 1khz triangular wave with 50% duty cycle using timer 0 in mode1
6. SERIAL DATACOMMUNICATION
   a. Receive data serially.

b. Transfer “HELLO” serially at 9600 band, 8 bit data and 1 stopbit.

7. Addition & Subtraction using 8086Kit
8. Interfacing 8279 – Key board Display.
9. Interfacing8255–PPI.
10. Stepper motor control using8253/8255

List of Additional Experiments: Any 2 of the following experiments are to be conducted

1. Interfacing of 8259- Programmable Interrupt Controller.
2. Traffic light control using 8051 micro controller.
3. A/D and D/A converter using8255.

Software(s)/ Hardware(s) used: EMU8086, 8255, 8259 and 8279 interfacing boards.

Course Outcomes

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

CO1 Understand and apply the fundamentals of assembly level programming of microprocessor.**{Knowledge level, KL1, KL3}**

CO2 Design and implement 8051 microcontroller based systems **{Knowledge level, KL1, KL2}**

CO3 Design interfacing circuits with 8086. **{Knowledge level, KL1, KL2}**

III-Year-II Semester **Power Systems Laboratory**

L	T	P	C
0	0	3	1.5

PRE-REQUISITES:
1. Power generation, Transmission and Protection
2. Power System Analysis

Preamble: To impart the practical knowledge of functioning of various power system components and determination of various parameters and simulation of load flows, transient stability, LFC and Economic dispatch.

Course Objectives: The student should be able to

1. To control the speed of three phase induction motors.
2. To determine /predetermine the performance of three phase induction.
3. To determine /predetermine the performance of single-phase induction.
4. To improve the power factor of single-phase induction motor.
5. To predetermine the regulation of three–phase alternator by various methods, find Xd/ Xq ratio of alternator and asses the performance of three–phase synchronous motor.

LIST OF EXPERIMENTS

Any Ten of the following experiments are to be conducted:

1. Sequence impedances of 3-phase transformer
2. Sequence impedances of 3-phase alternator by fault analysis
3. Calibration of Tong tester
4. ABCD parameters of transmission network
5. Load flow study using Gauss-Seidel method
6. Load flow study using Newton-Raphson method
7. Economic load dispatch without transmission losses
8. Economic load dispatch with transmission losses
9. Load frequency control of single area system without controller
10. Load frequency control of single area system with controller
11. Load frequency control of two area system without controller
12. Load frequency control of two area system without controller

Course Outcomes: Upon successful completion of the course, the student will be able to

CO1	Able to understand affect of various faults in various power system components.
CO2	Students can execute energy management systems functions at load
CO3	Able to determine the parameters of various power system components
CO4	Able to understand the power flows and stability in power system.

Textbooks:

1. Nagrath I J and Kothari D P , “Modern Power System analysis” Tata McGraw Hill
2. Wadhwa C L “Electrical Power Systems” New Age International
3. Badri Ram and Vishwakarma D N “Power System Protection and Switch Gear” Tata McGraw Hill. 4. Ned Mohan, First Course in Power Systems, Wiley.

Reference books:

1.Power System by V. K. Mehta.
2.“Power systems and analysis” by Hadisaadat, Tata McGraw Hill

e- Resources & other digital material

1.https://nptel.ac.in/courses/108/105/108105017
2.https://nptel.ac.in/courses/103/102/108102146
3.www.nptelvideos.in/2012/11/electrical-power systems-i.html
*4.*https://www.electrical4u.com/power systems

III-Year-II Semester

Electrical Simulation Laboratory

L	T	P	C
0	0	3	1.5

PRE-REQUISITES: 1) Electrical circuit analysis 2) Electrical Power systems Theory

Preamble: Electrical Simulation lab provides the essential facilities to the students to augment their concepts about the fundamentals of basic circuits and simulate integrator circuit, differentiator circuit, Boost converter, Buck converter, full convertor and PWM inverter. To perform transient analysis of RLC circuit. The lab covers the determination stability analysis of linear time invariant system using matlab of 8056 microprocessor, 8051 microcontroller.

Course Objectives: The student should be able to

1. To study programming based on 8086 microprocessor and 8051 Microcontroller
2. To study 8056 microprocessor based ALP using arithmetic, logical and shift operations
3. To study modular and Dos/Bios programming using 8086 microprocessor
4. To study to interface 8086 with I/O and other devices. parallel and serial communication using 8051 microcontroller

LIST OF EXPERIMENTS

Any Ten of the following experiments are to be conducted:

1. Transient response of rlc circuits.
2. Analysis of three-phase circuit representing the generator, transmission line and load
3. Modeling of transformer.
4. Integrator & differentiator
5. Single-phase full converter.
6. Single-phase ac voltage converter.
7. Buck & boost converter
8. Single-phase inverter with pwm control.
9. Three-phase full converter.
10. Stability analysis (bode, root locus, nyquist) of linear time invariant system using matlab.

List of Additional Experiments: Any of the two experiments are to be conducted

1. Simulation of three phase full converter using MOSFET and IGBTS.
2. Pspice simulation of Reasonant Pulse Communication Circuit.

Course Outcomes: Upon successful completion of the course, the student will be able to

Course Outcomes

CO1 Able to write assembly language program using 8086 micro based on arithmetic, logical, and shift operations. (**Analyze**)

CO2 Able to Will be able to do modular and Dos/Bios programming using 8086 micro processor. (**Remember and Understand**)

CO3 Able to interface 8086 with I/O and other devices (**Analyze**)

CO4 Able to do parallel and serial communication using 8051 micro controllers. (**Evaluate**)

Text books:

1. "Simulation of Power Electronic Circuit", by M.B. Patil, V.Ramanarayan, V.T. Ranganathan. Narosha, 2009.
2. Pspice for circuits and electronics using PSPICE – by M.H.Rashid, M/s PHI Publications.
3. Pspice A/D user`s manual – Microsim, USA.

Reference books:

1. The Art of Simulation using PSPICE- Taylor &Francis
2. A Guide to Circuit Simulation and Analysis using PSPICE- Paul.W.Tuinenga
3. PSpice Simulation of Power Electronics Circuits **-** E. Ramshaw,D.C. Schuurman

e- Resources & other digital material

1.https://archive.nptel.ac.in/courses/108/108/108108166/

2.https://www.youtube.com/watch?v=Ml6_bxXrBGs

3. www.ee.tttb.ac.in/-sequel

4.https://www.eeweb.com/tools/online-spice-simulator/

III-Year-II Semester Low Voltage Switchgear(SOC)

L	T	P	C
1	0	2	2

PRE-REQUISITES: 1) Power Systems and Electric Machines

Course objectives: The student should be able to study
1. The fundamentals of Switch gear.
2. The principle of operation of relays and classification
3. The Contactors working and circuit connections.
4.The applications of contactors.
5.The working of MPCB, MCCB, RCCB.

Unit-1 Fundamentals of Switchgear(6 hrs)
Need for switchgear and protection systems **(02 hrs)**
Basics of relays and switchgear **(02 hrs)**
Basics of fuse, HRC fuse and HRC fuse **(02 hrs)**
Unit-2 Fundamentals of relays (08 hrs)
Relay connection, Principle and operation of electromagnetic relays **(02 hrs)**
Classification of relays, I-T characteristics **(02 hrs)**
Relay Applications, **(04 hrs)**
Unit-3 Contactors and circuit connections (8hrs)
Construction of contactor.**(02hrs)**
Circuit connection, working and characteristics **(02 hrs)**
Types and applications (**02 hrs)**
Control wiring of contactor .**(02 hrs)**
Unit-4 Applications of Contactors (08 hrs)
Protection of motors,
Power wiring of contactors (**02 hrs)**
DOL, RDOL starters using contactors (**03 hrs)**
Star-Delta starter using contactors (**03 hrs)**
Unit-5 MPCB, MCCB, RCCB (10 hrs)
Introduction, Principle and Operation of MPCB **(06 hrs)**
Introduction, Principle and Operation of MCCB **(02hrs)**
Introduction, Principle and Operation of RCCB **(02hrs)**

Course Outcomes

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

CO1 **Understand** the need for protection systems **{Understand level, KL2}**

CO2 **Explain** the principle and operation of various relays.**{Apply level, KL3}**

CO3 **Explain** the working of contactors **{ Apply level, KL3}**

CO4 **Perform** the connections of different types of starters.**{ Apply level, KL3}**

CO5 **Analyze** the need for MPCB, MCCB and RCCB.**{Analyze level, KL4}**

Text books:

1. A text book on Power System Engineering by M.L. Soni, P.V.Gupta, U.S. Bhatnagar and A. Chakrabarti, Dhanpat Rai& Co Pvt. Ltd.
2. Electrical power systems by C.L.Wadhwa, New Age International (P) Ltd, Publishers, 1998..
3. Switchgear and protection by Sunil S. Rao Khanna Publications.

Reference books:

1. Fundamentals of Power System Protection by Paithankar Y.G and Bhide S.R. PHI, 2007
2. Handbook of Switchgears by BHEL, TMH, 2005.

e- Resources & other digital material

1. https://nptel.ac.in/courses/108107167
2. https://nptel.ac.in/courses/117107148

III-Year-II Semester PLC and SCADA (SOC)

L	T	P	C
1	0	2	2

PRE-REQUISITES:

Course objectives: The student should be able to

1. Study the fundamentals of PLC.
2. Study the PLC Hardware modules and implementation of PLC.
3. Study the Conceptsof PLC programmingand its applications.
4. Study the fundamentals of SCADA.
5. Study the Design and development of SCADA for various applications.

Unit-1 Introduction to PLC(8hrs)

Identify the specified parts of thegiven PLC along with its function. ldentify different Programmingdevices types. Differentiate different types of PLCs.Explain with sketches the redundancy concept for the given PLC.

Unit-2 PLC Hardware(08 hrs)

Identify and describe the given module of PLC. Describe the given addressing of PLC Use instruction set to perform the given operation.Develop ladder logic programs for the given application.Describe with sketches the steps to interface appropriate Input module with the given input device.

Unit-3 PLC programmingand applications (10 hrs)

Specify the proper I/O addressing format for PLC.Describe the format of different relay type instructions.Describe the format of different Timer and counter Instructions.Describe the format of different Logical and Comparison type instruction.

Describe the format of different data handling instructions. Describe the elements of different programming languages used to program PLC Develop PLC ladder program for the given simple example. Develop a PLC ladder program for the given industrial application.

Unit-4 Introduction to SCADA (06 hrs)

Describe applications of SCADA. Describe the function of the given element of SCADA Describe SCADA configuration. Differentiate SCADA and PLC.

Unit-5 SCADA interfacing and Applications -(8hrs)

Interface the given PLC with the SCADA system using OPC. Describe the steps to develop SCADA system for given industrial application.Describe the steps to screen for a given application. develop a simple SCADA.

Course Outcomes

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

CO1	Identify different components of PLC. **{Understand level, KL2}**
CO2	Select appropriate PLC modules for given application. **{Apply level, KL3}**
CO3	Develop PLC ladder program for a given application**{Analyze level, KL4}**
CO4	Test a simple SCADA application. **{Evaluate level, KL5}**

CO5 Test a simple PLC-SCADA application. **{Apply level, KL4}**

Text books:

1. "Introduction to Programmable logic controllers''. Dunning, G. Thomson /Delmar learning, 2005, ISBN 13 : 9781401884260
2. ''Programmable Logic Controller''. Jadhav, V. R. Khanna publishers, 2017 ISBN: 9788174092281
3. "Supervisory control and Data acquisition''. Boyar, S. A, ISA Publication (4th edition) ISBN: 978-1936007
4. 'Practical SCADA for industry''. Bailey David ; Wright Edwin.Newnes (an imprint of Elsevier), 2003 ISBN:0750658053.

Reference books:

1. ''Programmable logic controllers (Fourth edition)'', Petruzella, F.D, Tata — McGraw Hill India, 201 (),ISBN: 9740071067386.
2. ''Programmable logic controllers and Industrial automation An introduction'',Mitra, Madhuchandra; Sengupta, Samarjit. Penram International Publication, 2015, Fifth reprint, ISBN: 9788187972174

e- Resources & other digital material

Software:-www.fossee.com
www.logixpro.com
www.instrumentationengineers.org
www.ellipse.com

III-Year-II Semester PSCAD (SOC)

L	T	P	C
1	0	2	2

PRE-REQUISITES: Not specific

Course objectives: The student should be able to
1. Study the fundamentals of PSCAD.
2. Study Basic components and Their specifications in PSCAD.
3. Study Various controls used in PSCAD.
4. Study the Modelling of Transformers in PSCAD.
5. Study DC converter configuration in PSCAD.

Unit-1 Introduction to PSCAD(4hrs)
What is PSCAD, some common models found in PSCAD, who uses PSCAD and for what**(02 hrs)**
Classical example to Demonstrate PSCAD (**02 hrs)**
Unit-2 Basic components and Their Specifications in PSCAD Library (08 hrs)
Sources, Transmission line, Transformer, Circuit Breakers, Surge Arresters **(02hrs)**
Setting load flow with a generator**(02 hrs)**
Fast front study data (Station Layout, Busbar dimensions, Transformer winding capacitance)**(04 hrs)**
Unit-3 Controls (10 hrs)
CSMF components. Use of slider, switch, button and dial **(04hrs)**
Applications of CSMF components**(06hrs)**
Unit-4 Modelling of Transformers (06 hrs)
Core configuration, Ungrounded windings, saturation (**02hrs.)**
Harmonicmeasurement(**02 hrs)**
Load tap changer, phase shifting transformer (**02 hrs)**
Unit-5 DC Transmission(10 hrs)
Why use DC Transmission, DC converter configuration**(06 hrs)**
Twelve pulse converter modelling **(04hrs)**

Course Outcomes

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

CO1	**Understand** the fundamentals of PSCAD Software**{Understand level, KL2}**
CO2	**Explain** the principle and working of Different components in PSCAD. **{Apply level, KL3}**
CO3	**Understand** different controls in PSCAD.**{Understand level, KL2}**
CO4	**Model** Transformer in PSCAD. {
CO5	**Analyze** twelve pulse converters in PSCAD. **{Apply level, KL4}**

Text books:

1.Atousa Yazdani "Modern Distribution system with PSCAD Analysis", CRC Press.

Reference books:

1. Application Guide 2008 for PSCAD

e- Resources & other digital material

1. https://www.pscad.com/training-events/courses
2. https://elec-engg.com/pscad-training-for-protection-engineers/
3. https://www.powersystemdynamics.com/index.php/cad

III-Year-II Semester

Process Instrumentation (SOC)

L	T	P	C
1	0	2	2

PRE-REQUISITES:

Course objectives: The student should be able to

1. Selects measurement method for a process parameter by process instruments for temperature level, vibration, force and torque in a process plant.
2. Specify instrumentation for temperature level, vibration, force and torque application.
3. Identify, describe and Calibrate major instruments for temperature, level, vibration, force and torque in a process plant.

Unit-1 Introduction: Heat, Temperature, Temperature scales, Expansionthermometer,Solid Expansion Thermometer Bimetallic thermometer, Spiral Bimetal element, Helix Bimetal element.

Unit-2 Liquid Expansion Thermometer- Mercury in Glasstype, Filled system thermometer, Class I- Liquid FilledSystems, Class II- VapourSystems, Class III- Gas Filled Systems, Class V- Mercury Filled Systems, Thermocouples Principle: Seebeck,PeltierThomson effect.

Unit-3 Thermoelectric laws Cold junction compensation, Thermo well, Thermocouple extensionwires,Thermocouples selection criteria, Resistance Temperature Detector IndustrialRTD, 2-wireRTD, 3-wireRTD, 4-wireRTD, Thermostats, Integrated Circuit(IC) based Temperature sensors, Non-contact type thermometry, Radiation pyrometer, Optical pyrometer, Optical FibreThermometry, Ultrasonic thermometry, LaserthermometryTemperature switches and thermostats

Unit-4 Level measurement: Importance and Units, Level measurement methods, Direct methods, Bob and Tape method, Sight glass method, Indirect methods, Pressure gauge type, Air bellows, Capacitance typelevelmeasurement and Radiation type level measurement.

Unit-5 Differential pressure type level measurement, Ultrasonic leveldetector,Laser Level Sensors, Optical Level detector Level switches: Float type level switch, Displacer level switch, conductivity level switch.

Course Outcomes

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

CO1	**Understand**. the concept of heat, temperature and temperature concepts**{Understand level, KL2}**
CO2	**Explain**. the different types of thermometers.**{Apply level, KL3}**
CO3	**Analyze** the different types of resistance thermometer detector.**{Analyze level, KL4}**
CO4	**Evaluate** the importance of Level measurement and its methods.**{Evaluate level, KL5}**
CO5	**Analyze the operation of**Differential pressure type levelmeasurement.**{Apply level, KL4}**

Text books:

1. Liptak, B. G ,Process Measurement andAnalysis.I.S.A publication.
2. Eckman, D. P,Industrial Instrumentation, Wiley Eastern Limited publication.
3. Singh, S.K ,Industrial Instrumentation, Tata Mc Graw Hill Publication

Reference books:

1. Krishnaswamy, K. and S.Vijayachitra, Industrial Instrumentation, New AgeInternational Publication, New Delhi.
2. Jain, R.K Mechanical and Industrial Measurements, Khanna publication, New Delhi

e- Resources & other digital material

1. http://www.pc-education.mcmaster.ca/Instrumentation/temperature.
2. http://www.dugantech.com/Product_Group-Temperature/Technical%20Articles/TE
3. http://www.pc-education.mcmaster.ca/Instrumentation/level.

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IV- Year I- Semester	Name of the Course	L	T	P	C
	Utilization of Electrical Energy (Professional Elective III)	3	0	0	3

Pre-Requisites: Electrical Circuit Analysis, Power Systems,

Preamble: The objective of the course is to provide the first detailed treatment of fundamental understanding and application of electrical energy in power systems. Beginning with the basic terms, concepts and power system components representations, the course will present power generation technologies and power delivery systems.

Course objectives:

The main objectives are

1. To describe the concepts of electricity applications in heating and welding procedures
2. To explain the terminology of illumination engineering and its applications.
3. To gain the knowledge about electric traction systems and its performance parameters.
4. To describe the analytical concepts of electric traction systems with reference to braking, power and energy calculations.
5. To teach the theory about different electrical appliances and electric vehicles.

Unit No	Contents	Mapped CO
I	**Electric Heating & Welding (14hrs)** **Electric Heating (07 hrs)** Advantages and methods of electric heating–Resistance heating, induction heating and dielectric heating – Arc furnaces – Direct and indirect arc furnaces **Electric Welding (07 hrs)** Electric welding–Resistance and arc welding–Electric welding equipment–Comparison between AC and DC Welding	**CO1**
II	**Illumination(15 hrs)** **Illumination fundamentals (05 hrs)** Introduction, terms used in illumination, laws of illumination, polar curves, photometry, integrating sphere, sources of light. **Illumination concepts (10 hrs)** Discharge lamps, MV and SV lamps, comparison between tungsten filament lamps and fluorescent tubes, Basic principles of light control, Types and design of lighting, LED lighting, Street and flood lighting.	**CO2**
III	**Electric Traction-1(13 hrs)** **Electric Traction Speed - Time Curves and Mechanics of Train Movement (07 hrs)** Introduction, Systems of Traction, Systems of electric Traction, Speed-Time Curves	**CO3**

	for Train Movement, Mechanics of Train Movement, Train Resistance, Adhesive Weight, Coefficient of Adhesion, Load equalization. **Motors for Electric traction(06 hrs)** Introduction, Series and Shunt Motors for Traction Services, Two Series Motors are used to drive a Motor Car, AC Series Motor, Three Phase Induction Motor, Temperature rise calculations, Calculation of Tractive Effort, Horse Power and Specific Energy consumption for a given run.	
IV	**Electric Traction-2(13 hrs)** **Braking (06 hrs)** Introduction, Regenerative Braking of Three Phase Induction Motors, Braking of Single Phase Series Motors, Mechanical braking, Magnetic Track Brake, Electro–Mechanical Drum Brakes. **Electric Traction Systems and Power Supply (07 hrs)** AC Electrification, Sub-Stations, Feeding and Distribution System for AC and DC Traction systems, Electrolysis by Current through Earth, Negative Booster, System of Current Collection, Trolley Wires.	**CO4**
V	**Applications(13 hrs)** **Domestic electrical appliances:** Calculation of energy consumption and efficiency of i. Electric iron. ii. Electric toaster. iii. Electric water heater. iv. Microwave oven. v. Fans (Ceiling and Table fan) vi. Washing Machine. vii. Grinder/ Mixer/ juicer. viii. Vacuum Cleaner. ix. Flour Mill. x. Air conditioner, Concept of Star System for energy conservation.**(07 hrs)** **Electric Vehicles:(06 hrs)** Introduction, Configurations of Electric Vehicles, Performance of Electric Vehicles, Tractive Effort in Normal Driving vehicles, Energy Consumption calculations.	**CO5**
Content Beyond the syllabus:(Not considered for evaluation) Electric Elevator machines and their motors, Electrolytic processes, Electric circuits used in Refrigeration, Air Conditioning and Water coolers, LCD displays, Electromechanical processes.		

Course Outcomes:

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

No	Description	POs, PSOs	KL
CO1	**Describe** about electric heating and welding procedures	PO1, PSO2	2
CO2	**Articulate** the terminology of illumination, **Explain** the working of electric lamps and design of lightning schemes	PO1, PSO2	2, 3
CO3	**Discuss** systems of electric traction, speed-time curves and mechanics of movement.	PO1, PSO2	2
CO4	**Explain** about braking methods used in traction systems and **calculate** different performance parameters of traction	PO1, PSO2	3
CO5	**Examine** different real time electrical appliances and applications in electric vehicles	PO1, PSO2	3

Text books:
1. **"Utilization of Electrical Energy",** V V L Rao, Universities Press, 1981. 2. **"Art & Science of Utilization of Electrical Energy"**, H. Partab, 2^{nd} edition, DhanpatRai& Sons, 2017. 3. **"A Text book on Power System Engineering"**, M.L. Soni, P.V. Gupta, U.S. Bhatnagar and A. Chakrabarti, DhanpatRai Publishing Company (P) Limited, 2016. 4. **"Modern Electric,Hybrid Electric, and Fuel Cell Vehicles: Fundamentals Theory, and Design"**, MehrdadEhsani, YiminGao, Sebastien E Gay, Ali Emadi, 1^{st} edition, CRC Press, 2004.
Reference books:
1. **"Utilization of Electrical Power including Electric drives and Electric traction",** N.V. Suryanarayana, 2^{nd} edition, New Age Publishers, 2017. 2. **"Generation, Distribution and Utilization of Electric Energy"**, C.L.Wadhawa, 3^{rd} edition, New Age International Private Limited, 2015. 3. **"Utilization, Generation and Conservation of Electrical Energy",** Sunil S Rao,1^{st} edition, Khanna Publishers, 2000. 4. **"Utilization of Electric Power and Electric Traction",** G.C. Garg, 1^{st} edition, Khanna Publishers, 2018.
e-resources & other digital material
1. https://nptel.ac.in/courses/108/105/108105060/
2. https://www.governmentpolytechnicnayagarh.org/upload/ueet(Pm).pdf
3. https://www.coursera.org/learn/electric-utilities
4. https://www.coursera.org/learn/electric-power-systems
5. https://www.coursera.org/lecture/electric-power-systems/distribution-ZujEz
6. https://www.edx.org/learn/electricity
7. http://indianrailways.gov.in/railwayboard/uploads/codesmanual/ACTraction-II-P-I/ACTractionIIPartICh1_data.htm
8. https://en.wikipedia.org/wiki/Traction_substation
9. https://www.engineeringenotes.com/electrical-engineering/electric-traction-electrical-engineering/power-supply-arrangement-for-ac-track-electrification-electricity/37184
10. https://membership.corrosion.com.au/blog/stray-traction-effects-wheres-the-problem/
11. https://encyclopedia2.thefreedictionary.com/Negative+Booster+Transformer
12. https://en.wikipedia.org/wiki/Current_collector
13. https://en.wikipedia.org/wiki/Overhead_line

MICRO-SYLLABUS

Unit–1: Electric Heating & Welding (14 hrs)

Electric Heating (07 hrs)

Advantages and methods of electric heating–Resistance heating, induction heating and dielectric heating – Arc furnaces – Direct and indirect arc furnaces

Electric Welding (07 hrs)

Electric welding–Resistance and arc welding–Electric welding equipment–Comparison between AC and DC Welding

Unit No	Module Name	Micro content

1a.	**Electric Heating**	Introduction, Advantages of Electric Heating and Heating methods
		Resistance Heating
		Resistance Furnaces, Temperature Control of Resistance Furnaces
		Design of Heating Element
		Induction Heating: Core Type Induction Furnace
		Vertical Core-Type Induction Furnace, Coreless Induction Furnace
		Dielectric Heating
1b.	**Electric Welding**	Electric Welding: Introduction, Advantages and Disadvantages of Welding
		Types of Electric Winding, Resistance Welding
		Types of resistance welding, Spot welding, Seam welding
		Projection welding, Butt welding
		Introduction to Electric Arc Welding, Carbon arc welding, Metal arc welding
		Atomic hydrogen arc welding, Inert gas metal arc welding
		Electric Welding Equipment, Comparison between AC and DC Welding

Unit–2: Illumination (15 hrs)

Illumination fundamentals (05 hrs)

Introduction, terms used in illumination, laws of illumination, polar curves, photometry, integrating sphere, sources of light.

Illumination concepts (10 hrs)

Discharge lamps, MV and SV lamps, comparison between tungsten filament lamps and fluorescent tubes, Basic principles of light control, Types and design of lighting, LED lighting, Street and flood lighting.

Unit No	Module Name	Micro content
2a.	**Illumination fundamentals**	Introduction, nature of light
		Definitions of various quantities related to illumination fundamentals
		Laws of illumination
		Polar curves, Photometry
		Integrating sphere, Lux meter
		Sources of light
2b.	**Illumination concepts**	Incandescent Lamps, Carbon arc Lamp
		Gaseous Discharge Lamps, Fluorescent Lamp
		Sodium Vapour Lamp, Mercury Vapour Lamps
		Comparison between filament lamps and fluorescent lamp

		Principles of light control
		Types and design of lighting schemes
		LED lighting
		Street and Flood lighting

Unit–3: Electric Traction-1 (13 hrs)

Electric Traction Speed - Time Curves and Mechanics of Train Movement (07 hrs)

Introduction, Systems of Traction, Systems of electric Traction, Speed-Time Curves for Train Movement, Mechanics of Train Movement, Train Resistance, Adhesive Weight, Coefficient of Adhesion, Load equalization.

Motors for Electric traction (06 hrs)

Introduction, Series and Shunt Motors for Traction Services, Two Series Motors are used to drive a Motor Car, AC Series Motor, Three Phase Induction Motor, Temperature rise calculations, Calculation of Tractive Effort, Horse Power and Specific Energy consumption for a given run.

Unit No	Module Name	Micro content
3a.	**Electric Traction Speed - Time Curves and Mechanics of Train Movement**	Introduction , Traction systems, Different systems of traction
		Systems of railway electrification
		Comparison between A.C. and D.C. Traction
		Electric Traction systems
		Trapezoidal and Quadrilateral Speed-Time curves
		Mechanics of train movement
		Train Resistance, Adhesive Weight, Coefficient of Adhesion
		Load equalization
3b.	**Motors for Electric traction**	Introduction
		Series and Shunt Motors for Traction Services
		Two Series Motors are used to drive a Motor Car
		AC Series Motor
		Three Phase Induction Motor
		Temperature rise calculations
		Calculation of Tractive Effort, Horse Power
		Calculation of Specific Energy consumption for a given run

Unit–4: Electric Traction-2 (13 hrs)

Braking (06 hrs)

Introduction, Regenerative Braking of Three Phase Induction Motors, Braking of Single Phase Series Motors, Mechanical braking, Magnetic Track Brake, Electro–Mechanical Drum Brakes.

Electric Traction Systems and Power Supply (07 hrs)

AC Electrification, Sub-Stations, Feeding and Distribution System for AC and DC Traction systems, Electrolysis by Current through Earth, Negative Booster, System of Current Collection, Trolley Wires.

Unit No	Module Name	Micro content

4a.	**Braking**	Introduction
		Regenerative Braking of Three Phase Induction Motors
		Braking of Single Phase Series Motors
		Mechanical braking
		Magnetic Track Brake
		Electro–Mechanical Drum Brakes
4b.	**Electric Traction Systems and Power Supply**	AC Electrification
		Traction Sub-Stations
		Feeding and Distribution System for ACTraction systems
		Feeding and Distribution System forDC Traction systems
		Electrolysis by Current through Earth
		Negative Booster
		System of Current Collection
		Trolley Wires

Unit–5: Applications (13 hrs)
Domestic electrical appliances: Calculation of energy consumption and efficiency of
i. Electric iron. ii. Electric toaster. iii. Electric water heater. iv. Microwave oven. v. Fans (Ceiling and Table fan) vi. Washing Machine. vii. Grinder/ Mixer/ juicer. viii. Vacuum Cleaner. ix. Flour Mill. x. Air conditioner, Concept of Star System for energy conservation. **(07 hrs)**
Electric Vehicles: (06 hrs)
Introduction, Configurations of Electric Vehicles, Performance of Electric Vehicles, Tractive Effort in Normal Driving vehicles, Energy Consumption calculations.

Unit No	Module Name	Micro content
5a.	**Domestic electrical appliances**	Calculation of energy consumption and efficiency of i. Electric iron. ii. Electric toaster. iii. Electric water heater. iv. Microwave oven. v. Fans (Ceiling and Table fan) vi. Washing Machine. vii. Grinder/ Mixer/ juicer. viii. Vacuum Cleaner. ix. Flour Mill. x. Air conditioner
		Concept of Star System for energy conservation
5b.	**Electric Vehicles**	Introduction
		Configurations of Electric Vehicles
		Performance of Electric Vehicles
		Tractive Effort in Normal Driving vehicles
		Energy Consumption calculations

CO–POs& PSOs Mapping:

CO No.	PO Number												PSO Number	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
CO1	3	1											1	
CO2	3		1											1
CO3	2													
CO4	2	1											1	1
CO5	2	1					1						2	

Note: Strength of correlations isHigh: 3, Medium: 2, Low: 1

Module Coordinator **BOS** **HOD**

IV-Year-I Semester

Special Electrical Machines
(Professional Elective III)

L	T	P	C
3	0	0	3

PRE-REQUISITES:1) Electrical Machines-I &II

Course objectives: The student should be able to

1. To explain theory of different permanent magnetic material and applications.
2. To explain the performance and control of stepper motors, and their applications.
3. To describe the operation and characteristics of switched reluctance motor.
4. To explain the operation permanent magnet brushless square wave and sine wave motors
5. To explain the theory of travelling magnetic field and applications of linear motors

Unit-1 Permanent magnet materials and PMDC motors(15hrs)

Introduction-classification of permanent magnet materials used in electrical machines-minor hysteresis loop and recoil line-Stator frames of conventional dc machines-Development of electronically commutated dc motor from conventional dc motor.
(07hrs)

Permanent-magnet materials and characteristics-B-H loop and demagnetization characteristics-Temperature effects: high temperature effects-reversible losses Irreversible losses -Application of permanent magnets in motors. **(08hrs)**

Unit-2 Stepper Motors (14 hrs)

Classification of stepper motors – Hybrid and Variable Reluctance Motor (VRM) - Construction and principle of hybrid type synchronous stepper motor – Different configuration for switching the phase windings control circuits for stepper motors – Open loop and closed loop control of 2-phase hybrid stepping motor. **(08hrs)**

Construction and principle of operation of Variable Reluctance Motor (VRM) – Single stack and multiple stack – Open loop control of 3- phase VR Stepper Motor- Applications**(06hrs)**

Unit-3 Switched Reluctance Motors (10hrs)

Construction – Comparison of conventional and switched reluctance motors – Design of stator and rotor pole arcs – Torque producing principle and torque expression
(5 hrs)

Different converter configurations for SRM – Drive and power circuits for SRM – Position sensing of rotor – Applications of SRM**(5 hrs)**

Unit-4 Square and Sine Wave Permanent Magnet Brushless DC Motor (15hrs)

Types of constructions – Surface mounted and interior type permanent magnet – Principle of operation of BLDC motor. Torque and EMF equations – Torque speed characteristics – Performance and efficiency- Square wave brushless motors with 120^0 and 180^0 magnetic areas commutation. **(8 hrs)**

Sine wave Permanent Magnet Brushless Motor Torque and EMF equations –Torque/speed characteristics – Comparison between square wave and sine wave permanent magnet motors - Applications. **(7 hrs)**

Unit-5 Linear Induction Motors (10hrs)
Construction– principle of operation–Double sided LIM from rotating type Induction Motor **(5 hrs)**
Schematic of LIM drive for traction – Development of one sided LIM with back iron equivalent circuit of LIM. **(5 hrs)**

Course Outcomes

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

CO1 To understand theory of different permanent magnetic material and applications.**{Understand level, KL2}**

CO2 To explain the performance and control of stepper motors, and their applications.**{Understand level, KL2}**

CO3 To describe the operation and characteristics of switched reluctance motor **{ Understand level, KL2}**

CO4 To explain the operation permanent magnet brushless square wave and sine wave motors .**{Understand level, KL2}**

CO5 To explain the theory of travelling magnetic field and applications of linear motors . **{Understand level, KL2}**

Text books:

1. Brushless Permanent magnet and reluctance motor drives, Clarenden press, T.J.E. Miller, 1989, Oxford.
2. Special electrical Machines, K.VenkataRatnam, University press, 2009, New Delhi.

Reference books:

1. Special Electrical Machines ,G.Janradhana, PHI Publishers

e- Resources & other digital material

3. https://nptel.ac.in/courses/108/102/108102156/

Module Coordinator **BOS** **HOD**

IV- Year I- Semester	Name of the Course	L	T	P	C
	High Voltage Engineering (Professional Elective III)	3	0	0	3

PRE-REQUISITES: 1) Physics & Chemistry

Course objectives: The student should be able to

1. **Understand electric field distribution and computation in different configuration of electrode systems**
2. **Understand HV breakdown phenomena in gases, liquids and solids dielectrics**
3. **Acquaint with the generating principle of operation and design of high DC, AC and**
   Impulse voltages and currents
4. **Understand various techniques of AC, DC and Impulse measurement of high voltages and currents**.
5. **Know the insulating characteristics of dielectric materials** and **various testing techniques of HV equipment**

Syllabus		
Unit No	**Contents**	**Mapped CO**
I	**Introduction to High Voltage Technology (13Hrs)** Electric Field Stresses – Uniform and non–uniform field configuration of electrodes – Estimation and control of electric Stress – Numerical methods for electric field computation (elementary treatment only)	**CO1**
II	**Break down phenomenon in gaseous, liquid and solid insulation (13 Hrs)** **Gases as insulating media – Ionization process – Townsend's criteria of breakdown in gases – Paschen's law – Liquid as Insulator – Pure and commercial liquids – Breakdown in pure and commercial liquid – Intrinsic breakdown – Electromechanical breakdown – Thermal breakdown –Breakdown of solid dielectrics, composite dielectrics used in practice.**	**CO2**
III	**Generation of High voltages and High currents (13 Hrs)** **Generation of high DC voltages – Generation of high alternating voltages – Generation of impulse voltages and currents**	**CO3**
IV	**Measurement of High voltages and High current (13Hrs)** **Measurement of high AC, DC and Impulse voltages – Voltages and measurement of high currents – Direct, alternating and Impulse.**	**CO4**
V	**Testing of electrical materials and apparatus (13Hrs)** **Measurement of DC resistivity – Measurement of dielectric constant and loss factor – Partial discharge measurements. Testing of insulators and bushings– Testing of cables – Testing of transformers** **Applications of high voltage engineering ─ Electrostatic precipitators ─ food**	**CO5**

	processing – water treatment	

Content Beyond the syllabus:

1. **Applications of insulating materials in various equipment:** Applications in power transformers, rotating machines, cables, circuit breakers, power capacitors, HV bushings.
2. **Advancements in insulators design:** polymer insulators, composite insulators.
3. **Condition monitoring of high voltage equipment:** Intelligent monitoring of high voltage equipment with optical fibre sensors and chromatic techniques.

Course Outcomes	
Upon successful completion of the course, the student will be able to	
CO1	Acquainted **with the performance of high voltages with regard to different configurations of electrode systems. (**Analyze, KL4)
CO2	Understand **theory of breakdown and withstand phenomena of all types of dielectric materials (**understand, KL2)
CO3	Acquaint **with the techniques of generation of AC,DC and Impulse voltages (**understand, KL2)
CO4	Apply **knowledge for measurement of high voltage and high current AC, DC and Impulse. (**apply, KL3**)**
CO5	Experiment **to measure dielectric property of electrical material and know the techniques of testing various equipment's used in HV engineering and applications (**Analyze, KL4)

Learning Resources

Text books:

1. "**High Voltage Engineering: Fundamentals**", **E.Kuffel, W.S.Zaengl, J.Kuffel**, 2nd Edition, Elsevier, 2000.
2. "**High Voltage Engineering**", M.S.Naidu, V.Kamaraju, 3rd Edition, TMH, 2003.

Reference books:

1. "**High Voltage Engineering and Testing**", Ryan, 3rd Edition, IET Publishers, 2013.
2. "**High Voltage Engineering**", C.L.Wadhwa, 1st Edition, New Age Publishers, 1997.
3. "**High Voltage and Electrical Insulation Engineering**", Ravindra Aurora, Wolfgang Mosch, John Wiley Publications, 2011.

e- Resources & other digital material

1. https://nptel.ac.in/courses/108/104/108104048/
2. https://cds.cern.ch/record/1005044/files/p113

Micro-Syllabus

Unit – 1: Introduction to High Voltage Technology (13Hrs)

Electric Field Stresses – Uniform and non–uniform field configuration of electrodes – Estimation and control of electric Stress – Numerical methods for electric field computation

Unit No	Module	Micro content

1a. Electric Field stresses	Electric field stresses	Electric field stress
		Gas/Vacuum as insulator
		Liquid dielectrics
		Solids and composite dielectrics
		Uniform and non-uniform electric fields
1b. Estimation and control of electric stress	Estimation and control of electric stress	Estimation of electric field
		Estimation of electric field in geometric boundaries
		Numerical methods for electric field computation (elementary treatment only) Computation of field by Finite Difference Method only
		Surge voltages, their distribution and control

Unit-2: Break down phenomenon in gaseous, liquid and solid insulation (13 Hrs)
Gases as insulating media – Ionization process – Townsend's criteria of breakdown in gases – Paschen's law – Vacuum insulation -- Liquid as Insulator – Pure and commercial liquids – Breakdown in pure and commercial liquid – Intrinsic breakdown – Electromechanical breakdown – Thermal breakdown –Breakdown of solid dielectrics, composite dielectrics used in practice

Unit	Module	Micro content
2a. Breakdown phenomenon in gases	Conduction and breakdown in gases	Gases as insulating media
		Ionization process: Ionization by collision, photo ionization, electron emission due to positive ion impact, photons, meta-stables impact with neutral atoms, electron attachment
		Townsends current growth equation (with Townsends 1^{st} ionization coefficient)
		Current growth in the presence of secondary processes (with Townsends 2^{nd} ionization coefficient)
		Townsends criteria for breakdown
		Breakdown in electronegative gases
		Streamer theory of breakdown in gases
		Paschen's law
		Breakdown in non-uniform fields and corona discharges (elementary treatment only)
	Vacuum insulation	Vacuum as insulating media, conduction and breakdown in vacuum
2b.	Conduction and	Liquids as insulators

Breakdown in liquids and solid insulation	breakdown in liquids	Classification of liquid dielectrics
		Characteristics of liquid dielectrics
		Pure and commercial liquids
		Conduction and breakdown in pure liquids
		Conduction and breakdown in commercial liquids: Suspended particle mechanism Cavitations and bubble mechanism Stressed oil volume mechanism
	Conduction and breakdown in solid dielectrics	Solids as insulators: intrinsic breakdown
		Electromechanical breakdown, thermal breakdown
		Breakdown in solid dielectrics in practice: Chemical and electrochemical deterioration and breakdown, breakdown due to treeing and tracking
		Solid dielectrics used in practice (elementary treatment only)
Unit-3: **Generation of High voltages and High currents (13 Hrs)** **Generation of high DC voltages – Generation of high alternating voltages – Generation of impulse voltages and currents**		
Unit	**Module**	**Micro content**
Generation of high voltages	Generation of high DC voltages	Voltage doubler circuits
		Cockcroft-Walton Voltage multiplier circuit
		Van De Graff generator
		Simple problems on voltage doubler and multiplier circuit only
	Generation of High AC voltages	Cascaded transformer connection
		Resonant transformers
		Generation of high frequency ac voltages: Tesla coil
		Generation of impulse voltages: standard impulse wave form and representation (Analysis of impulse generator circuit of series RLC type only)
		Multistage impulse generator: Marx circuit
		Generation of switching surges
3b. Generation of high currents	Generation of high currents	Impulse current waveform and representation
		RLC impulse current generator
		Simple problems on impulse waveform generator
		Generation of rectangular pulses
		Tripping and control of impulse generator

Unit-4: Measurement of high voltages and High current
(13Hrs)
Measurement of high AC, DC and Impulse voltages – Voltages and measurement of high currents – Direct, alternating and Impulse.

Unit	Module	Micro content
4a.Measurement of high voltages	Measurement of high DC voltages	High Ohmic series resistance with micro ammeter
		Resistance potential divider for DC voltages
	Measurement of high AC & impulse voltages	Series impedance voltmeter
		Series capacitance voltmeter
		Electrostatic voltmeters
		Peak reading ac voltmeters: Chubb-Fortescue method
		Spark gap arrangement for high voltage measurements
4b. Measurement of High currents	Measurement of high AC,DC and impulse currents	Measurement of high DC currents: Hall generators
		Measurement of high power frequency currents with CT
		Measurement of high impulse current: Rogowski coil

Unit-5: Testing of electrical materials, apparatus and applications (13Hrs)
Measurement of DC resistivity – Measurement of dielectric constant and loss factor – Partial discharge measurements
Testing of insulators and bushings– Testing of cables – Testing of transformers
Applications of high voltage engineering ─ Electrostatic precipitators ─ food processing ─ water treatment

Unit	Module	Micro content
5a. Testing of materials	Non-destructive testing	Measurable properties of dielectric
		Measurement of DC resistivity (using dc galvanometer and loss of charge method)
		Measurement of dielectric constant and loss factor (Schering bridge with power frequency only)
		Partial discharge measurements and energy associated with single discharge
		Discharge detection using straight detectors
		Balanced detection method
5b.Teting of apparatus & applications	Destructive testing and applications	Definition of standard specifications: Disruptive discharge voltage, withstand voltage, 50% flashover voltage, 100% flashover voltage, creepage distance
		Testing of insulators and bushings
		Testing of cables
		Testing of transformers
		Applications : Electrostatic precipitators

		Food processing and water treatment

CO-PO mapping Table

Contribution of Course Outcomes towards achievement of Program Outcomes & Strength of correlations **(High: 3, Medium: 2, Low: 1)**														
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO-1	PSO-2
CO1	3	1	1										1	1
CO2	3	1												
CO3	2													
CO4	2													
CO5	3			2										

Module Coordinator **BOS** **HOD**

IV- Year I- Semester	Name of the Course	L	T	P	C
	ELECTRICAL ENGINEERING MATERIALS (Professional Elective III)	3	0	0	3

PRE-REQUISITES:

Course objectives: The student should be able to

1. Know insulator, semiconductor and conductor
2. Know conducting, insulating, semiconducting, dielectric and magnetic materials;theirphysical, mechanical, and electrical properties.
3. Know different types of constructional material, uses and testing.
4. Practical uses of various materials in different fields.

Syllabus		
Unit No	**Contents**	**Mapped CO**
I	**Conducting Materials:(9hrs)** Electron theory of metal , Resistance and resistivity, linear and nonlinear resistance, Properties of conducting material – low resistivity material and high resistivity materials,Different conducting materials like copper, aluminum, ACSR, AAC, silver, carbon, tungsten, eureka, constantan, manganin, invar ,Thermocouple, superconductor, annealing ,Materials used in house wiring	**CO1**
II	**Semiconducting Material:(10hrs)** Introduction, commonly used semiconducting material, application of semiconducting materials, energy level diagram of conductor, semiconductor and insulator , Formation of p-n junction. Characteristics of different semiconducting materials (germanium and silicon) Simple idea and application of thermistor, photoconductive cell, photovoltaic cell, varistor, LCD and strain gauge,Introduction and application of Hall-Effect Generator piezo-electric materials,Printed circuit board (PCB), types and uses, the process of preparing PCB, advantages of using PCB	**CO2**
III	**Insulating Materials:(7hrs)** Classification based on physical state and on thermal basis, Properties of insulating materials, Properties and application of different insulating materials, Hygroscopocity, effect of moisture on insulating material, impregnation	**CO3**
IV	**Dielectric Material:(7hrs)** Dielectric strength, factors affecting dielectric strength, dielectric loss, factors affecting dielectric loss, dissipation factor, dielectric constant,Polarization, Charging and discharging of dielectric, different dielectric (solid, liquid, gaseous)	**CO4**
V	**Magnetic Material:(10hrs)** Magnetic field strength, unit pole, flux, magnetic circuit, MMF, permeability, residual magnetism, retentivity, coercive force, curie temperature, magnetostriction. Classification based on permeability, electromagnet and uses, Aging and its affect on	**CO5**

	permanent magnet losses in ferromagnetic material, Hysteresis, hysteresis loop, hysteresis loss, factors on which hysteresis loss depends, eddy current loss, electrical sheet metal, permanent magnetic material, magnetization curve for ferromagnetic material , Soft and hard magnetic material, effect of silicon on ferromagnetic material, pure alloy, carbon steel, ferrite , Magnetic memory devices used in computer	

Course Outcomes	
Upon successful completion of the course, the student will be able to	
CO1	**Understand** the properties of conductor, insulator and semiconductor.
CO2	**Understand** the properties of different conducting, insulating, semiconducting and magnetic material.
CO3	**Assess** the quality of these materials.
CO4	**Analyze**different types of constructional materials, use and testing.
CO5	**Understand** the various materials in different electrical engineering field.

Learning Resources
Text books:
1. Electrical Engineering Materials – TTTI Madras 2. Electrical and Electronics Engineering Materials – J B Gupta 3. Electrical Engineering Materials – P L Kapoor
Reference books: 1. Electrical Engineering Materials – J Dekker 2. Electrical Engineering Materials – Raina, Bhattacharjee 3. Electrical Engineering Materials – Navneet Gupta **4.** Electronic Engineering Materials and Devices by John Allison
e- Resources & other digital material
1. https://www.youtube.com/watch?v=XaId7WR0mGo
2. https://www.youtube.com/watch?v=m9l1tVXyFp8
3. https://www.youtube.com/watch?v=dMzQcyW62VU&list=PL63n2PcxRiNcW6kYMoglxTLUAcfDJ7xUR
4. https://www.youtube.com/watch?v=R3yi8FPpWX4
5. https://www.youtube.com/@iit

Micro-Syllabus

Unit – 1: Conducting Materials:(9hrs)

Electron theory of metal,Resistance and resistivity, linear and nonlinear resistance, Properties of conducting material – low resistivity material and high resistivity materials,Different conducting materials like copper, aluminum, ACSR, AAC, silver, carbon, tungsten, eureka, constantan, manganin, invar ,Thermocouple, superconductor, annealing ,Materials used in house wiring.

Unit	Module	Micro content
Conducting Materials	Different conducting materials	Electron theory of metal
		Resistance and resistivity, linear and non linear resistance
		Properties of conducting material – low resistivity material and high resistivity materials
		Different conducting materials like copper, aluminum, ACSR, AAC, silver, carbon, tungsten, eureka, constantan, manganin, invar
		Thermocouple, superconductor, annealing
		Materials used in house wiring

Unit-2:Semiconducting Material:(10hrs)

Introduction, commonly used semiconducting material, application of semiconducting materials, energy level diagram of conductor, semiconductor and insulator , Formation of p-n junction. Characteristics of different semiconducting materials (germanium and silicon) Simple idea and application of thermistor, photoconductive cell, photovoltaic cell, varistor, LCD and strain gauge,Introduction and application of Hall-Effect Generator piezo-electric materials,Printed circuit board (PCB), types and uses, the process of preparing PCB, advantages of using PCB.

Unit	Module	Micro content
Semiconducting Material	Semiconducting Material and PCB	Introduction, commonly used semiconducting material, application of semiconducting materials
		Energy level diagram of conductor, semiconductor and insulator
		Formation of p-n junction.
		Characteristics of different semiconducting materials (germanium and silicon)
		Simple idea and application of thermistor, photoconductive cell, photovoltaic cell, varistor, LCD and strain gauge
		Introduction and application of Hall-Effect Generator piezo-electric materials
		Printed circuit board (PCB), types and uses, the process of preparing PCB, advantages of using PCB

<table>
<tr><td colspan="3">Unit-3:Insulating Materials:(7hrs)
Classification based on physical state and on thermal basis, Properties of insulating materials, Properties and application of different insulating materials, Hygroscopocity, effect of moisture on insulating material, impregnation</td></tr>
<tr><th>Unit</th><th>Module</th><th>Micro content</th></tr>
<tr><td rowspan="4">Insulating Materials</td><td rowspan="4">Insulating Materials</td><td>Classification based on physical state and on thermal basis</td></tr>
<tr><td>Properties of insulating materials</td></tr>
<tr><td>Properties and application of different insulating materials</td></tr>
<tr><td>Hygroscopocity, effect of moisture on insulating material, impregnation</td></tr>
<tr><td colspan="3">Unit-4:Dielectric Material:(7hrs)
Dielectric strength, factors affecting dielectric strength, dielectric loss, factors affecting dielectric loss, dissipation factor, dielectric constant, Polarization, Charging and discharging of dielectric, different dielectric (solid, liquid, gaseous)</td></tr>
<tr><th>Unit</th><th>Module</th><th>Micro content</th></tr>
<tr><td rowspan="3">Dielectric Material</td><td rowspan="3">Dielectric Material</td><td>Dielectric strength, factors affecting dielectric strength, dielectric loss, factors affecting dielectric loss, dissipation factor, dielectric constant</td></tr>
<tr><td>Polarization</td></tr>
<tr><td>Charging and discharging of dielectric, different dielectric (solid, liquid, gaseous)</td></tr>
<tr><td colspan="3">Unit-5:Magnetic Material:(10hrs)
Magnetic field strength, unit pole, flux, magnetic circuit, MMF, permeability, residual magnetism, retentivity, coercive force, curie temperature, magnetostriction. Classification based on permeability, electromagnet and uses, Aging and its affect on permanent magnet losses in ferromagnetic material, Hysteresis, hysteresis loop, hysteresis loss, factors on which hysteresis loss depends, eddy current loss, electrical sheet metal, permanent magnetic material, magnetization curve for ferromagnetic material , Soft and hard magnetic material, effect of silicon on ferromagnetic material, pure alloy, carbon steel, ferrite, Magnetic memory devices used in computer.</td></tr>
<tr><th>Unit</th><th>Module</th><th>Micro content</th></tr>
<tr><td rowspan="3">Magnetic Material</td><td rowspan="3">Magnetic Material</td><td>Magnetic field strength, unit pole, flux, magnetic circuit, MMF, permeability, residual magnetism, retentivity, coercive force, curie temperature, magnetostriction.</td></tr>
<tr><td>Classification based on permeability, electromagnet and uses</td></tr>
<tr><td>Aging and its affect on permanent magnet losses in ferromagnetic material</td></tr>
</table>

		Hysteresis, hysteresis loop, hysteresis loss, factors on which hysteresis loss depends, eddy current loss
		Electrical sheet metal, permanent magnetic material, magnetization curve for ferromagnetic material
		Soft and hard magnetic material, effect of silicon on ferromagnetic material, pure alloy, carbon steel, ferrite
		Magnetic memory devices used in computer

CO-PO mapping Table

Contribution of Course Outcomes towards achievement of Program Outcomes & Strength of correlations **(High: 3, Medium: 2, Low: 1)**														
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO-1	PSO-2
CO1	2					3	3			2		2	2	1
CO2	1					2	3			2		1	1	2
CO3	2					3	2			1		3	1	2
CO4	1					2	2			2		2	2	2
CO5	2					3	3			2		2	2	1

Module Coordinator **BOS** **HOD**

IV- Year I- Semester	Name of the Course	L	T	P	C
	Electric Drives (Professional Elective IV)	3	0	0	3

PRE-REQUISITES:

1) Power Electronics
2) Electric motors

Course objectives: The student should be able to

- To learn the fundamentals of electric drive and different electric braking methods.
- To analyze the operation of single phase converter controlled dc motors and four quadrant operation of dc motors using dual converters.
- To understand the concept of speed control of induction motor by using AC voltage controllers and voltage source inverters.
- To learn the principles of static rotor resistance control and various slip power recovery schemes.
- To understand the speed control mechanism of synchronous motors

Syllabus		
Unit No	**Contents**	**Mapped CO**
I	**Fundamentals of Electric Drives** Electric drive – Fundamental torque equation – Load torque components – Nature and classification of load torques – Steady state stability – Load equalization– Four quadrant operation of drive (hoist control) – Braking methods**:** Dynamic – Plugging – Regenerative methods.	**CO1**
II	**Controlled Converter Fed DC Motor Drives** 1-phase half and fully controlled converter fed separately and self-excited DC motor drive –Output voltage and current waveforms – Speed-torque expressions – Speed-torque characteristics — Principle of operation of dual converters and dual converter fed DC motor drives -Numerical problems.	**CO2**
III	**DC–DC Converters Fed DC Motor Drives** Single quadrant – Two quadrant and four quadrant DC-DC converter fed separately excited and self-excited DC motors – Continuous current operation– Output voltage and current waveforms – Speed–torque expressions – Speed–torque characteristics –Four quadrant operation – Closed loop operation (qualitative treatment only).	**CO3**
IV	**Stator side control of 3-phase Induction motor Drive** Stator voltage control using 3-phase AC voltage regulators – Waveforms –Speed torque characteristics– Variable Voltage Variable Frequency control of induction motor by PWM voltage source inverter – Closed loop v/f control of induction motor drives (qualitative treatment only). **Rotor side control of 3-phase Induction motor Drive** Static rotor resistance control – Slip power recovery schemes – Static Scherbius drive – Static Kramer drive – Performance and speed torque characteristics – Advantages –	**CO4**

	Applications.	
V	**Control of Synchronous Motor Drives** Separate control & self-control of synchronous motors – Operation of self-controlled synchronous motors by VSI– Closed Loop control operation of synchronous motor drives (qualitative treatment only).–Variable frequency control–Pulse width modulation.	**CO5**
Content Beyond the syllabus:		

Course Outcomes	
Upon successful completion of the course, the student will be able to	
CO1	**Understand** the fundamentals of electric drive and different electric braking methods.
CO2	**Analyze** the operation of three phase converter fed dc motors and four quadrant operations of dc motors using dual converters.
CO3	**Describe** the converter control of dc motors in various quadrants of operation
CO4	**Know** the concept of speed control of induction motor by using AC voltage controllers and Differentiate the stator side control and rotor side control of three phase induction motor.
CO5	**Explain** the speed control mechanism of synchronous motors

Learning Resources

Text books:

1. Fundamentals of Electric Drives – by G K DubeyNarosa Publications
2. Power Semiconductor Drives, by S.B.Dewan, G.R.Slemon, A.Straughen, Wiley-India Edition.

Reference books:

1. Electric Motors and Drives Fundamentals, Types and Apllications, by Austin Hughes and Bill Drury, Newnes.
2. Thyristor Control of Electric drives – VedamSubramanyam Tata McGraw Hill Publications.
3. Power Electronic Circuits, Devices and applications by M.H.Rashid, PHI
4. Power Electronics handbook by Muhammad H.Rashid, Elsevier.

Micro-Syllabus

Unit – 1: Fundamentals of Electric Drives

Electric drive – Fundamental torque equation – Load torque components – Nature and classification of load torques – Steady state stability – Load equalization– Four quadrant operation of drive (hoist control) – Braking methods**:** Dynamic – Plugging – Regenerative methods.

Unit No	Module	Micro content
Fundamentals of Electric Drives	Electric drive	Introduction to Electric Drives
		Fundamental torque equation
		Load torque components
		Nature and classification of load torques
		Steady state stability
		Load equalization

		Four quadrant operation of drive (hoist control)
	Braking methods**:**	Dynamic method
		Plugging method
		Regenerative method
		Numerical Problems

Unit-2: Controlled Converter Fed DC Motor Drives

1-phase half and fully controlled converter fed separately and self-excited DC motor drive –Output voltage and current waveforms – Speed-torque expressions – Speed-torque characteristics –– Principle of operation of dual converters and dual converter fed DC motor drives -Numerical problems.

Unit No	Module	Micro content
Controlled Converter Fed DC Motor Drives	**Controlled Converter Fed DC Motor Drives**	1-phase half controlled converter fed separately excited DC motor drive.
		1-phase fully controlled converter fed separately excited DC motor drive.
		1-phase half controlled converter fed self excited DC motor drive.
		1-phase fully controlled converter fed self excited DC motor drive.
		principle of operation of dual converters
		Dual converter fed DC motor drives
		Numerical problems

Unit-3: **DC–DC Converters Fed DC Motor Drives**

Single quadrant – Two quadrant and four quadrant DC-DC converter fed separately excited and self-excited DC motors – Continuous current operation– Output voltage and current waveforms – Speed–torque expressions – Speed–torque characteristics –Four quadrant operation – Closed loop operation (qualitative treatment only).

Unit No	Module	Micro content
DC–DC Converters Fed DC Motor Drives	**DC–DC Converters Fed DC Motor Drives**	Single quadrantDC-DC converter fed separately excited DC motors.
		Single quadrant DC-DC converter fedself-excited DC motors
		Two quadrantDC-DC converter fed separately excited DC motors.
		Two quadrant DC-DC converter fedself-excited DC motors
		Four quadrantDC-DC converter fed separately excited DC motors.
		Four quadrant DC-DC converter fedself-excited DC motors
		Closed loop operation (qualitative treatment only).

Unit-4: Stator side control of 3-phase Induction motor Drive Stator voltage control using 3-phase AC voltage regulators – Waveforms –Speed torquecharacteristics– Variable Voltage Variable Frequency control of induction motor by PWM voltage source inverter – Closed loop v/f control of induction motor drives(qualitative treatment only). **Rotor side control of 3-phase Induction motor Drive** Static rotor resistance control – Slip power recovery schemes – Static Scherbius drive – Static Kramer drive – Performance and speed torque characteristics – Advantages –Applications.		
Unit No	**Module**	**Micro content**
Speed control of 3-phase Induction motor Drive	**Stator side control of 3-phase Induction motor Drive**	Stator voltage control using 3-phase AC voltage regulators
		Variable Voltage Variable Frequency control of induction motor by PWM voltage source inverter
		Closed loop v/f control of induction motor drives(qualitative treatment only).
	Rotor side control of 3-phase Induction motor Drive	Static rotor resistance control
		Slip power recovery schemes – Static Scherbius drive
		Static Kramer drive
Unit-5: Control of Synchronous Motor Drives Separate control & self-control of synchronous motors – Operation of self-controlledsynchronous motors by VSI– Closed Loop control operation of synchronous motor drives (qualitative treatment only).–Variable frequency control–Pulse width modulation.		
Unit No	**Module**	**Micro content**
Control of Synchronous Motor Drives	**Control of Synchronous Motor Drives**	Separate control of synchronous motors
		self-control of synchronous motors
		Operation of self-controlled synchronous motors by VSI
		Closed Loop control operation of synchronous motor drives
		Variable frequency control–Pulse width modulation.

Module Coordinator **BOS** **HOD**

IV- Year I- Semester	Name of the Course	L	T	P	C
	High Voltage AC & DC Transmission (Professional Elective IV)	3	0	0	3

PRE-REQUISITES:1) Power Electronics,
2) Power Systems-I & II

Course objectives: The student should be able to

1. To understand the phenomena associated with transmission line, operating at extra high voltages and detail analysis of several phenomena viz. electrostatic field, charges, voltage gradient and conductor configuration
2. The objective is to discuss phenomena of corona, losses, audible noise, radio interference and measurement of these quantities.
3. To understand the phenomena of HVDC, HVDC equipment comparison with AC and the latest state of art in HVDC transmission.
4. To understand method of conversion of AC to DC, performance of various level of pulse conversion and control characteristics of conversion
5. To understand the requirements of reactive power control and filtering technique in HVDC system and to understand the harmonics in AC side of power line in a HVDC system and design of filters

Syllabus		
Unit No	**Contents**	**Mapped CO**
I	**Introduction of EHV AC transmission(13 hrs)** Necessity of EHV AC transmission – Advantages and problems – Power handling capacity and line losses – Mechanical considerations – Resistance of conductors - Electrostatics – Field of sphere gap – Field of line charges and properties **(07hrs)** Charge ~ potential relations for multi–conductors – Surface voltage gradient on conductors – Bundle spacing and bundle radius Examples – Distribution of voltage gradient on sub conductors of bundle – Examples. **(06 hrs)**	**CO1**
II	**Corona effects(11 hrs)** Power loss and audible noise (AN) – Corona loss formulae – Charge voltage diagram – Generation – Characteristics – Limits and measurements of AN **(05hrs)** Radio interference (RI) – Corona pulses generation – Properties and limits –Biological effects Electrical and magnetic fields on human beings and animals- Recent advances in UHV power transmission**(06 hrs)**	**CO2**
III	**Basic Concepts of DC Transmission(13 hrs)** Basic Concepts of DC Transmission Economics & Terminal equipment of HVDC transmission systems: Types of HVDC Links – Apparatus required for HVDC Systems **(07 hrs)** Comparison of AC &DC transmission – Application of DC Transmission System –	**CO3**

	Planning & Modern trends in DC transmission.**(6hrs)**	
IV	**Analysis of HVDC Converters and System Control(13 hrs)** Choice of Converter configuration – Analysis of Graetzciruit – Characteristics of 6 Pulse & 12 Pulse converters – Cases of two 3 phase converters in star – Star mode and their performance **(7 hrs)** Principal of DC Link Control - Converters Control Characteristics – Firing angle control – Current and extinction angle control– Starting and stopping of DC link – Power Control. **(6 hrs)**	**CO4**
V	**Reactive Power Control, Harmonics and Filters in HVDC(15 hrs)** Reactive Power Requirements in steady state – Conventional control strategies – Alternate control strategies sources of reactive power – AC Filters – Shunt capacitors – Synchronous condensers. **(6 hrs)** Harmonics and Filters Generation of Harmonics – Characteristics harmonics – Calculation of AC Harmonics – Non–Characteristics harmonics – Adverse effects of harmonics – Calculation of voltage & current harmonics – Effect of Pulse number on harmonics. Types of AC filters, Design of Single tuned filters – Design of High pass filters..**(9 hrs)**	**CO5**
Content Beyond the syllabus: **Reactive Power Requirements:** Reactive Power Requirements in steady state-Conventional control strategies-Alternate control strategiessources of reactive power-AC Filters – shunt capacitors-synchronous condensers. (Elementary treatment only).		

Course Outcomes	
Upon successful completion of the course, the student will be able to	
CO1	Acquaint with HV transmission system with regard to power handling capacity, losses, conductor resistance and electrostatic field associate with HV**{Understand level, KL2}**
CO2	To develop ability for determining corona, radio interference, audible noise generation and frequency spectrum for single and three phase transmission lines.**{ Analyze level, KL4}**
CO3	To acquire knowledge in transmission of HVDC power with regard to terminal equipment, type of HVDC connectivity and planning of HVDC system **{ Understand level, KL2}**
CO4	To be able to develop knowledge with regard to choice of pulse conversion, control characteristic, firing angle control and effect of source impedance. **{ Analyze level, KL4}**
CO5	To develop knowledge of reactive power requirements of conventional control, filters and reactive power compensation in HVDC system, calculate voltage and current harmonics, and design of filters. **{ Analyze level, KL4}**

Learning Resources
Text books:

1. HVDC Power Transmission Systems: Technology and system Interactions – by K.R.Padiyar, New Age International (P) Limited, and Publishers.
2. Direct Current Transmission – by E.W.Kimbark, John Wiley & Sons.
3. EHVAC Transmission Engineering by R. D. Begamudre, New Age International (P) Ltd..

Reference books:

1. EHVAC and HVDC Transmission Engineering and Practice – S.Rao.
2. Power Transmission by Direct Current – by E.Uhlmann, B.S.Publications
3. HVDC Transmission – J. Arrillaga.

e- Resources & other digital material

1. https://nptel.ac.in/courses/108/102/108102047/
2. https://www.coursera.org/learn/electric-power-systems

Micro-Syllabus

UNIT-I: Introduction of EHV AC transmission:(13 hrs)

Preliminaries of EHV Transmission: Necessity of EHV AC transmission – Advantages and problems – Power handling capacity and line losses – Mechanical considerations – Resistance of conductors -

Voltage gradients: Electrostatics – Field of sphere gap – Field of line charges and properties Charge - potential relations for multi–conductors – Surface voltage gradient on conductors – Bundle spacing and bundle radius Examples – Distribution of voltage gradient on sub conductors of bundle – Examples.

Unit No	Module	Micro content
1.a. Preliminaries of EHV Transmission	Requirement of EHV transmission	Necessity of high voltage transmission
		EHV transmission system advantages and disadvantages
	Power handling capacity	Standard transmission voltages, average values of line parameters
		Power handling capacity and line losses: simple problems
	Mechanical considerations	Types of vibrations and oscillations: Aeolian vibrations, galloping, wake induced oscillations
		Dampers and spacers
	Resistance of conductors and temperature effects	Resistance of conductors
		Effect of conductor resistance
		Power loss in transmission
		Temperature rise of conductors and current carrying capacity
		Bundle conductors: bundle spacing and bundle radius, GMR of bundle

<table>
<tr><td rowspan="7">1.b Voltage gradients</td><td rowspan="3">Electrostatics</td><td>Field of point charge and its properties</td></tr>
<tr><td>Field of sphere gap, field of line charges and their properties,</td></tr>
<tr><td>Charge potential relations for multi conductor line</td></tr>
<tr><td rowspan="4">Surface voltage gradients</td><td>Surface voltage gradients on conductors: single conductor, 2-conductor bundle</td></tr>
<tr><td>Maximum SVG for bundle conductor with N>=3</td></tr>
<tr><td>Mangoldt formula</td></tr>
<tr><td>Distribution of voltage gradient on sub conductors of bundle –simple problems</td></tr>
<tr><td colspan="3">UNIT-II: Corona effects: (11 hrs)
Power loss and audible noise (AN) – Corona loss formulae – Charge voltage diagram – Generation – Characteristics – Limits and measurements of AN
Radio interference (RI) – Corona pulses generation – Properties and limits –Biological effects Electrical and magnetic fields on human beings and animals- Recent advances in UHV power transmission</td></tr>
<tr><th>Unit No</th><th>Module</th><th>Micro content</th></tr>
<tr><td rowspan="7">2.a Corona effects (AN)</td><td rowspan="4">Power loss</td><td>I^2R loss and corona los</td></tr>
<tr><td>Corona loss formulae</td></tr>
<tr><td>The corona current</td></tr>
<tr><td>Charge-voltage diagram and corona loss</td></tr>
<tr><td rowspan="3">Audible Noise</td><td>Audible noise: generation and characteristics</td></tr>
<tr><td>Limits for audible noise</td></tr>
<tr><td>AN measurements and meters</td></tr>
<tr><td rowspan="4">2.b
Corona effects
(RI)</td><td rowspan="2">Radio interference</td><td>Corona pulses generation and their properties</td></tr>
<tr><td>Limits for RI fields</td></tr>
<tr><td>Biological effects</td><td>Effects of electrical fields and magnetic fields on human beings and animals</td></tr>
<tr><td>Recent advances</td><td>Recent advances in UHV transmission and challenges</td></tr>
<tr><td colspan="3">Unit III Basic Concepts of DC Transmission(13 hrs)
Basic Concepts of DC Transmission Economics & Terminal equipment of HVDC transmission systems: Types of HVDC Links – Apparatus required for HVDC Systems
Comparison of AC &DC transmission – Application of DC Transmission System – Planning &</td></tr>
</table>

<table>
<tr><td colspan="3">Modern trends in DC transmission.</td></tr>
<tr><th>Unit No</th><th>Module</th><th>Micro content</th></tr>
<tr><td rowspan="3">3.a Basic Concepts of DC Transmission</td><td>Basic Concepts</td><td>Introduction to DC Transmission</td></tr>
<tr><td>Types of HVDC Links</td><td>Monopolar HVDC Link, Bipolar HVDC Link, Homopolar HVDC link, back to back HVDC Link</td></tr>
<tr><td>Apparatus Required</td><td>Apparatus required in HVDC transmission, like converter stations, Converter Transformer, smoothing reactor, Filters, Reactive Power Sources, Switchgear components</td></tr>
<tr><td rowspan="3">3.b Basic Concepts of DC Transmission</td><td>Comparison of AC and DC</td><td>Comparison of AC and DC Transmission , Economics of Comparison, Technical Comparison, Reliability</td></tr>
<tr><td>Application</td><td>Applications of DC Transmission</td></tr>
<tr><td>Planning and Modern Trends</td><td>Planning of DC Transmission and Modern Trends DC Transmission</td></tr>
<tr><td colspan="3">Unit IV Analysis of HVDC Converters and System Control(13 hrs)
Choice of Converter configuration – Analysis of Graetz circuit – Characteristics of 6 Pulse & 12 Pulse converters – Cases of two 3 phase converters in star – Star mode and their performance
Principal of DC Link Control - Converters Control Characteristics – Firing angle control – Current and extinction angle control– Starting and stopping of DC link – Power Control</td></tr>
<tr><th>Unit No</th><th>Module</th><th>Micro content</th></tr>
<tr><td rowspan="4">4.a Analysis of HVDC Converters and System Control</td><td>Choice of Converter configuration</td><td>Types of Converters, Pulse number, Valve utilization factor, Transformer Utilization factor,</td></tr>
<tr><td>Analysis of Graetz Circuit</td><td>Analysis of Graetz circuit without overlap, Average DC voltage, Current, Harmonics analysis</td></tr>
<tr><td>Analysis of Graetz Circuit</td><td>Analysis of Graetz circuit without overlap, Average DC voltage, Current, Harmonics analysis, Cases of two and three valve conduction mode of 3 phase converter and its performance</td></tr>
<tr><td>12 Pulse Converter</td><td>12 Converter operation , average dc output voltage , AC Current Harmonics</td></tr>
<tr><td rowspan="2">4.b Analysis of HVDC Converters and System Control</td><td>Principal of DC Link Control</td><td>Steady State Equivalent circuit, Converter Control Characteristics, Voltage dependent control</td></tr>
<tr><td>Firing angle control</td><td>Firing angle control, Individual phase control-constant alpha control, inverse cosine control, drawbacks of IPC,Equidistant Pulse Control-Pulse Frequency Control (PFC), Pulse Period Control, pulse Phase Control (PPC) , drawbacks of EPC</td></tr>
</table>

	Constant Current Control	Current and Extension angle control, Starting and Stopping of dc link , power Control

Unit V Reactive Power Control, Harmonics and Filters in HVDC(15 hrs)

Reactive Power Requirements in steady state – Conventional control strategies –Alternate control strategies sources of reactive power – AC Filters – Shunt capacitors – Synchronous condensers.

Harmonics and Filters Generation of Harmonics – Characteristics harmonics – Calculation of AC Harmonics – Non–Characteristics harmonics – Adverse effects of harmonics – Calculation of voltage & current harmonics – Effect of Pulse number on harmonics. Types of AC filters, Design of Single tuned filters – Design of High pass filters.

Unit No	Module	Micro content
5.a Reactive Power Control, Harmonics and Filters in HVDC	Reactive Power Control	Reactive power requirements in Steady state, Alternative control strategies,
	Sources of Reactive Power	Sources of reactive power,-AC filters, Shunt Capacitors, Synchronous condenser
5.b Reactive Power Control, Harmonics and Filters in HVDC	Generation of Harmonics	Sources of Harmonics generation, adverse effects of harmonics, Generation of harmonics-Characteristic harmonics , calculation of voltage and current harmonics , Non characteristic harmonics , effect of pulse number on harmonics
	Design of filters	Types of AC Filters, Design of Single tuned filters – Design of High pass filters.

Co Po Mapping Table

Contribution of Course Outcomes towards achievement of Program Outcomes & Strength of correlations

(High: 3, Medium: 2, Low: 1)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PS03
CO1	2	3	2	1								1			
CO2	2	3	2	1								1	1		
CO3	2	3	2	1								1			
CO4	2	3	2	1								1			1
CO5	2	3	2	1								1			1

Module Coordinator **BOS** **HOD**

IV- Year I- Semester	Name of the Course	L	T	P	C
	Energy Conservation & Auditing ((Professional Elective IV))	3	0	0	3

PRE-REQUISITES: 1) Managerial Economics and Financial Analysis

Course objectives: The student should be able to

1. To understand energy efficiency, scope, conservation and technologies.
2. To design energy efficient lighting systems.
3. To estimate/calculate power factor of systems and propose suitable compensation techniques.
4. To calculate life cycle costing analysis and return on investment on energy efficient technologies.

Syllabus		
Unit No	**Contents**	**Mapped CO**
I	**Unit – 1:Basic Principles of Energy Audit**:(12hrs) Energy audit – Definitions – Concept – Types of audit – Energy index – Cost index – Pie charts –Sankey diagrams – Load profiles – Energy conservation schemes and energy saving potential – Numerical problems-Energyauditofindustries-energysavingpotential,energyauditofprocessindustry,thermalpowerstation,buildingenergyaudit.	**CO1**
II	**Unit – 2:Lighting :(14hrs)** Modification of existing systems – Replacement of existing systems – Priorities: Definition of terms and units – Luminous efficiency – Polar curve – Calculation of illumination level – Illumination of inclined surface to beam – Luminance or brightness – Types of lamps – Types of lighting – Electric lighting fittings (luminaries) – Flood lighting – White light LED and conducting Polymers – Energy conservation measures	**CO2**
III	**Unit – 3:Power Factor and energy instruments:(14hrs)** Power Factor and energy instruments: Power factor – Methods of improvement – Location of capacitors – Power factor with non linear loads – Effect of harmonics on Power factor – Numerical problems. Energy Instruments – Watt–hour meter – Data loggers – Thermocouples – Pyrometers – Lux meters – Tong testers – Power analyzer	**CO3**
IV	**Unit – 4:Economic Aspects and Financial Analysis: (12 hours)** Understanding energy cost - Economics Analysis – Depreciation Methods – Time value of money – Rate of return – Present worth method – Replacement analysis – Life cycle costing analysis – Energy efficient motors (basic concepts) – Economics of energy efficient motors and systems.	**CO4**
V	**Unit – 5:Computation of Economic Aspects : (12 hours)** Need of investment, appraisal and criteria - Calculation of simple payback period– Return on investment – Net present value – Internal rate of return – numerical examples – Power factor correction – Lighting – Applications of life cycle costing	**CO5**

	analysis – Return on investment – Numerical examples.	

Course Outcomes	
Upon successful completion of the course, the student will be able to	
CO1	**Explain** energy efficiency, conservation and various technologies**{Understand level, KL2}**
CO2	**Design** energy efficient lighting systems**{Create level, KL6}**
CO3	**Analyze** power factor of systems and propose suitable compensation techniques**{Analyze level, KL4}**
CO4	**Analyze** life cycle costing analysis **{Analyze level, KL4}**
CO5	**Analyze**return on investment on energy efficient technologies.**{Analyze level, KL4}**

Learning Resources
Text books:
1. Hand Book of Energy Audit by Sonal Desai- Tata McGraw hill 2. Energy efficient electric motors by John .C. Andreas, Marcel Dekker Inc Ltd–2nd edition, 1995
Reference books:
1. Energy management by W.R. Murphy & G. Mckay Butter worth, Elsevier publications. 2012 2. Electric Energy Utilization and Conservation by S C Tripathy, Tata McGraw hill publishing company Ltd. New Delhi. 3. Energy management by Paul o' Callaghan, Mc–Graw Hill Book company–1st edition, 1998. 4. Energy management hand book by W.C.Turner, John wiley and sons. 5. Energy management and conservation –k v Sharma and pvenkataseshaiah-I K International Publishing House pvt.ltd,2011. 6. http://www.energymanagertraining.com/download/Gazette_of_IndiaPartIISecI37_25-08-2010.pdf
e- Resources & other digital material
1. http://www.enernoc.com/our-resources/term-pages/what-is-an-energy-audit
2. http://energy.gov/energysaver/professional-home-energy-audits
3. http://www.cpri.in/about-us/departmentsunits/energy-efficiency-and-renewable-energy-

Micro-Syllabus

Unit – 1:Basic Principles of Energy Audit: (10hrs)

Energy audit – Definitions – Concept – Types of audit – Energy index – Cost index – Pie charts – Sankey diagrams – Load profiles – Energy conservation schemes and energy saving potential – Numerical problems

Unit	Module	Micro content
1a. Basic definitions of	Basic definitions of energy audit	COMPANY/BUILDING WHERE ENERGY AUDIT IS PERFORMED

energyaudit		ENERGY-AUDIT METHODOLOGY
		Detailed audit
		Audit Preparation
1b. Energy conservation schemes	Energy conservation schemesand energy saving potential	Primary energy and Secondary energy
		Commercial energy and Non-commercial energy
		Waste-heat utilization
		Keeping the boiler surface clean from soot deposition

Unit – 2:Lighting : (14hrs)

Modification of existing systems – Replacement of existing systems – Priorities: Definition of terms and units – Luminous efficiency – Polar curve – Calculation of illumination level – Illumination of inclined surface to beam – Luminance or brightness – Types of lamps – Types of lighting – Electric lighting fittings (luminaries) – Flood lighting – White light LED and conducting Polymers – Energy conservation measures

Unit	Module	Micro content
2a. Modification of existing systems	Modification of existing systems	Fundamentals of Lighting
		Ballasts
		Fixtures
		Lighting System Audit
2b. Types of lamps – Types of lighting	Types of lamps – Types of lighting	Different Lighting Systems
		Incandescent lamp, Fluorescent lamps

Unit – 3:Power Factor and energy instruments: (14hrs)

Power Factor and energy instruments: Power factor – Methods of improvement – Location of capacitors – Power factor with non linear loads – Effect of harmonics on Power factor – Numerical problems. Energy Instruments – Watt–hour meter – Data loggers – Thermocouples – Pyrometers – Lux meters – Tong testers – Power analyzer

Unit	Module	Micro content
3a.Power Factor	**Power Factor**	Definition
		Capacitor Banks
		Synchronous Condensers
		Static Var Compensators (SVCs)
		Advantages of location of capacitors
3b. energy instruments	**energy instruments**	Electrical Measurement
		Thermal Measurement
		Air-leakage measurement

Unit – 4:Economic Aspects and Financial Analysis: (12 hours)

Understanding energy cost - Economics Analysis – Depreciation Methods – Time value of money – Rate of return – Present worth method – Replacement analysis – Life cycle costing analysis – Energy efficient motors (basic concepts) – Economics of energy efficient motors and systems.

Unit	Module	Micro content
4a. Understanding energy cost	Understanding energy cost	Power Costs
		Fuel Costs
		Energy invoicespurposes
4b. Economics of energy efficient motors and systems	Economics of energy efficient motors and systems	Introduction
		Motor technologies and markets
		Standards and regulations
		Supporting policies
		Finance and delivery mechanisms

Unit – 5:Computation of Economic Aspects : (12 hours)

Need of investment, appraisal and criteria - Calculation of simple payback period–Return on investment – Net present value – Internal rate of return – numerical examples – Power factor correction – Lighting – Applications of life cycle costing analysis – Return on investment – Numerical examples.

Unit	Module	Micro content
5a.Computation of Economic Aspects	**Computation of Economic Aspects**	Introduction
		Investment appraisal techniques
		Net present value
		Payback period
		Accounting rate of return
5b. Applications of life cycle costing analysis	**Applications of life cycle costing analysis**	Initial cost
		Service cost
		Preventative maintenance cost
		Operating cost

CO-PO mapping Table

Contribution of Course Outcomes towards achievement of Program Outcomes & Strength of correlations **(High: 3, Medium: 2, Low: 1)**														
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO-1	PSO-2
CO1	2											1		1
CO2			2											
CO3	1	2												1
CO4	1	2												
CO5		2												

Module Coordinator **BOS** **HOD**

IV- Year I- Semester	Name of the Course	L	T	P	C
	Power System Reliability (Professional Elective IV)	3	0	0	3

PRE-REQUISITES:

a. Power Systems- I
b. Power Systems- II
c. Probability and Stochastic Methods

Course objectives: The student should be able to

1. Study various methods and measure for determining reliability of a system
2. Compute failure frequencies and duration for components failure.
3. Study models for reliability determination and identify probable failures in electrical generation system.
4. Compute outage and identify contingency in power transmission system
5. Identify the reliability models for radial distribution system

Syllabus		
Unit No	**Contents**	**Mapped CO**
I	**Network Modelling and Reliability Analysis (12 hrs)** **Reliability concepts** – exponential distributions – meantime to failure – series and parallel system – MARKOV process – recursive technique - Bathtub curve **(07 hrs)** **Reliability Measures** MTTF, MTTR, MTBF**(05 hrs)**	**CO1**
II	**Frequency & Duration Techniques(12 hrs)** Frequency and duration concept – Evaluation of frequency of encountering state, mean cycle time for one and two component repairable models **(06 hrs)** evaluation of cumulative probability and cumulative frequency of encountering of merged states**(06 hrs)**	**CO2**
III	**Generation System Reliability Analysis(12 hrs)** **Reliability model of a generation system:** recursive relation for unit addition and removal – load modelling - Merging of generation load model **(07 hrs)** evaluation of transition rates for merged state model – cumulative Probability, cumulative frequency of failure evaluation – LOLP, LOLE**(05 hrs)**	**CO3**
IV	**Transmission System Reliability Analysis(12 hrs)** Deterministic contingency analysis-Determination of reliability indices like LOLP and expected value of demand not served.	**CO4**
V	**Distribution System Reliability Analysis(12 hrs)** Basic Concepts – Additional interruption indices - Evaluation of Basic and performance reliability indices of radial networks.	**CO5**
Content Beyond the syllabus:		

Reliability under preventive maintenance, Energy index of reliability, Applications of reliability indices in power system planning, Applications of reliability indices in power system interconnection

Course Outcomes	
Upon successful completion of the course, the student will be able to	
CO1	**Demonstrate** basic reliability measures**{Understand level, KL2}**
CO2	**Apply** failure frequency and duration for power system applications **{Apply level, KL3}**
CO3	**Analyze** the failure probability of generation system **{Analyze level, KL4}**
CO4	**Analyze** the outage and contingency of transmission system. **{Analyze level, KL4}**
CO5	**Analyze** the reliability of radial distribution networks. **{Analyze level, KL4}**

Learning Resources
Text books:
1. R. Billinton, R.N.Allan, "Reliability Evaluation of Power systems" second edition, Springer. 2. Charles E. Ebeling, "An Introduction to Reliability and Maintainability Engineering", TATA Mc Graw - Hill – Edition.
Reference books:
1. R. Billinton, R.N.Allan, "Reliability Evaluation of Engineering System", Plenum Press, New York. 2. Eodrenyi, J., "Reliability modelling in Electric Power System", John Wiley, (1980)
e- Resources & other digital material
1. https://ieeexplore.ieee.org/abstract/document/8614407
2. https://www.sciencedirect.com/science/article/abs/pii/095183209090007A
3. https://ekeeda.com/degree-courses/electrical-engineering/power-system-planning-and-reliability
4. https://www.intechopen.com/chapters/57936

Micro-Syllabus

Unit I: Network Modelling and Reliability Analysis (12 hrs) **Reliability concepts** – exponential distributions – meantime to failure – series and parallel system – MARKOV process – recursive technique - Bathtub curve **(07 hrs)** **Reliability Measures** MTTF, MTTR, MTBF**(05 hrs)**		
Unit No	**Module**	**Micro content**
1a. Reliability concepts	**Reliability concepts**	Exponential distributions - Meantime to Failure
		Series and Parallel System
		MARKOV process
		Recursive technique
		Bathtub curve
1b. Reliability Measures	**Reliability Measures**	MTTF
		MTTR

		MTBF

Unit-2:Frequency & Duration Techniques (12 hrs)

Frequency and duration concept – Evaluation of frequency of encountering state, mean cycle time for one and two component repairable models **(08 hrs)**

evaluation of cumulative probability and cumulative frequency of encountering of merged states**(04 hrs)**

Unit No	Module	Micro content
2a. Frequency & Duration	**Frequency & Duration**	Frequency and duration concept
		Evaluation of frequency of encountering state
		mean cycle time for one component repairable model
		mean cycle time for two components repairable model
2b. Cumulative probability and frequency determination	**Cumulative probability and frequency determination**	evaluation of cumulative probability of encountering of merged states
		evaluation of cumulative frequency of encountering of merged states

Unit-3: Generation System Reliability Analysis (12 hrs)

Reliability model of a generation system: recursive relation for unit addition and removal – load modelling - Merging of generation load model **(07 hrs)**

Evaluation of transition rates for merged state model – cumulative Probability, cumulative frequency of failure evaluation – LOLP, LOLE**(05 hrs)**

Unit No	Module	Micro content
3a. Reliability model of a generation system	**Reliability model of a generation system**	recursive relation for unit addition
		recursive relation for unit removal
		load modelling
		Merging of generation load model
3b. Evaluation of transition rates for merged state model	**Evaluation of transition rates for merged state model**	cumulative Probability
		cumulative frequency of failure evaluation – LOLP
		cumulative frequency of failure evaluation- LOLE

Unit-IV. Transmission System Reliability Analysis (12 hrs)

Deterministic contingency analysis-Determination of reliability indices like LOLP and expected value of demand not served.

Unit No	Module	Micro content
4a. Contingency analysis	**Contingency analysis**	Deterministic contingency analysis
		Load flow contingency
		Multiple Contingency problem
4b. Determination of	**4b. Determination of**	LOLP
		Expected value of demand not served

reliability indices	**reliability indices**	Improving reliability indices
Unit-5: Distribution System Reliability Analysis (12 hrs) Basic Concepts – Additional interruption indices**(04 hrs)** Evaluation of Basic and performance reliability indices of radial networks**(08 hrs)**		
Unit No	**Module**	**Micro content**
5a. **Interruption indices**	**Interruption indices**	Basic Concepts
		Additional interruption indices
5b. Reliability Indices of Radial Networks	Reliability Indices of Radial Networks	Evaluation of Basicreliability indices of radial networks
		Evaluation ofperformance reliability indices of radial networks

CO-PO mapping Table

Contribution of Course Outcomes towards achievement of Program Outcomes & Strength of correlations **(High: 3, Medium: 2, Low: 1)**														
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO-1	PSO-2
CO1				3										
CO2	3													
CO3		3		2										
CO4		3		2										
CO5		3		2										

Module Coordinator **BOS** **HOD**

IV- Year I- Semester	Name of the Course **ELECTRIC VEHICLES** (Professional Elective V)	L	T	P	C
		3	0	0	3

PRE-REQUISITES: 1) Power Electronics and Electrical Machines

Course Objectives: The student shall be able to

1. KnowtheEvolutionofElectrical Vehicles.
2. Understand Electric Vehicle Dynamics and Propulsion.
3. Differentiate Various Configurations of Electric and Hybrid Electric Vehicles.
4. Understand battery Energy Storage Technologies for EVs.
5. Know Different EV Charging technologies.

Syllabus		
Unit No	**Contents**	**Mapped CO**
I	**Introduction to Electric Vehicles: (10hrs)** Historical Background, Overview of Electrical Vehicles in India, Benefits of Using EVs, Overview of Types of EVs and its Challenges, Components of Electrical Vehicles, Comparison with Internal combustion Engine.	**CO1**
II	**Vehicle Dynamics andMotor Drive Technologies: (12hrs)** Aero Dynamic Drag, Rolling Resistance, Uphill Resistance, Acceleration, Tractive Force, Regeneration, Numerical Problems, EV drive train, Vehicle performance parameters, Overview of different motors used in EVs.	**CO2**
III	**EV and HEV Configurations: (12hrs)** Typical BEV Configuration, BEV Configurations Based on different types of Mechanical arrangements, BEV configuration with different energy sources, BEV configuration with single or multiple motors, HEV Configurations: Series Hybrid EV, Parallel Hybrid EV, Series-parallel EV, Complex EV.	**CO3**
IV	**Battery Energy Storage Systems: (12hrs)** Introduction, Battery Parameters, Equivalent Circuit Model of Battery, EV Batteries, comparison of batteries, Battery State of charge (SOC), State of Health (SOH) Estimation, Battery Pack Development.	**CO4**
V	**EV Charging Technologies: (12hrs)** EV Charging Schemes, EV Charging Methods: Constant current charging (CC), Constant Voltage charging (CV), Constant current constant voltage charging(CCCV), Multi-stage charging (MSC), Pulse Charging, Trickle charging, Classification of EV Charging infrastructure in India,Assessment of EV Charging Demand, Vehicle to grid Integration.	**CO5**
Content Beyond the Syllabus: Modelling of Electric Vehicle, Overview of Battery management systems (BMS).		

Course Outcomes	
Upon successful completion of the course, the student will be able to	
CO1	Understand the Evolution of Electric Vehicles.**{Understand level, KL2}**
CO2	**Understand**Electric vehicle dynamics and propulsion.**{Understand level, KL2}**
CO3	**Analyze**Electric and hybrid Electric vehicle Configurations**{Analyze level, KL4}**
CO4	**Explain** the use of different Energy storage devices used for Electric vehicles. . **{Understand level, KL2}**
CO5	**Appreciate**the importance of EV Charging Technology.**{Apply level, KL3}**

Learning Resources
Textbooks:
1. C.CChan,K.TChau:"Modern ElectricVehicleTechnology",OxfordUniversityPress Inc., NewYork2001. 2. JamesLarminie,JohnLowry,"ElectricVehicleTechnologyExplained", Wiley,2003.
Reference books:
1. IqbalHusain,"ElectricandHybridVehiclesDesignFundamentals", CRCPress2005. 2. AliEmadi,"AdvancedElectricDriveVehicles", CRCPress,2015. 3. M.Ehsani,Y.Gao,S.E.GayandA.Emadi,"ModernElectric,HybridElectric,andFuelCellVehicles:Fundamentals,Theory,and Design", CRCPress, 2004. 4. T.Denton,"Electricand HybridVehicles",Routledge,2016.
e- Resources & other digital material
1. https://onlinecourses.nptel.ac.in/noc23_ee01/preview
2. https://nptel.ac.in/courses/108106170
3. https://www.udemy.com/course/electric-vehicles-comprehensive-course/

Micro-Syllabus

Unit-1: Introduction to Electric Vehicles: (10hrs)
Historical Background, Overview of Electrical Vehicles in India, Benefits of Using EVs, Overview of Types of EVs and its Challenges, Components of Electrical Vehicles, Comparison with Internal combustion Engine.

Unit No	Module	Microcontent
1. Introduction to Electric Vehicles	**Introduction to Electric Vehicles**	Historical Background
		Overview of Electrical Vehicles in India
		Benefits of Using EVs
		Overview of Types of EVs and its Challenges
		Components of Electrical Vehicles
		Comparison of EV with Internal combustion Engine.

Unit-2: Vehicle Dynamics and Motor Drive Technologies: (12hrs)
Aero Dynamic Drag, Rolling Resistance, Uphill Resistance, Acceleration, Tractive Force, Regeneration, Numerical Problems, EV drive train, Vehicle performance parameters, Overview of

different motors used in EVs.		
Unit No	**Module**	**Microcontent**
2a. Vehicle Dynamics	**Vehicle Dynamics**	Aero Dynamic Drag
		Rolling Resistance
		Uphill Resistance
		Acceleration
		Tractive force
		Regeneration
		Numerical Problems
2b. EV drive train And Vehicle performance parameters	**EV drive train And Vehicle performance parameters**	Drive train configuration.
		Vehicle power Plant
		Performance characteristics for a vehicle power plant
		Torque Vs Speed and Power Vs speed Characteristics of Electric motor
		Overview of different motors used in EVs

EV and HEV Configurations: (12hrs)
Typical BEV Configuration, BEV Configurations Based on different types of Mechanical arrangements, BEV configuration with different energy sources, BEV configuration with single or multiple motors,
HEV Configurations: Series Hybrid EV, Parallel Hybrid EV, Series-parallel EV, Complex EV.

Unit No	**Module**	**Microcontent**
3a. BEV Configurations	**BEV Configurations based on Mechanical Arrangements**	BEV configuration with longitudinal front wheel drives
		BEV configuration with fixed gear and no clutch
		BEV configuration with transverse front-wheel drive
		BEV configuration with dual motor drive
		BEV configuration with in-wheel and outer rotor motor drive
		BEV configuration with single or multiple motors
	BEV Configurations based on Energy Sources	BEV Configuration with Battery energy source
		BEV Configuration with hybrid batteries
		BEV Configuration with fuel cell energy sources
		BEV Configuration with UC/UF as an energy source
3b. HEV Configurations	**HEV Configurations**	Hybridization of EVs
		Advantages of Hybridization of EVs
		Series Hybrid EV
		Parallel Hybrid EV
		Series-parallel EV

		Complex EV
Unit-4: Battery Energy Storage Systems: (12hrs) Introduction, Battery Parameters, Equivalent Circuit Model of Battery, EV Batteries, comparison of batteries, Battery State of charge (SOC), State of Health (SOH) Estimation, Battery Pack Development, Charging Schemes of an EV.		
Unit No	**Module**	**Microcontent**
4. **Battery Energy Storage Systems**	**Battery Energy Storage Systems**	Introduction
		Battery Parameters
		Equivalent Circuit Model of Battery
		EV Batteries
		Comparison of batteries
		Battery State of Charge (SOC) Estimation
		Battery State of Health (SOC) Estimation
		Battery Pack Development (Electrical)
Unit-5:EV Charging Technologies: EV Charging Schemes, EV Charging Methods: Constant current charging (CC), Constant Voltage charging (CV), Constant current constant voltage charging (CCCV), Multi-stage charging (MSC), Pulse Charging, Trickle charging, Classification of EV Charging infrastructure in India, Assessment of EV Charging Demand, Vehicle to grid Integration.		
Unit No	**Module**	**Microcontent**
5. EV Charging Technologies	**EV Charging Schemes**	Normal Charging
		Opportunity Charging
		Fast Charging
		Battery Swapping
	EV Charging Methods	Constant current charging
		Constant voltage charging
		Constant current and constant voltage charging
		Multi-stage charging
		Pulse charging
		Trickle charging
	Classification of EV Charging Infrastructure in India	Private Charging
		Semi-public charging
		Public Charging
		Assessment of EV Charging Demand
		Vehicle to grid Integration

CO-PO mapping Table

Contribution of Course Outcomes towards achievement of Program Outcomes & Strength of correlations **(High: 3, Medium: 2, Low: 1)**														
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO-1	PSO-2
CO1	3													
CO2	3	3												
CO3	2													
CO4	3	2	2				1						1	
CO5	3													

Module Coordinator **BOS** **HOD**

IV- Year I- Semester	Name of the Course	L	T	P	C
	Digital Control Systems (Professional Elective V)	3	0	0	3

PRE-REQUISITES: 1) Control Systems

Course objectives: The student should be able to

1. To understand the concepts of digital control systems and assemble various componentsassociatedwithit.Advantages comparedtotheanalogtype.
2. The theory of z–transformations and application for the mathematical analysis of digitalcontrolsystems.
3. To representthe discrete–time systemsin state–spacemodel andevaluation of statetransition matrix, the design of state feedback control by "the pole placement method."
4. To examine the stabilityofthe systemusingdifferenttests.
5. To studythe conventionalmethodofanalyzingdigitalcontrolsystemsinthe w–plane.

Unit No	Contents	Mapped CO
	Syllabus	
I	**Introductionandsignalprocessing (06 hrs)** Introduction to analog and digital control systems – Advantages of digital systems – Typicalexamples – Continuous and Discrete Time Signals – Sample and hold devices – Frequencydomaincharacteristicsofzeroorderhold.	**CO1**
II	**z–transformations (12 hrs)** Z–Transforms – Theorems – Finding inverse z–transforms – Formulation of differenceequationsand solving – Block diagram representation – Pulse transfer functions and finding open loop andclosedloopresponses.	**CO2**
III	**Stabilityanalysis (10 hrs)** Mappingbetweenthes–Planeandthez–Plane–PrimarystripsandComplementarystrips–Stabilitycriterion –ModifiedRouth'sstabilitycriterionandJury'sstabilitytest.	**CO3**
IV	**StatespaceanalysisandtheconceptsofControllabilityandObservability (06 hrs)** Statespacerepresentationofdiscretetimesystems–SolvingDiscreteTimestatespaceequations – State transition matrix and its properties– Discretization of continuous time stateequations –Conceptsofcontrollabilityandobservability–Tests(withoutproof). StateFeedbackControllersandStateObservers **(06 hrs)** Designofstatefeedbackcontroller throughpoleplacement–Necessaryandsufficientconditions –Ackerman'sformula	**CO4**
V	**Design ofdiscrete–timecontrolsystemsbyconventionalmethods (08 hrs)** Transientandsteadystatespecifications–Designusingfrequencyresponseinthew–planefor lag andleadcompensators–Rootlocustechnique inthe z–plane.	**CO5**
Content Beyond the syllabus: Designofstateobservers(FullOrder andReducedOrder).		

Course Outcomes	
Upon successful completion of the course, the student will be able to	
CO1	Understand theadvantagesofdiscretetimecontrolsystemsandthe“knowhow”of variousassociatedaccessories.**{understand level, kL2}**
CO2	Applyz–transformationsandtheirroleinthemathematical analysisof differentsystems(like Laplacetransformsinanalogsystems).**{Apply level, KL3}**
CO3	Analyze thestabilitycriterionfordigitalsystemsandmethodsadoptedfortesting the same are explained.**{analyze level, kL4}**
CO4	Evaluating the conventionalandstatespacemethodsofdesign. **{evaluate level, kL5}**
CO5	Applying the design procedure in the w-plane. **{Apply level, KL4}**

Learning Resources
Text books:
1. Discrete–TimeControlsystems–K. Ogata,PearsonEducation/PHI, 2ndEdition. 2. DigitalControlandStateVariableMethodsbyM.Gopal,TMH,4^{th}Edition.
Reference books:
1. DigitalControlSystems, Kuo,OxfordUniversityPress, 2ndEdition,2003. 2. Digital Control Systems Analysis and Design- 3^{rd} edition- Charles S Phillips, H.Troy Nagle - PHI
e- Resources & other digital material
1. https://nptel.ac.in/courses/108103008

Micro-Syllabus

Unit 1: Introductionandsignalprocessing (06 hrs) Introduction to analog and digital control systems – Advantages of digital systems – Typicalexamples – Continuous and Discrete Time Signals – Sample and hold devices – Frequencydomaincharacteristicsofzeroorderhold.		
Unit No	**Module**	**Micro content**
1	**Introduction**	Introduction to analog and digital control systems
		Advantages of digital systems
		Typicalexamples
	Signalprocessing	Continuous and Discrete Time Signals
		Sample and hold devices
		Frequencydomaincharacteristicsofzeroorderhold.
Unit 2: z–transformations (12 hrs) Z–Transforms – Theorems – Finding inverse z–transforms – Formulation of		

	differenceequationsand solving – Block diagram representation – Pulse transfer functions and finding open loop andclosedloopresponses.	
Unit No	**Module**	**Micro content**
2	**z–transformations**	Z–Transforms
		Theorems
		Finding inverse z–transforms
		Formulation of differenceequationsand solving
		Block diagram representation
		Pulse transfer functions and finding open loop andclosedloopresponses.
Unit 3: Stabilityanalysis (10 hrs) Mappingbetweenthes–Planeandthez–Plane–PrimarystripsandComplementarystrips–Stabilitycriterion –ModifiedRouth'sstabilitycriterionandJury'sstabilitytest.		
Unit No	**Module**	**Micro content**
3	**Stabilityanalysis**	Mappingbetweenthes–Planeandthez–Plane
		PrimarystripsandComplementarystrips
		PrimarystripsandComplementarystrips
		Jury'sstabilitytest
		ModifiedRouth'sstabilitycriterion
Unit 4: StatespaceanalysisandtheconceptsofControllabilityandObservability (06 hrs) Statespacerepresentationofdiscretetimesystems–SolvingDiscreteTimestatespaceequations – State transition matrix and its properties–Discretization of continuous time stateequations –Conceptsofcontrollabilityandobservability–Tests(withoutproof). StateFeedbackControllersandStateObservers **(06 hrs)** Designofstatefeedbackcontroller throughpoleplacement–Necessaryandsufficientconditions –Ackerman'sformula.		
Unit No	**Module**	**Micro content**
4.a	**Statespaceanalysis**	Statespacerepresentationofdiscretetimesystems
		SolvingDiscreteTimestatespaceequations
		State transition matrix and its properties
		Discretization of continuous time

		stateequations
4.b	**TheconceptsofControllabilityandObservability**	Conceptsofcontrollabilityandobservability–Tests (withoutproof).
		Designofstatefeedbackcontroller throughpoleplacement
		Necessaryandsufficientconditions
		Ackerman'sformula

Unit 5: Design ofdiscrete–timecontrolsystemsbyconventionalmethods (08 hrs)

Transientandsteadystatespecifications–Designusingfrequencyresponseinthew–planefor lag andleadcompensators–Rootlocustechnique inthe z–plane.

Unit No	**Module**	**Micro content**
5	**Design ofdiscrete–timecontrolsystemsbyconventionalmethods**	Transientandsteadystatespecifications
		Designusingfrequencyresponseinthew–planefor lag andleadcompensators
		Rootlocustechnique inthe z–plane

CO-PO mapping Table

Contribution of Course Outcomes towards achievement of Program Outcomes & Strength of correlations **(High: 3, Medium: 2, Low: 1)**														
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO-1	PSO-2
CO1	3													
CO2	3												1	
CO3	2	1												
CO4	2	2	1											1
CO5	3	1												1

Module Coordinator **BOS** **HOD**

IV- Year I- Semester	Name of the Course	L	T	P	C
	Advanced Power System Protection (Professional Elective V)	3	0	0	3

PRE-REQUISITES: Power System Protection

Course objectives: To make the student

1) To know construction of static relays
2) To understand the operation of amplitude and phase comparators
3) To comprehend the concepts of Static over current, static differential and static distance relays.
4) To understand multi-input comparators and concept of power swings on the distance relays.
5) To know the operation of microprocessor based protective relays.

Syllabus		
Unit No	**Contents**	**Mapped CO**
I	**STATIC RELAYS & COMPARATORS** (8 Hrs) Static relays - Basic construction of Static relays – Level detectors – Replica Impedance-Mixing circuits-General equation for two input phase and Amplitude Comparators – their types – Duality between Amplitude and Phase Comparator –Conic section characteristics–Three input Amplitude Comparator – Hybrid comparator – Switched distance schemes – Polyphase distance schemes-Phase faults scheme –Three phase scheme–Combined and Ground fault scheme.	**CO1**
II	**TYPES OF STATIC RELAYS** (9 Hrs) Instantaneous over current relay – Time over current relays - Basic principles - Definite time and Inverse definite time over current relays, directional over current relays - Static Differential Relays-Analysis of static differential relays–Static relay schemes-Dual bias transformer differential protection – Harmonic restraint relay.	**CO2**
III	**NUMERICAL RELAYS** (9 Hrs) Advantages of Numerical Relays – Numerical network-Digital Signal processing–Estimation of Phasors – Full Cycle Fourier Algorithm – Half Cycle Fourier Algorithm-practical considerations for selection of Algorithm– Discrete Fourier Transform.	**CO3**
IV	**DISTANCE RELAYS AND POWER SWINGS** (12 Hrs) Static Distance Relays - Static Impedance - reactance - MHO and Angle Impedance relay sampling comparator – Realization of reactance and MHO relay using a sampling comparator. Effect of power swings on the performance of Distance relays-Power swing analysis - Principle of out of step tripping and blocking relays - Effect of line length and source impedance on distance relays.	**CO4**
V	**MICROPROCESSOR BASED PROTECTIVE RELAYS** (10 Hrs) Over current relays – Impedance relays – Directional relay – Reactance relay (Block diagram and flowchart approach only).Generalized mathematical expression for	**CO5**

	distance relays-Measurement of resistance and reactance – MHO and offset MHO relays – Realization of MHO characteristics – Realization of Offset MHO characteristics (Block diagram and flow chart approach only) - Basic principle of Digital computer relaying.	

Course Outcomes	
Upon successful completion of the course, the student will be able to	
CO1	**Describe** the construction of static relay and identify the advantages of static relay over electromagnetic relay. **{Understand level, KL2}**
CO2	**Explore** the operation of rectifier bridge comparators, instantaneous comparators, phase comparators, multi input comparators, static differential and distance relays. **{Understandlevel, KL2}**
CO3	**Describe** instantaneous, definite time and inverse definite minimum time over current relays and numerical relays. **{Understand level, KL2}**
CO4	**Analyz**e the concept of power swings on distance relays. **{Analyz**e **level, KL4}**
CO5	**Analyze**the concept of microprocessor based protective relays and their operation.**{Analyz**e **level, KL4}**

Learning Resources
Text books:
1. T.S. Madhava Rao, Power system Protection static relay, Tata McGrawHill Publishing Company limited, 2nd Edition, 2004. 2. Badri Ram and D.N. Vishwakarma, Power system Protection and Switchgear, Tata McGraw Hill Publication Company limited, 2nd Edition, 2013.
Reference books:
1. Bhavesh Bhalja, R. P. Maheshwari, N. G. Chothani, Protection and Switchgear, Oxford University Press, 2nd Edition, New Delhi, India, 2018. 2. Oza, B. A., N. C. Nair, R. P. Mehta, et al., Power System Protection & Switchgear, Tata McGraw Hill, New Delhi, 1st Edition, 2011.

Micro syllabus

Unit-I:STATIC RELAYS & COMPARATORS (8 Hrs)
Static relays - Basic construction of Static relays – Level detectors – Replica Impedance-Mixing circuits-General equation for two input phase and Amplitude Comparators – their types – Duality between Amplitude and Phase Comparator –Conic section characteristics–Three input Amplitude Comparator – Hybrid comparator – Switched distance schemes – Polyphase distance schemes-Phase

faults scheme –Three phase scheme–Combined and Ground fault scheme.

Unit No	Module	Micro content
I	**Static Relay Construction**	Basic construction of Static relays
		Level detectors
		Replica Impedance
		Mixing circuits
		General equation for two input phase and Amplitude Comparators and their types.
		Duality between Amplitude and Phase Comparator
	Amplitude and Phase Comparator	Conic section characteristics
		Three input Amplitude Comparator, Hybrid comparator
		Switched distance schemes, Switched distance schemes
		Phase faults scheme,Three phase scheme.
		Combined and Ground fault scheme.

Unit-II:TYPES OF STATIC RELAYS (9 Hrs)

Instantaneous over current relay – Time over current relays - Basic principles - Definite time and Inverse definite time over current relays, directional over current relays - Static Differential Relays-Analysis of static differential relays–Static relay schemes-Dual bias transformer differential protection – Harmonic restraint relay.

Unit No	Module	Micro content
II	**Types Of Static Relays**	Instantaneous over current relay
		Time over current relays
		Definite time and Inverse definite time over current relays
		Directional over current relays
	Static Differential Relays	Analysis of static differential relays
		Static relay schemes
		Dual bias transformer differential protection
		Harmonic restraint relay.

Unit-III: NUMERICAL RELAYS (9 Hrs)

Advantages of Numerical Relays – Numerical network-Digital Signal processing–Estimation of Phasors – Full Cycle Fourier Algorithm – Half Cycle Fourier Algorithm- practical considerations for selection of Algorithm– Discrete Fourier Transform.

Unit No	Module	Micro content
III	**Numerical Relays**	Advantages of Numerical Relays
		Numerical network, Digital Signal processing
		Full Cycle Fourier Algorithm

		Half Cycle Fourier Algorithm
		Practical considerations forselection of Algorithm
		Discrete Fourier Transform
Unit-IV: DISTANCE RELAYS AND POWER SWINGS (12 Hrs) Static Distance Relays - Static Impedance - reactance - MHO and Angle Impedance relay sampling comparator – Realization of reactance and MHO relay using a sampling comparator. Effect of power swings on the performance of Distance relays- Power swing analysis - Principle of out of step tripping and blocking relays - Effect of line length and source impedance on distance relays.		
Unit No	**Module**	**Micro content**
IV	**Distance Relays**	Static Distance Relays, Static Impedance, reactance
		MHO and Angle Impedance relay sampling comparator
		Realization of reactance and MHO relay using a sampling comparator
	Power swings	Effect of power swings on the performance of Distance relays
		Power swing analysis
		Principle of out of step tripping and blocking relays
		Effect of line length and source impedance on distance relays.
Unit-V: MICROPROCESSOR BASED PROTECTIVE RELAYS (10 Hrs) Over current relays – Impedance relays – Directional relay – Reactance relay (Block diagram and flowchart approach only).Generalized mathematical expression for distance relays-Measurement of resistance and reactance – MHO and offset MHO relays – Realization of MHO characteristics – Realization of Offset MHO characteristics (Block diagram and flow chart approach only) - Basic principle of Digital computer relaying.		
Unit No	**Module**	**Micro content**
V	**Microprocessor Based Protective Relays**	Over current relays (Block diagram and flowchart approach only)
		Impedance relays(Block diagram and flowchart approach only)
		Directional relay(Block diagram and flowchart approach only)
		Reactance relay (Block diagram and flowchart approach only)
		Generalized mathematical expression for distance relays, Measurement of resistance and reactance
	MHO Relay	Realization of MHO characteristics(Block diagram and flow chart approach only)

		Realization of Offset MHO characteristics (Block diagram and flow chart approach only)
		Basic principle of Digital computer relaying.

CO-PO mapping Table

Contribution of Course Outcomes towards achievement of Program Outcomes & Strength of correlations **(High: 3, Medium: 2, Low: 1)**														
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO-1	PSO-2
CO1	3	2											2	
CO2	3	2												
CO3	3	3						2						
CO4	3	2						2						
CO5	3	3						2						

Module Coordinator **BOS** **HOD**

IV- Year I- Semester	Name of the Course	L	T	P	C
	Electric Power Quality (Professional Elective V)	3	0	0	3

PRE-REQUISITES: 1. Power Electronics
2. FACTS Devices

Preamble: An Enlarged utilization of Power Electronics loads gives the awareness on the power quality. A reasonable understanding on the basics of various power quality problems and their solutions to applied electricity is therefore important for an electrical engineer. This course coversdifferent power quality problems occurring in power system and provides brief idea about their solutions with comparative study.

Course objectives: The main objectives are

1. Different types of power quality phenomena and identify sources for voltage sag, voltage swell, interruptions, transients, long duration over voltages and harmonics in a power system.
2. Power quality terms and study power quality standards.
3. The principle of voltage regulation, power factor improvement methods and study the effect the harmonic distortion and its solutions.
4. The relationship between distributed generation and power quality.
5. The power quality monitoring concepts and the usage of measuring instruments

Syllabus		
Unit No	**Contents**	**Mapped CO**
I	**Introduction to Power Quality (12 Hrs)** Overview of power quality –Concern about the power quality –General classes of power quality and voltage quality problems –Transients –Long–duration voltage variations –Short–duration voltage variations –Voltage unbalance –Waveform distortion –Voltage fluctuation –Power frequency variations- Power quality terms –Voltage sags, Voltage swells, and harmonics interruptions, voltage flicker and voltage spikes –Sources of voltage sag, swell and interruptions –Nonlinear loads. Source of transient over voltages –Principles of over voltage protection, Devices for over voltage protection –Utility capacitor switching transients.	**CO1**
II	**Voltage Regulation and power factor improvement (12 Hrs)** Principles of regulating the voltage –Device for voltage regulation –Utility voltage regulator application –Capacitor for voltage regulation –Enduser capacitor application –Regulating utility voltage with distributed resources –Flicker –Power factor penalty –Static VAR compensations for power factor improvement.	**CO2**
III	**Harmonic distortion and solutions (12 Hrs)** Voltage distortion vs. Current distortion –Harmonics vs. Transients –Harmonic indices –Sources of harmonics –Effect of harmonic distortion –Impact of capacitors, transformers, motors and meters –Point of common coupling –Passive and active filtering –Numerical problems.	**CO3**

IV	**Distributed Generation and Power Quality (12Hrs)** Resurgence of distributed generation –DG technologies –Interface to the utility system –Power quality issues and operating conflicts –DG on low voltage distribution networks.	**CO4**
V	**Monitoring and Instrumentation (12 Hrs)** Power quality monitoring and considerations –Historical perspective of PQ measuring instruments –PQ measurement equipment –Assessment of PQ measuring data –Application of intelligent systems –PQ monitoring standards.	**CO5**
Content Beyond the syllabus: Total Harmonic Distortion and Total Demand Distortion.		

Course Outcomes	
Upon successful completion of the course, the student will be able to	
CO1	**Understand** the different types of power quality problems and analyze power quality terms and power quality standards. **{Apply level, KL2}**
CO2	**Explain** the principle of voltage regulation and power factor improvement methods. **{Evaluate level, KL3}**
CO3	**Analyze** the effect the harmonic distortion and its solutions. **{Analyze level, K34}**
CO4	**Demonstrate** the relationship between distributed generation and power quality**{Understand level, KL2}**
CO5	**Understand** the power quality monitoring concepts and the usage of measuring instruments. **{Explain level, KL2}**

Learning Resources
Text books:
12. Electrical Power Systems Quality, Dugan R C, McGranaghan M F, Santoso S, and Beaty H W, Second Edition, McGraw‑Hill, 2012, 3rd edition.. 13. Electric power quality problems ‑M.H.J.Bollen IEEE series-Wiley India publications,2011.
Reference books:
1. Power Quality Primer, Kennedy B W, First Edition, McGraw‑Hill, 2000. 2. Understanding Power Quality Problems: Voltage Sags and Interruptions, Bollen M HJ, First Edition,IEEE Press; 2000. 3. Power System Harmonics, Arrillaga J and Watson N R, Second Edition, John Wiley& Sons, 2003. 4. Electric Power Quality control Techniques, W. E. Kazibwe and M. H. Sendaula, VanNostradReinhold,New York. 5. Power Quality C.Shankaran, CRC Press, 2001 6. Harmonics and Power Systems ‑Franciso C.DE LA Rosa‑CRC Press (Taylor &Francis
e- Resources & other digital material
2. https://www.digimat.in/nptel/courses/video/108107157/L01.html
3. https://nptel.ac.in/courses/108106025
4. https://onlinecourses.nptel.ac.in/noc20_ee10/preview
5. https://onlinecourses.nptel.ac.in/noc20_ee10/preview

Micro-Syllabus

Unit-1 Introduction to Power Quality (12 Hrs)

Overview of power quality -Concern about the power quality -General classes of power quality and voltage quality problems -Transients -Long-duration voltage variations -Short-duration voltage variations -Voltage unbalance -Waveform distortion -Voltage fluctuation -Power frequency variations- Power quality terms -Voltage sags, Voltage swells, and harmonics interruptions, voltage flicker and voltage spikes -Sources of voltage sag, swell and interruptions -Nonlinear loads. Source of transient over voltages -Principles of over voltage protection, Devices for over voltage protection -Utility capacitor switching transients.

Unit	Module	Micro content
1.a **Power quality classes & waveform distortion**	**Voltage Quality problems & Transients**	Overview of power quality
		General classes of power quality
		Transients
		Long-duration voltage variations
		Short-duration voltage variations
1.b **Voltage fluctuation and its sources**	**Voltage Sag, Swell and interruptions**	Voltage sags
		Voltage swell and interruptions
		Source of transient over voltages
		Principles of over voltage protection
		Devices for over voltage protection

Unit-2:Voltage Regulation and power factor improvement (12 Hrs)

Principles of regulating the voltage -Device for voltage regulation -Utility voltage regulator application -Capacitor for voltage regulation -Enduser capacitor application -Regulating utility voltage with distributed resources -Flicker -Power factor penalty -Static VAR compensations for power factor improvement.

Unit	Module	Micro content
3.a **Device for voltage regulation**	**Principles of regulating the voltage voltage regulation**	Principles of regulating the voltage
		Device for voltage regulation
		Utility voltage regulator application
		Capacitor for voltage regulation
3.b **Static VAR compensations**	**Regulating utility voltage with distributed resources power factor improvement**	Enduser capacitor application
		Distributed Resources
		Power factor penalty&Static VAR compensations

Unit-3: **Harmonic distortion and solutions (12 Hrs)**

Voltage distortion vs. Current distortion -Harmonics vs. Transients -Harmonic indices -Sources of harmonics -Effect of harmonic distortion -Impact of capacitors, transformers, motors and meters -Point of common coupling -Passive and active filtering -Numerical problems.

Unit	Module	Micro content

5.a Voltage distortion & Current distortion	**Harmonic indices, Sources of harmonics**	Voltage distortion vs. Current distortion
		Harmonics vs. Transients
		Harmonic indices
		Sources of harmonics
		Effect of harmonic distortion
5.b. Concept of Filters	**Passive and active filtering**	Point of common coupling
		Passive and active filtering
		Numerical problems.

Unit-4:Distributed Generation and Power Quality (12Hrs)
Resurgence of distributed generation -DG technologies -Interface to the utility system -Power quality issues and operating conflicts -DG on low voltage distribution networks.

Unit	**Module**	**Micro content**
7.a Distributed Generation	**DG technologies**	Introduction to DG
		DG technologies
		Interface to the utility system
		Challenges Interface to the utility system
7.b Operating conflicts	**Power quality issues and operating conflicts**	Power quality issues
		Quality issues and operating conflicts
		DG on low voltage distribution networks

Unit-5:Monitoring and Instrumentation (12 Hrs)
Power quality monitoring and considerations -Historical perspective of PQ measuring instruments -PQ measurement equipment -Assessment of PQ measuring data -Application of intelligent systems -PQ monitoring standards.

Unit	**Module**	**Micro content**
9.a Power quality monitoring	**Power quality monitoring and considerations**	Power quality monitoring and considerations
		Historical perspective of PQ measuring instruments
9.b PQ measurement equipment	**Assessment of PQ measuring data**	PQ measurement equipment
		Assessment of PQ measuring data
		Application of intelligent systems
		PQ monitoring standards

CO-PO mapping Table

Contribution of Course Outcomes towards achievement of Program Outcomes & Strength of correlations **(High: 3, Medium: 2, Low: 1)**														
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO-1	PSO-2
CO1	3	2												
CO2	2	2											1	
CO3	3	3											1	
CO4	2	2											1	
CO5	2	2												

Module Coordinator **BOS** **HOD**

IV- Year I- Semester	Name of the Course	L	T	P	C
	Principles of Signals and Systems (Open elective II)	3	1	0	3

PRE-REQUISITES: Engineering Mathematics-1, 3

Course objectives:

1. Describe the signals mathematically and understand how to perform mathematical operations on signals and to know about various types of systems
2. Compute the Fourier series and Fourier transform of signals and to do analysis on signals
3. Compute the output of an LTI system from the impulse response and to know about concept of convolution and correlation along with sampling theorem
4. To understand Laplace transforms and their properties for analysis of signals and systems.
5. To understand Z-transforms and their properties for analysis of signals and systems.

Syllabus		
Unit No	**Contents**	**Mapped CO**
I	**Introduction to Signals and Systems (12 hrs)** **Signals:** Definition of Signal and representation (Continuous time and discrete time), Elementary signals such as Dirac delta, unit step, unit ramp, sinusoidal and exponential. Basic operations on signals such as shifting, reversal and scaling in time and amplitude; Classification of signals. Problems on signals **Systems:** Definition of system (CT and DT), classification and characteristics of systems; Problems on classification and characteristics of signals and systems	**CO1**
II	**Fourier series and Fourier Transform (12 hrs)** **Fourier Series:** Representation of Fourier series for CT periodic signals Dirichlet's conditions for convergence, Properties of Fourier Series, Trigonometric Fourier Series and Exponential/Complex Fourier Series, Fourier spectrum. Problems on CTFS. Introduction of Discrete Time Fourier Series (DTFS) (DTFS-elementary treatment only) **Fourier Transform:** Representation of Fourier transform, Deriving Fourier Transform from Fourier series, Fourier Transform convergence condition, Fourier Transform of standard signals, Fourier Transform of Periodic Signals, Properties of Fourier Transform, Fourier Transforms involving Impulse function and Signum function, Problems on CTFT. Introduction to Hilbert Transform (H-Transform elementary treatment only).	**CO2**
III	**Analysis of LTI Systems, Convolution and Sampling theorem (17 hrs)** **Analysis of Linear Time-Invariant (LTI) Systems:** Properties of LTI systems, impulse response and transfer function, LTI system response, Filter characteristics of linear systems. Distortion less transmission through a system, Signal bandwidth, system bandwidth, Ideal LPF, HPF and BPF characteristics, Causality, stability. **Convolution:** Concept of convolution, convolution in time and frequency domain properties, graphical and analytical convolution, Problems on CT convolution. Concept of correlation (elementary treatment only)	**CO3**

	Sampling Theorem: Graphical and analytical proof for Band Limited Signals, impulse sampling, Natural and Flat top Sampling, Reconstruction of signal from its samples, effect of under sampling –Aliasing, Introduction to Band Pass sampling. Problems on sampling theorem.	
IV	**Laplace Transforms (12 hrs)** Laplace Transforms (L.T), Inverse Laplace Transform, Concept of Region of Convergence(ROC) for Laplace Transforms, Properties of ROC of Laplace Transform, Properties of Laplace Transform, Relation between LT and Fourier Transform of a signal, Response of LTI system using Laplace Transform, Laplace transform of causal periodic signals, Laplace transform of certain signals using waveform synthesis.	**CO4**
V	**Unit-5: Z-Transforms (12 hrs)** Concept of Z- Transform of discrete sequence and Inverse Z-Transform, Distinction between Laplace, Fourier and Z -transforms, Region of Convergence in Z-Transform, Constraints on ROC for various classes of signals, Properties of ROC of Z-Transform, Properties of Z-transforms, Inverse Z-transform, Response of LTI system using Z-Transform. Introduction to DTFT, Relationship between ZT and DTFT (DTFT-elementary treatment only).	**CO5**

Course Outcomes	
Upon successful completion of the course, the student will be able to	
CO1:	Understand mathematical representation of various types of signals and classification of systems. **(Understand)**
CO2:	Analyse the characteristics of CT signals and CT systems using Fourier series and Fourier transform. **(Analyse, Apply)**
CO3:	Determine the response of LTI system. Understand the concept of convolution, correlation, applying of sampling technique. **(Understand, Apply)**
CO4:	Compute Laplace transforms to analyze continuous time signals and systems and understand the concept of region of convergence. **(Compute)**
CO5:	Compute Z-transform to analyze discrete-time signals and systems, and understand the concept of region of convergence. **(Compute)**

Learning Resources

Text books:

1. Signals and Systems by A. Anand Kumar, PHI Learning Private Limited, 3rd Edition, 2018.
2. Signals and Systems by Tarun Kumar Rawat, Oxford Higher Education, 2010
3. Principles of Linear Systems and Signals by B.P.Lathi, Oxford publications, 2nd Edition, 2006.

Reference books:

1. Signals and Systems by A.V. Oppenheim, A.S. Willsky and S.H.Nawab, PHI, 2nd Edition
2. Signals & Systems - Simon Haykin and Barry Van Veen, Wiley, 2nd Edition, 2007
3. Signals, Systems & Communications by B.P. Lathi, BS Publications, 2003.

e- Resources & other digital material
1. https://nptel.ac.in/courses/108106163
2. https://nptel.ac.in/courses/108104100
3. https://nptel.ac.in/courses/108105065

Micro-Syllabus

Unit-1: Introduction to Signals and Systems

Signals: Definition of Signal and representation (Continuous time and discrete time), Elementary signals such as Dirac delta, unit step, unit ramp, sinusoidal and exponential. Basic operations on signals such as shifting, reversal and scaling in time and amplitude; Classification of signals. Simple problems on signals

Systems: Definition of system (CT and DT), classification and characteristics of systems; simple problems on classification and characteristics of signals and systems

(CT: Continuous Time; DT: Discrete Time)

Unit	Module	Micro content
1a. Basics of signals	Definition of Signal	Continuous Time Signal and representation
		Discrete Time Signal and representation
	Elementary signals (CT & DT)	impulse , Unit step, Unit ramp
		Sinusoidal
		Exponential, Complex exponential
		Rectangular pulse function
		Triangular pulse function
		Signum function
		Sinc function
		Gaussian function
	Classification of signals (CT & DT)	Even and odd
		Periodic and aperiodic
		Energy and power
		Random and deterministic
		Causal and non-causal
		Problems on classification of signals
	Basic operations on signals	time shifting, time reversal, time scaling
		Amplitude scaling
	Related problems on basic operation on signals	
1b. Systems	Definition of System	Continuous Time and Discrete Time systems
	Classification and characteristics of systems	Lumped and distributed parameter systems
		Static and dynamic systems
		Causal and non-causal systems
		Linear and non-linear systems
		Time invariant and Time variant systems
		Stable and unstable systems
		Invertible and non-invertible systems
		FIR and IIR systems
	Related Problems	

Unit-2: Fourier series and Fourier Transform

Fourier Series: Representation of Fourier series for CT periodic signals , Dirichlet's conditions for convergence, Properties of Fourier Series, Trigonometric Fourier Series and Exponential/Complex Fourier Series, Fourier spectrum. Problems on CTFS. Introduction of Discrete Time Fourier Series (DTFS) (elementary treatment only)

Fourier Transform: Representation of Fourier transform, Deriving Fourier Transform from Fourier series, Fourier Transform convergence condition, Fourier Transform of standard signals, Fourier Transform of Periodic Signals, Properties of Fourier Transform, Fourier Transforms involving Impulse function and Signum function, Problems on CTFT. Introduction to Hilbert Transform (elementary treatment only).

Unit	**Module**	**Micro content**
2a. Fourier Series	Representation of Fourier series and Dirichlet's condition's	Introduction and definition of Fourier Series
		Existence condition for Fourier series
	Properties of Fourier series (CTFS)	Linearity property
		Time shifting, reversal, scaling, differentiation, integration property
		Convolution property
		Modulation or multiplication property
		Conjugation and conjugate symmetry property
		Parsevals theorem or property
		Problems on properties of CTFS of periodic signals
	Trigonometric Fourier Series	Definition and representation
		Evaluation of Fourier coefficients of TFS
		Wave symmetry properties with proofs (Even, Odd, Half wave and Quarter wave symmetry)
		Problems on Trigonometric Fourier series of periodic signals
	Exponential Fourier Series	Determination of coefficients of exponential Fourier series
		Exponential FS from Trigonometric FS
		Trigonometric FS from Exponential FS
		Problems on exponential Fourier series of periodic signals
	Fourier Spectrum	Definition and description
		Its graphical representation
		Problems on Fourier spectrum
	Introduction to Discrete Time Fourier Series	Definition and representation only (elementary treatment only)
2b. Fourier Transform	Representation and derivation of Fourier Transform	Introduction and Fourier transform representation of aperiodic signals
		Derivation of CTFT from CTFS
		Magnitude and phase representation
	Convergence of FT	Dirichlet's conditions for convergence

	Fourier Transform of standard signals and periodic signals	Constant, impulse and unit step function
		Single and double sided real exponential
		Complex exponential function
		Signum, rectangular and triangular
		Sine and cosine function
	Properties of Fourier Transform	Linearity property, Time shifting, time scaling, time reversal, Time differentiation, time integration, Frequency shifting, frequency differentiation, convolution, multiplication. Duality, modulation, conjugation and Parseval's theorem
		Problems on properties of CTFT
	Fourier transforms involving impulse and signum functions	CTFT of different signals and the signals involving impulse and signum functions
	Hilbert transform	Introduction and description (elementary treatment only)
	Related Problems	

Unit-3: Analysis of LTI Systems, Convolution and Sampling theorem

Analysis of Linear Time-Invariant (LTI) Systems: Properties of LTI systems, impulse response and transfer function, LTI system response, Filter characteristics of linear systems. Distortion less transmission through a system, Signal bandwidth, system bandwidth, Ideal LPF, HPF and BPF characteristics, Causality, stability.

Convolution: Concept of convolution, convolution in time and frequency domain properties, graphical and analytical convolution, Problems on CT convolution. Concept of correlation (elementary treatment only)

Sampling Theorem: Graphical and analytical proof for Band Limited Signals, impulse sampling, Natural and Flat top Sampling, Reconstruction of signal from its samples, effect of under sampling – Aliasing, Introduction to Band Pass sampling. Problems on sampling.

Unit	**Module**	**Micro content**
3a. Analysis of LTI systems and convolution	Properties of LTI system	Commutative, associative, distributive property
		Systems with and without memory, causality, stability, invertibility and unit step response
	Impulse response, transfer function, LTI system response	Definitions of impulse response
		Definitions of transfer function
		Derivation of response of LTI system and LTI system properties
	Filter characteristics of linear systems. Distortion less transmission through a system	How LTI acts as Filter with example
		Definition of distortion less transmission, derivation of the conditions for distortion less system
	Signal bandwidth, system bandwidth	Definition and explanations of Signal bandwidth and system bandwidth
	Ideal LPF, HPF and BPF characteristics	Definition and frequency response explanation of each.

	Convolution	Concept of convolution of signals
		convolution theorems (time and frequency convolution) and properties
		Convolution by graphical and analytical methods (CT only)
		Problems on convolution of CT signals
	Correlation	Concept of correlation and comparison of convolution and correlation (elementary treatment only)
3b. Sampling theorem	Sampling theorem Graphical and analytical proof	Proof of sampling theorem for band limited signals by analytical and graphical methods and nyquist rate of sampling
	Impulse sampling, natural sampling and flat top sampling	Basic principles, time and frequency domain representation with equations and diagrams
	Reconstruction of signal from its samples	Ideal reconstruction of filter, zero order hold methods with explanation and derivations
	Effect of under sampling: aliasing	Aliasing effect explanation with graphs and its remedy
	Introduction to band pass sampling	Statement and explanation only
	Problems on sampling	Problems related to nyquist rate, nyquist interval, sampling frequency

Unit-4: Laplace Transforms

Laplace Transforms (L.T), Inverse Laplace Transform, Concept of Region of Convergence(ROC) for Laplace Transforms, Properties of ROC of Laplace Transform, Properties of Laplace Transform, Relation between LT and Fourier Transform of a signal, Response of LTI system using Laplace Transform, Laplace transform of causal periodic signals, Laplace transform of signals using waveform synthesis.

Unit	Module	Micro content
4. Laplace Transforms	Laplace Transforms (L.T), Relation between LT and Fourier Transform of a signal, Concept of Region of Convergence(ROC) for Laplace Transforms	Introduction, types and definitions of L.Ts and representation and existence
		Derivation and explanation of relation between LT and CTFT of a signal
		Concept of ROC
	Properties of ROC of Laplace Transform	ROC constraints for various commonly used signals—related problems
	Properties of Laplace Transform	Linearity, time shifting, shifting in s-domain, time scaling, time reversal, time differentiation, differentiation in s-domain, time convolution, time multiplication, time integration properties, initial value and final value theorems, Parseval's property with proofs--- related problems
	Inverse Laplace Transform	Definition and different methods of ILT--- related problems

	Response of LTI system using Laplace Transform, Laplace transform of causal periodic signals, Laplace transform of certain signals using waveform synthesis	System response using L.T Transfer function and differential equations, stability, causality of LTI systems….related problems
		L.T. of causal periodic signals and related problems
		L.T. of signals using waveform synthesis
	Related Problems	

Unit-5: Z-Transforms

Concept of Z- Transform of discrete sequence and Inverse Z-Transform, Distinction between Laplace, Fourier and Z -transforms, Region of Convergence in Z-Transform, Constraints on ROC for various classes of signals, Properties of ROC of Z-Transform, Properties of Z-transforms, Inverse Z-transform, Response of LTI system using Z-Transform. Introduction to DTFT, Relationship between ZT and DTFT (elementary treatment only).

Unit	**Module**	**Micro content**
5. Z-Transforms	Concept of Z- Transform and Inverse Z-Transform, Distinction between Laplace, Fourier and Z -transforms	Introduction and definition of Z-transforms and Inverse Z-transform
		Distinction between Z.T, DTFT and L.T
	Region of Convergence in Z-Transform, Constraints on ROC for various classes of signals	Concept of ROC and constraints of ROC for various sequences
	Properties of Z-Transform	Properties of Z.T. with proofs ---related problems
	Inverse Z-transform	Different methods (Long division method, partial fraction expansion method and residue method) and related problems
	Response of LTI system using Z-Transform	System response and impulse response using Z.T….related problems
		Relationship between transfer function and difference equation
		Solution of difference equation using Z-transform
	Introduction to DTFT and relationship between ZT and DTFT	DTFT representation and relationship between DTFT and ZT (elementary treatment only)

CO-PO mapping Table

Contribution of Course Outcomes towards achievement of Program Outcomes & Strength of correlations **(High: 3, Medium: 2, Low: 1)**														
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO-1	PSO-2
CO1	3	3	2											2
CO2	3	3	2											2
CO3	3	2	3											2
CO4	3	2	2											2
CO5	3	2	2											2

Module Coordinator **BOS** **HOD**

IV- Year I - Semester	Name of the Course	L	T	P	C
	Machine Learning (Open elective II)	2	0	0	2

PRE-REQUISITES: 1) Basic Statistics, 2) Data Mining

Course objectives: The student should be able to

1. Recognize the characteristics of machine learning, binary classification
2. Solve classification problems using multiclass classification and concept learning
3. Apply Tree based and Rule based learning models to real world problems
4. Apply Linear models and Distance based classification and clustering algorithms
5. Analyze Bayesian classifiers and Understand the concept behind neural networks for learning non-linear functions

Syllabus		
Unit No	**Contents**	**Mapped CO**
I	**The ingredients of machine learning, Tasks: (08 hrs)** The problems that can be solved with machine learning, Looking for structure, Evaluating performance on a task, **Models: the output of machine learning:** Geometric models, Probabilistic models, Logical models, Grouping and grading, **Features:** the workhorses of machine learning, Two uses of features, Feature construction and transformation. **Binary classification and related tasks: (06 hrs)** Classification, Assessing classification performance, Visualizing classification performance, Class probability estimation, Assessing Class probability estimates	**CO1**
II	**Beyond binary classification: (07 hrs)** Handling more than two classes, **Multi class classification:** Multi class scores and probabilities, Regression, Unsupervised and descriptive learning, Predictive and descriptive clustering. **Concept learning: (07 hrs)** The hypothesis space, Least general generalization, Internal disjunction ,Paths through the hypothesis space, Most general consistent hypotheses, Closed concepts, Beyond conjunctive concepts	**CO2**
III	**Tree models: (06 hrs)** Decision trees, Ranking and probability estimation trees, Tree learning as variance reduction. **Rule models: (06 hrs)** Learning ordered rule lists, Learning unordered rule sets, Descriptive rule learning, First-order rule learning.	**CO3**
IV	**Linear models: (07 hrs)**	**CO4**

	The least-squares method, multivariate linear regression, regularized regression, using least-squares regression for classification, Support vector machines, Soft margin SVM. **Distance Based Models: (07 hrs)** Ways of measuring distance, Neighbours and exemplars, Nearest Neighbours classification, Distance based clustering, k means algorithm, Clustering around mediods, Silhouettes, Hierarchical Clustering.	
V	**Bayesian Learning: (06 hrs)** Introduction, Bayes Theorem, Bayes Optimal Classifier, Gibbs Algorithm, Naïve Bayes Classifier, Learning to classify Text. **Artificial Neural Networks: (06 hrs)** Introduction, Neural network representation, appropriate problems for neural network learning, Multilayer networks and the back propagation algorithm.	**CO5**
Content Beyond the syllabus: **Features:** Kinds of feature, Feature transformations, Feature construction and selection. Model ensembles: Bagging and random forests, Boosting. **Dimensionality Reduction:** Principal Component Analysis (PCA), Implementation and demonstration.		

Course Outcomes	
Upon successful completion of the course, the student will be able to	
CO1	**Recognize** the characteristics of machine learning, binary classification **{Understand level, KL2} {Analyze level, KL4}**
CO2	**Solve** classification problems using multiclass classification and concept learning **{Evaluate level, KL5}**
CO3	**Apply** Tree based and Rule based learning models to real world problems **{Apply level, KL3}**
CO4	**Apply** Linear models and Distance based classification and clustering algorithms **{Apply level, KL3}**
CO5	**Analyze** Bayesian classifiers and **Understand** the concept behind neural networks for learning non-linear functions **{Understand level, KL2} {Analyze level, KL4}**

Learning Resources
Text books:
1. Machine Learning: The art and Science of algorithms that make sense of data, Peter Flach, Cambridge University Press, 2012. 2. Tom M. Mitchell, Machine Learning, India Edition 2013, McGraw Hill Education. 3. Chris Albon : Machine Learning with Python Cookbook , O'Reilly Media, Inc.2018.
Reference books:

1. Stephen Marsland, "Machine Learning – An Algorithmic Perspective", Second Edition, Chapman and Hall/CRC Machine Learning and Pattern Recognition Series, 2014. 2. Ethem Alpaydın, Introduction to machine learning, second edition, MIT press. 3. T. Hastie, R. Tibshirani and J. Friedman, "Elements of Statistical Learning", Springer Series , 2nd edition.
e- Resources & other digital material
1. Kevin Murphy, "Machine Learning: A Probabilistic Perspective", MIT Press, 2012, https://www.cs.ubc.ca/~murphyk/MLbook/pml-intro-5nov11.pdf
2. Professor S. Sarkar , IIT Kharagpur "Introduction to machine learning", https://www.youtube.com/playlist?list=PLYihddLFCgYuWNL55Wg8ALkm6u8U7gps
3. Professor Carl Gustaf Jansson, KTH, Video Course on Machine Learning https://nptel.ac.in/noc/individual_course.php?id=noc19-cs35
4. Tom Mitchell, "Machine Learning", http://www.cs.cmu.edu/~tom/10701_sp11/lectures.shtml

Micro-Syllabus

Unit – 1: The ingredients of machine learning, Tasks: (08 hrs)

The problems that can be solved with machine learning, Looking for structure, Evaluating performance on a task, **Models: the output of machine learning:** Geometric models, Probabilistic models, Logical models, Grouping and grading, **Features:** The workhorses of machine learning, Two uses of features, Feature construction and transformation.

Binary classification and related tasks: (06 hrs)

Classification, Assessing classification performance, Visualizing classification performance, Class probability estimation, Assessing Class probability estimates.

Unit No	Module	Micro content
1a. The ingredients of machine learning, Tasks	**The ingredients of machine learning, Tasks**	The problems that can be solved with machine learning
		Looking for structure
		Evaluating performance on a task
	Models: the output of machine learning	Geometric models, Probabilistic models
		Logical models, Grouping and grading
	Features	The workhorses of machine learning
		Two uses of features
		Feature construction and transformation
1b. Binary classification and related tasks	**Binary classification and related tasks**	Classification
		Assessing classification performance
		Visualizing classification performance
		Class probability estimation
		Assessing Class probability estimates

Unit-2: Beyond binary classification: (07 hrs)

Handling more than two classes, Multi class classification, Multi class scores and probabilities, Regression, Unsupervised and descriptive learning, Predictive and descriptive clustering.

Concept learning: (07 hrs)

The hypothesis space, Least general generalization, Internal disjunction, Paths through the hypothesis space, Most general consistent hypotheses, Closed concepts, Beyond conjunctive concepts.

Unit No	Module	Micro content
2a. Beyond binary classification	**Beyond binary classification**	Handling more than two classes
		Multi class classification
		Multi class scores and probabilities
		Regression
		Unsupervised and descriptive learning
		Predictive and descriptive clustering
2b. Concept learning	**Concept learning**	The hypothesis space
		Least general generalization
		Internal disjunction
		Paths through the hypothesis space
		Most general consistent hypotheses
		Closed concepts
		Beyond conjunctive concepts

Unit-3: **Tree models: (06 hrs)**

Decision trees, Ranking and probability estimation trees, Tree learning as variance reduction.

Rule models: (06 hrs)

Learning ordered rule lists, Learning unordered rule sets, Descriptive rule learning, First-order rule learning.

Unit No	Module	Micro content
3a. Tree models	**Tree models**	Decision trees
		Ranking and probability estimation trees
		Tree learning as variance reduction
3b. Rule models	**Rule models**	Learning ordered rule lists
		Learning unordered rule sets
		Descriptive rule learning
		First-order rule learning

Unit-4: Linear models: (07 hrs)

The least-squares method, multivariate linear regression, regularized regression, using least-squares regression for classification, Support vector machines, Soft margin SVM.

Distance Based Models: (07 hrs)

Ways of measuring distance, Neighbours and exemplars, Nearest Neighbours classification, Distance based clustering, k means algorithm, Clustering around mediods, Silhouettes, Hierarchical Clustering.

Unit No	Module	Micro content
4a. Linear models	**Linear models**	The least-squares method
		multivariate linear regression
		regularized regression
		using least-squares regression for classification

		Support vector machines
		Soft margin SVM
4b. Distance Based Models	**Distance Based Models**	Ways of measuring distance
		Neighbours and exemplars
		Nearest Neighbours classification
		Distance based clustering
		k means algorithm
		Clustering around mediods
		Silhouettes
		Hierarchical Clustering

Unit-5: Bayesian Learning: (06 hrs)

Introduction, Bayes Theorem, Bayes Optimal Classifier, Gibbs Algorithm, Naïve Bayes Classifier, Learning to classify Text.

Artificial Neural Networks: (06 hrs)

Introduction, Neural network representation, appropriate problems for neural network learning, Multilayer networks and the back propagation algorithm.

Unit No	Module	Micro content
5a. Bayesian Learning	**Bayesian Learning**	Introduction
		Bayes Theorem, Bayes Optimal Classifier
		Gibbs Algorithm
		Naïve Bayes Classifier, Learning to classify Text
5b. Artificial Neural Networks	**Artificial Neural Networks**	Introduction
		Neural network representation
		appropriate problems for neural network learning
		Multilayer networks and the back propagation algorithm

CO-PO mapping Table

Contribution of Course Outcomes towards achievement of Program Outcomes & Strength of correlations **(High: 3, Medium: 2, Low: 1)**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO -1	PSO -2
CO1	1	1	1	1										
CO2	2	1	2	2										
CO3	2	1	2	2										
CO4	2	1	2	2										
CO5	2	1	2	2										

Module Coordinator **BOS** **HOD**

IV- Year I - Semester	Name of the Course	L	T	P	C
	Green Buildings (Open elective II)	3	0	0	3

Course Objectives:

1) This course aims to highlight importance of Energy- Efficient Buildings within the context of Energy issues in the 21st century.
2) To familiarize students with the concept of Energy efficiency, Renewable sources of energy and their effective adaptation in green buildings
3) To give a fuller understanding of Building Form and Fabric, Infiltration, ventilation, Lighting, cooling and water conservation.
4) To highlight the importance of Environmental Management as well as Environmental Impact Assessment methods in Energy efficient buildings.

UNIT I :

Green Buildings within the Indian Context, Types of Energy, Energy Efficiency and Pollution, Better Buildings, Reducing energy consumption, Low energy design**.**

UNIT II:

Renewable Energy sources that can be used in Green Buildings – Conventional and Non Conventional Energy, Solar energy, Passive Solar Heating, Passive Solar collection, Wind and other renewables. A passive solar strategy, Photovoltaics, Rainwater Harvesting Climate and Energy, Macro and Microclimate. Indian Examples.

UNIT III:

Building Form – Surface area and Fabric Heat Loss, utilizing natural energy, Internal Planning, rouping of buildings. Building Fabrics- Windows and doors, Floors, Walls, Masonry, Ecological walling systems, Thermal Properties of construction material.

UNIT IV:

Infiltration and ventilation, Natural ventilation in commercial buildings, passive cooling, modelling air flow and ventilation, Concepts of daylight factors and day lighting, daylight assessment, artificial lighting, New light sources. Cooling buildings, passive cooling, mechanical cooling. Water conservation- taps, toilets and urinals, novel systems, collection and utilization of rain water.

UNIT V:

Energy awareness, monitoring energy consumption, Building Environmental Assessment - environmental criteria - assessment methods - assessment tools (e.g. LEED, GRIHA & IGBC Certification for buildings. Ecohomes, Sustainable architecture and urban design – principles of environmental architecture, Benefits of green buildings – Energy Conservation Building code - NBC -Case Studies – Green Buildings in Auroville and Dakshina Chitra, Tamil Nadu, India

TEXT BOOKS:

1. William T. Meyer., Energy Economics and Building Design., New York: McGraw-Hill, Inc Indian Green Building Council

REFERENCE BOOKS:

1. Public Technology, Inc. (1996). Sustainable Building Technical Manual: Green Building Design, Construction, and Operations. Public Technology, Inc., Washington, DC.
2. Sim Van Der Ryn, Stuart Cowan, "Ecological Design", Island Press (1996).
3. Dianna Lopez Barnett, William D. Browning,"A Primer on Sustainable Building", Rocky Mountain Green Development Services.
4. The HOK Guidebook to Sustainable Design, Sara Mendler and William Odell, John Wiley.
5. David A. Gottfried, Sustainable Building Technical Manual., Public Technology Inc
6. Richard D. Rush, . Building System Integration Handbook., New York: John Wiley & Sons
7. Ben Farmer & Hentie Louw., Companion to Contemporary Architectural Thought, London & New York: Routledge
8. Peter Noever (ed)., Architecture in Transition: Between Deconstruction and New Modernism., Munich: Prestel.

Micro Syllabus of Green Buildings

Unit-I: Green Buildings within the Indian Context, Types of Energy, Energy Efficiency and Pollution, Better Buildings, Reducing energy consumption, Low energy design.

Unit	**Module**	**Micro content**
Introduction to green buildings	Introduction to green buildings	Green Buildings within the Indian Context
		Green building and its relevance
		Green Building Rating Systems in India
		Types of Energy
		Energy Efficiency and Pollution
		Better Buildings
		Reducing energy consumption
		Low energy design

Unit– II:

Renewable Energy sources that can be used in Green Buildings – Conventional and Non Conventional Energy, Solar energy, Passive Solar Heating, Passive Solar collection, Wind and other renewables. A passive solar strategy, Photovoltaics, Rainwater Harvesting, Climate and Energy, Macro and Microclimate. Indian Examples.

Unit	**Module**	**Micro content**
II	Renewable Energy sources that can be used in Green Buildings	Conventional Energy
		Non Conventional Energy
	Solar Energy	Passive Solar Heating
		Passive Solar collection
		A passive solar energy strategy

	Wind and other renewable	Photovoltaics
		Solar Photovoltaic Systems
		Types of Solar PV Generating System
	Rainwater Harvesting	Artificial ground water recharge
		Roof top rainwater harvesting
		Harvesting in limited rainfall areas
		Rainwater harvesting for plotted/group housing developments
	Climate and Energy	Climate and Energy
	Macro and Microclimate	Site and Micro Climate
		MACRO CLIMATE
		MICRO CLIMATE
		Micro Climate – Effect of local terrain and Buildings
		IMPROVING MICRO CLIMATE THROUGH DESIGN
		Factor affecting micro climate

Unit-III:

Building Form – Surface area and Fabric Heat Loss, utilizing natural energy, Internal Planning, rouping of buildings. Building Fabrics- Windows and doors, Floors, Walls, Masonry, Ecological walling systems, Thermal Properties of construction material.

Unit	**Module**	**Micro content**
III	Building Forms	Building Form Development Plan
		Building Form, Orientation and Shading
		Envelope Optimization
	Thermal Performance	Enhancement of thermal performance of walls
		Types of thermal insulation materials:

Unit-IV:

Infiltration and ventilation, Natural ventilation in commercial buildings, passive cooling, modelling air flow and ventilation, Concepts of daylight factors and day lighting, daylight assessment, artificial lighting, New light sources. Cooling buildings, passive cooling, mechanical cooling. Water conservation- taps, toilets and urinals, novel systems, collection and utilization of rain water.

Unit	**Module**	**Micro content**
IV	Infiltration and ventilation	Infiltration
		Passive Cooling Techniques
	Lighting	Lighting
		Day lighting
		Day lighting and Controls

<table>
<tr><td rowspan="5"></td><td rowspan="5"></td><td>Artificial Lighting</td></tr>
<tr><td>Lighting and Ventilation of Rooms</td></tr>
<tr><td>Rainwater Harvesting</td></tr>
<tr><td>Window design for natural ventilation</td></tr>
<tr><td>SKYLIGHT</td></tr>
<tr><td colspan="3">Unit-V: Energy awareness, monitoring energy consumption, Building Environmental Assessment - environmental criteria - assessment methods - assessment tools (e.g. LEED, GRIHA & IGBC Certification for buildings. Ecohomes, Sustainable architecture and urban design – principles of environmental architecture, Benefits of green buildings – Energy Conservation Building code - NBC -Case Studies – Green Buildings in Auroville and Dakshina Chitra, Tamil Nadu, India</td></tr>
<tr><td>Unit</td><td>Module</td><td>Micro content</td></tr>
<tr><td rowspan="10">V</td><td rowspan="2">Environmental assessment methods for buildings (LEED, BREEAM, HQE)</td><td>LEED (Leadership in Energy and Environmental Design</td></tr>
<tr><td>BREEAM (Building Research Establishment Environmental Assessment)</td></tr>
<tr><td rowspan="3">Three primary rating systems for Green buildings in India</td><td>Green Rating for Integrated Habitat Assessment (GRIHA)</td></tr>
<tr><td>Indian Green Building Council (IGBC)</td></tr>
<tr><td>Bureau of Energy Efficiency (BEE)</td></tr>
<tr><td rowspan="5">energy efficiency of a building</td><td>energy efficiency of a building</td></tr>
<tr><td>energy efficiency in buildings importance</td></tr>
<tr><td>Determining a building’s energy performance
Energy use indicators</td></tr>
<tr><td>Five Principles of an environmental architecture</td></tr>
<tr><td>The Energy Conservation Building Code</td></tr>
</table>

Module Coordinator **BOS** **HOD**

IV- Year I - Semester	Name of the Course	L	T	P	C
	VLSI Design (Open elective II)	3	0	0	3

Course Objectives:

1. Apply the electrical properties of CMOS and BiCMOS circuits to understand design concepts and processes
2. Familiarize with the basic circuit concepts to determine circuit delays, and also to utilize scaling of MOS circuits for miniaturization.
3. Interpret the CMOS static features to design digital circuits.
4. Understand the CMOS dynamic analytical aspects to design combinational and sequential circuits.
5. Build a strong knowledge on the fundamentals of FPGA design structures and their applications.

UNIT-I

IC Technology: VLSI Design Flow, Introduction to IC Technology, Basic MOS transistors, Fabrication Process of NMOS, PMOS and CMOS, Introduction to BiCMOS Technology, Comparison between CMOS and Bipolar technologies.

Basic Electrical Properties: I_{ds} vs. V_{ds} relationships, Aspects of MOS transistor Threshold voltage, MOS transistor transconductance and output conductance, figure of merit, The Pass transistor, The NMOS Inverter, Determination of pull up to pull down ratio for NMOS inverter driven by another NMOS inverter directly or through one or more pass transistors, Alternative forms of pull ups, The CMOS Inverter, BiCMOS Inverter, Latch-up in CMOS circuits, MOS Layers, Stick diagrams, Layout Encoding and Design Rules, Stick Diagram and Layout Diagrams Examples.

UNIT-II

Basic Concepts: Sheet resistance, Sheet resistance concept applied to MOS transistors and Inverters, Area Capacitance of layers, Standard unit of capacitance, some area capacitance calculations, The Delay unit, Inverter delays, Driving large Capacitive Loads, Propagation delays, wiring capacitances, Choice of layers.

Scaling: Scaling models and scaling factors, Scaling factors for device parameters, Limitations of scaling, Limits due to subthreshold currents, Limits due to current density.

UNIT-III

Static CMOS Design: Complementary CMOS: Propagation Delay, Voltage Transfer Characteristics, Power Consumption. Ratioed Logic: Basic Concept, Effect of decrease in Wp, **Differential Cascode Voltage Switch Logic (DCVSL)**. Pass-Transistor Logic: Design of Logic Gates, Transmission Gate.

UNIT-IV **Dynamic CMOS Design:** Dynamic Logic-Basic Principles, Speed and Power Dissipation of Dynamic Logic, Issues in Dynamic Design, Cascading Dynamic Gates, Choosing a Logic Style, Latch Versus Register, multiplexer based latches, Master-Slave Based Edge Triggered Register, Dynamic Transmission-Gate edge-triggered register, setup time, hold time, Clocked CMOS register.
UNIT-V **Introduction to PLDs**: Overview of PLDs, CPLD: Introduction to CPLD, Example of CPLD: Xilinx CoolRunner, FPGA: Introduction to FPGA, Organization of FPGA, Programming Technologies, Programmable Logic Block Architectures, Programmable Interconnects and I/O Blocks.

Text books:

1. D. A. Pucknell and K. Eshraghian, Basic VLSI Design, (3/e), PHI Learning Pvt. Ltd., 2009.
2. J. M. Rabaey, A. Chandrakasan and B. Nikolic, Digital Integrated Circuits, Prentice Hall, (2/e), 2003.
3. C. H. Roth, L. K. John and B. K. Lee, Digital Systems Design using Verilog, Cengage Learning, 2016.

Reference books:

1. K. Eshraghian, D. A. Pucknell and S. Eshraghian, Essentials of VLSI Circuits and Systems, Prentice-Hall of India Private Limited, 2005.
2. M. D. Ciletti, Advanced Digital Design with the Verilog HDL, Eastern Economy Edition, PHI, 2004.
3. A. Pang and P. Membrey, Beginning FPGA: Programming Metal: Your Brain on Hardware, APress, 2017.
4. W. Wolf, FPGA-based System Design, Prentice Hall Modern Semiconductor Design Series, 2004.

Micro-Syllabus of VLSI Design

UNIT-I **-- 15 Hrs** **IC Technology:** VLSI Design Flow, Introduction to IC Technology, Basic MOS transistors, Fabrication Process of NMOS, PMOS and CMOS, Introduction to BiCMOS Technology, Comparison between CMOS and Bipolar technologies. **Basic Electrical Properties:** I_{ds} vs. V_{ds} relationships, Aspects of MOS transistor Threshold voltage, MOS transistor transconductance and output conductance, figure of merit, **Channel Length Modulation and its effect.** The Pass transistor, The NMOS Inverter, Determination of pull up to pull down ratio for NMOS inverter driven by another NMOS inverter directly or through one or more pass transistors, Alternative forms of pull ups, The CMOS Inverter, BiCMOS Inverter, Latch-up in CMOS circuits, MOS Layers, Stick diagrams, Layout Encoding and Design Rules, Stick Diagram and Layout Diagrams Examples

Unit	Module	Micro content

IC Technology & Basic Electrical Properties	Introduction to IC Technology	Introduction to IC Technology, Moore's Law, VLSI Design Flow,
	Basic MOS transistors	Operation of Enhancement and Depletion mode NMOS and PMOS Transistors, Information about Layers in MOS Transistors
	Fabrication Process	Fabrication process of NMOS, PMOS and CMOS Transistors
	BiCMOS Technology	Introduction to BiCMOS technology, comparison with NMOS and CMOS Technologies
	Basic Electrical Properties	Relationship between Ids and Vds, Theshold Voltage, Transconductance, Output Conductance abd Figure of Merit and related problems, Channel Length Modulation
	NMOS Inverter	Pass Transistor Logic, NMOS inverter Operation, Zpu/Zpd Ratio of an NMOS Inverter Driven by Another NMOS Inverter directly and through Pass Transistors, Alternate Forms of Pull-ups
	CMOS Inverter	CMOS Inverter Operation, Transfer Characteristics, Current vs Vin, Analysis over the operating regions of CMOS Inverter, Latch-up in CMOS, BiCMOS Inverter
	Stick Diagram	Stick Diagram Symbols in NMOS, PMOS, CMOS and BiCMOS Designs, Examples on Inverter, AND, OR, NAND and NOR Gates and upto 4-variable Boolean Functions
	Design Rules and Layout Encoding	Lambda-based Design Rules: Design Rules for Wires, Transistor Design Rules, Design Rules for Contact Cuts, CMOS related additional Design Rules, General Observations on Design Rules, Layout Examples on NMOS and CMOS based Inverter, NAND and NOR gates

UNIT-II **-- 14 Hrs**

Basic Concepts: Sheet resistance, Sheet resistance concept applied to MOS transistors and Inverters, Area Capacitance of layers , Standard unit of capacitance, some area capacitance calculations, The Delay unit, Inverter delays, Driving large Capacitive Loads, Propagation delays, wiring capacitances, Choice of layers.

Scaling: Scaling models and scaling factors, Scaling factors for device parameters, Limitations of scaling, Limits due to subthreshold currents, Limits due to current density.

Unit	Module	Micro content
Basic Concepts & Scaling	Sheet Resistance	Sheet Resistance Concept, and its Application in MOS Transistors and Inverters, Related problems with layout examples
	Area Capacitance	Area Capacitance of different layers in MOS Transistors, Standard Unit of Capacitance, Some Area Capacitance Calculations
	Delay Unit	Introduction to Delay Unit with respect to Sheet Resistance and Area Capacitance, Determining the Delay of NMOS Inverter
		Determining the delay of CMOS Inverter and its Estimation
		Driving Large Capacitive Loads
		Propagation Delays
	Wiring Capacitances	Fringing Field, Interlayer and Peripheral Capacitances, Choice of Layers
	Scaling	Scaling Models and Scaling Factors of Device Parameters
		Limitations of Scaling, Limitations due to Subthreshold Currents, Limitations due to Current Density

UNIT-III **-- 12 Hrs**

Static CMOS Design: Complementary CMOS: Propagation Delay, Voltage Transfer Characteristics, Power Consumption. Ratioed Logic: Basic Concept, Effect of decrease in Wp, **Differential Cascode Voltage Switch Logic (DCVSL)**. Pass-Transistor Logic: Design of Logic Gates, Transmission Gate.

Unit	Module	Micro content
Static CMOS Design	Complementary CMOS	Propagation Delay, Voltage Transfer Characteristics, Power Consumption
	Ratioed Logic	Basic Concept, Effect of decrease in Wp, Differential Cascode Voltage Switch Logic (DCVSL)
	Pass-Transistor Logic	Design of Logic Gates,
		Transmission Gate

<table>
<tr><td colspan="3">UNIT-IV -- 12 Hrs
Dynamic CMOS Design: Dynamic Logic-Basic Principles, Speed and Power Dissipation of Dynamic Logic, Issues in Dynamic Design, Cascading Dynamic Gates, Choosing a Logic Style, Latch Versus Register, multiplexer based latches, Master-Slave Based Edge Triggered Register, Dynamic Transmission-Gate edge-triggered register, setup time, hold time, Clocked CMOS register.</td></tr>
<tr><th>Unit</th><th>Module</th><th>Micro content</th></tr>
<tr><td rowspan="4">Dynamic CMOS Design</td><td rowspan="4">Dynamic CMOS Logic</td><td>Dynamic Logic: Basic Principals, Speed and Power Dissipation of Dynamic Logic, Issues in Dynamic Design: Charge Leakage, Charge Sharing, Basics on Cadcading Dynamic Gates: Domino Logic, np-CMOS, Choosing a Logic Style</td></tr>
<tr><td>Timing Metrics of Sequential Circuits, Latch vs. Register</td></tr>
<tr><td>Multiplexer-based Latches: Positive and Negative Latches based on Multiplexer, Master-Slave Edge-Triggered Register</td></tr>
<tr><td>Dynamic Transmission-Gate edge-triggered register, setup time, hold time, Clocked CMOS register</td></tr>
<tr><td colspan="3">UNIT-V -- 12 Hrs
Introduction to PLDs: Overview of PLDs, CPLD: Introduction to CPLD, Example of CPLD: Xilinx CoolRunner, FPGA: Introduction to FPGA, Organization of FPGA, Programming Technologies, Programmable Logic Block Architectures, Programmable Interconnects and I/O Blocks.</td></tr>
<tr><th>Unit</th><th>Module</th><th>Micro content</th></tr>
<tr><td rowspan="5">Introduction to PLDs</td><td>Introduction</td><td>Introduction to PLDs: Overview, Comparison of PLDs</td></tr>
<tr><td rowspan="2">CPLD</td><td>Introduction to CPLD</td></tr>
<tr><td>Example of CPLD: Xilinx CoolRunner XCR3064XL CPLD, architecture, Function Block and Macrocell</td></tr>
<tr><td rowspan="2">Introduction to FPGA</td><td>Introduction, Examples of FPGA, Organization: Basic Elements, Architectures includes Matrix based, Row based, Hierarchical PLD and Sea-of-Gates</td></tr>
<tr><td>Programming Technologies: Static RAM, EPROM/EEPROM/flash, Anti-fuse, Comparision. Programmable Logic Block</td></tr>
</table>

		Architectures
		Programmable Interconnects: Interconnects in Symmetric based FPGAs, Interconnects in Row-based FPGAs, Programmable I/O blocks
Total No. of Hours Required		**-- 65 Hrs**

Module Coordinator **BOS** **HOD**

IV- Year I- Semester	Name of the Course	L	T	P	C
	DATA ANALYTICS FOR SMART GRIDS (Open Elective III)	3	0	0	3

PRE-REQUISITES: Power Systems and Python

Course Objectives: The student should be able to

1. Study the basics of conventional grid and Transformation to smart grid using new technologies.
2. Understand the major components, grid layout and standards of smart grids.
3. Demonstrate various smart grid communication and measurement technologies.
4. Distinguish the data collection devices and data management in smart grids.
5. Critique the different power system issues using data analytic tools.

Syllabus		
Unit No	**Contents**	**Mapped CO**
I	**Introduction to Smart Grids (12 hrs)** Overview of conventional grid-Evolution of Indian electric grid-Factors affecting performance of existing grid-Working definitions of smart grid-Functions of smart grid components-Difference between conventional and smart grid-Benefits of smart grid-Characteristics of smart grid-Stages of the Transformation to smart grid –Technologies used in smart grid-General view of the smart grid market drivers-Smart grid stakeholder roles and functions-Challenges of smart grid-Barriers of smart grid- Smart grid activities in India.	**CO1**
II	**Architecture and Standards of Smart Grid (11 hrs)** **Architecture of Smart Grid (06 hrs)** Smart grid layout: Generation domain-Transmission domain-Distribution domain-Customer domain- Market domain-Operation domain- Service provider domain. Smart grid major components: Smart infrastructure-Smart communication-Smart management-Smart protection. Supervisory control and data acquisition (SCADA) system: Components of SCADA system- SCADA applications-SCADA advantages-Substation automation-Distribution automation. **Standards of Smart Grid (05 hrs)** Introduction-Classification of standards-Standards development organizations--Standards for the various electric grid levels-Interoperability: Benefits and challenges of interoperability-Smart grid network interoperability-Interoperability standards-Regulatory authorities in Indian power sector.	**CO2**
III	**Smart Grid Communication and Measurement Technology(14 hrs)** **Smart Grid Communication (06 hrs)** Introduction-Classification of smart grid communication technologies-Comparison between wireless communication technologies- Comparison between wired communication technologies-Communications infrastructure- Architecture of SG Communication- Requirements of SG Communication-Challenges of smart grid communication. **Smart Grid Measurement Technology (08 hrs)**	**CO3**

	Smart Meters(SM): Introduction- Evolution of electricity metering- Block diagram of a smart meter- Communication infrastructure for smart metering- Communication protocols for smart metering-Comparison between conventional and smart metering. Advanced metering infrastructure (AMI) :Introduction-Components of AMI-Block diagram of typical AMI system-Automated Meter Reading (AMR) versus Advanced Metering Infrastructure (AMI)–Benefits of advanced metering. Remote Terminal Unit (RTU): Introduction- Evolution of RTUs- Components of RTU. Phasor Measurement Units (PMU): Introduction- Concept of PMUs- Block diagram of PMU- Architecture of PMU- Applications of PMU- Comparison of SCADA data and PMU data- Benefits of PMU. Wide Area Monitoring Systems (WAMS):Introduction-Future uses of PMU data in EMS and DMS with WAMS- Case studies in EMS and WAMS- WAMS applications.	
IV	**Data Management in Smart Grid (11 hrs)** Introduction-Intelligent electronic devices (IED)-Evolution of IEDs- IED functional block diagram- Sources of data in smart grid- Big Data Architecture and Patterns- Building the Foundation for Big Data Processing- Privacy Information Impacts on Smart Grid-Meter Data Management for Smart Grid- Benefits of big data systems in energy management-Simulation Tools for Validation of Smart Grid- Review of Smart Grid Planning and Analysis Tools.	**CO4**
V	**Big Data Applications for Smart Grid(12 hrs)** Introduction-Need of data analytics in smart grid-Characteristics of big data for smart grid-Pattern of big data volume in electric utilities- Smart grid frame work with key stages of big data analytics-Scope of big data analytics in smart grids-Key challenges to apply big data analytics to smart grids- Performance Analysis Tools to Manage Big Data- Transforming Big Data for High Value Action- potential applications of big data analytics in smart grids.	**CO5**

Content beyond the syllabus:

Research activities in the smart grid-multidisciplinary research activities-Concept of Demand Side Management(DSM) and Demand Response(DR)- Data plotting and visualization using Python.

Course Outcomes

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

CO1	**Understand** the basics of conventional grid and Transformation to smart grid using new technologies.**{Understand level, KL2}**
CO2	**Describe** the major components, grid layout and standards of smart grids. **{Understand level, KL2}**
CO3	**Interpret** the various smart grid communication and measurement technologies. **{Apply level, KL3}**
CO4	**Analyze** the data collection devices and data management in smart grids. **{Analyze level, KL4}**
CO5	**Appraise** the different power system issues using data analytic tools. **{ Analyze level, KL4 and Evaluate level, KL5}**

Learning Resources

Text books:

1. “Smart Grid and Enabling Technologies” ,Shady S Refaat and Omar Ellabban,IEEE Press-John Wiley & Sons Ltd.,2021.

2. "Smart GridTechnology and Applications",Janaka E andKithsiri L, John Wiley & Sons Ltd., 2012. 3. "Smart Grid Communication Infrastructures: Big Data, Cloud Computing and Security", Feng Ye, Yi Qian and Rose Qingyang Hu, IEEE Press-John Wiley & Sons Ltd., 2018.
Reference books:
1. "Smart Grid: Fundamentals of Design and Analysis", James Momoh, IEEE Press-John Wiley & Sons Ltd., 2012. 2. "Smart Grids:Infrastructure, Technology and Solutions", Stuart Borlase, CRC Press-Taylor & Francis Group,2013. 3. "Power System SCADA and Smart Grid", Mini S Thomas and J. D McDonald, CRC Press- Taylor & Francis Group,2015. 4. "Big Data Analytics Strategies for the Smart Grid", Carol L Stimmel, CRC Press-T&FGroup,2015. 5. "Smart Grid Technology: A Cloud Computing and Data Management Approach", Sudip Misra and Samaresh Bera, Cambridge University Press, 2018.
e- Resources & other digital material
1. https://onlinecourses.nptel.ac.in/noc19_ee64/course?
2. https://onlinecourses.swayam2.ac.in/arp19_ap60/course
3. https://onlinecourses.nptel.ac.in/noc22_cs65/announcements?force=true
4. https://onlinecourses.nptel.ac.in/noc22_cs08/announcements?force=true
5. https://onlinecourses.nptel.ac.in/noc22_cs28/announcements?force=true
6. https://ieeexplore.ieee.org/document/9272794

Micro-Syllabus

Unit-1:Introduction to Smart Grids (12 hrs)

Overview of conventional grid-Evolution of Indian electric grid-Factors affecting performance of existing grid-Working definitions of smart grid-Functions of smart grid components-Difference between conventional and smart grid-Benefits of smart grid-Characteristics of smart grid-Stages of the Transformation to smart grid –Technologies used in smart grid-General view of the smart grid market drivers-Smart grid stakeholder roles and functions-Challenges of smart grid-Barriers of smart grid-Smart grid activities in India.

Unit No	Module	Micro content
1.Introduction to Smart Grid	**Introduction to Smart Grid**	Overview of conventional grid
		Evolution of Indian electric grid
		Factors affecting performance of existing grid
		Working definitions of smart grid
		Functions of smart grid components
		Difference between conventional and smart grid
		Benefits and Characteristics of smart grid
		Stages of the Transformation to smart grid
		Technologies used in smart grid
		General view of the smart grid market drivers
		Smart grid stakeholder roles and functions
		Challenges and Barriers of smart grid
		Smart grid activities in India.

Unit-2: Architecture and Standards of Smart Grid (11 hrs)

Architecture of Smart Grid (06 hrs)

Smart grid layout: Generation domain-Transmission domain-Distribution domain-Customer domain-Market domain-Operation domain- Service provider domain. Smart grid major components: Smart infrastructure-Smart communication-Smart management- Smart protection. Supervisory control and data acquisition (SCADA) system: Components of SCADA system- SCADA applications-SCADA advantages-Substation automation-Distribution automation.

Standards of Smart Grid (05 hrs)

Introduction-Classification of standards-Standards development organizations--Standards for the various electric grid levels-Interoperability: Benefits and challenges of interoperability-Smart grid network interoperability-Interoperability standards-Regulatory authorities in Indian power sector.

Unit No	Module	Micro content
2a. Architecture of Smart Grid	**Architecture of Smart Grid**	Smart grid layout with schematic diagrams of different domains.
		Smart grid major components
		Supervisory control and data acquisition (SCADA) system-Components, Applications and Advantages.
		Substation automation with integration of different components.
		Distribution automation with distribution management system.
2b. Standards of Smart Grid	**Standards of Smart Grid**	Classification of standards with the rules
		Standards development organizations and its functions.
		Benefits,Challenges and Standards of interoperability.
		Regulatory authorities in Indian power sector and its activities.

Unit-3: Smart Grid Communication and Measurement Technology(14 hrs)

Smart Grid Communication (06 hrs)

Introduction-Classification of smart grid communication technologies-Comparison between wireless communication technologies- Comparison between wired communication technologies-Communications infrastructure- Architecture of SG Communication- Requirements of SG Communication-Challenges of smart grid communication.

Smart Grid Measurement Technology (08 hrs)

Smart Meters(SM): Introduction- Evolution of electricity metering- Block diagram of a smart meter-Communication infrastructure for smart metering- Communication protocols for smart metering-Comparison between conventional and smart metering. Advanced metering infrastructure (AMI) :Introduction-Components of AMI-Block diagram of typical AMI system-Automated Meter Reading (AMR) versus Advanced Metering Infrastructure (AMI)–Benefits of advanced metering. Remote Terminal Unit (RTU): Introduction- Evolution of RTUs- Components of RTU. Phasor Measurement Units (PMU): Introduction- Concept of PMUs- Block diagram of PMU- Architecture of PMU-Applications of PMU- Comparison of SCADA data and PMU data- Benefits of PMU. Wide Area Monitoring Systems (WAMS):Introduction-Future uses of PMU data in EMS and DMS with WAMS-Case studies in EMS and WAMS- WAMS applications.

Unit No	Module	Micro content
3a. Smart Grid Communication	**Smart Grid Communication**	Classification of smart grid communication technologies.
		Comparison between wireless communication technologies.
		Comparison between wired communication technologies.
		Communications infrastructure
		Architecture, Requirements and Challenges of SG Communication
3b. Smart Grid Measurement Technology	**Smart Grid Measurement Technology**	Smart Meters (SM)- Evolution, Block diagram Communication infrastructure and protocols.
		Comparison between conventional and smart metering.
		Advanced metering infrastructure (AMI)- Components, Block diagram and Benefits of advanced metering.
		Remote Terminal Unit (RTU)- Evolution and Components of RTU.
		Phasor Measurement Units (PMU)-Concept, Block diagram, Architecture, Applications and Benefits of PMU.
		Comparison of SCADA data and PMU data
		Wide Area Monitoring Systems (WAMS)-Future uses, Case studies and Applications.

Unit-4:Data Management in Smart Grid (11 hrs)

Introduction-Intelligent electronic devices (IED)-Evolution of IEDs- IED functional block diagram-Sources of data in smart grid- Big Data Architecture and Patterns- Building the Foundation for Big Data Processing- Privacy Information Impacts on Smart Grid-Meter Data Management for Smart Grid-Benefits of big data systems in energy management-Simulation Tools for Validation of Smart Grid-Review of Smart Grid Planning and Analysis Tools.

Unit No	Module	Micro content
4. Data Management in Smart Grid	**Data Management in Smart Grid**	Intelligent electronic devices (IED)-Evolution and functional block diagram.
		Sources of data in smart grid from field devices.
		Big Data Architecture, Patterns, Processing and Privacy Information Impacts on Smart Grid.
		Meter Data Management for Smart Grid and its Benefits.
		Simulation Tools for Validation of Smart Grid
		Review of Smart Grid Planning and Analysis Tools.

Unit-5:Big Data Applications for Smart Grid(12 hrs)

Introduction-Need of data analytics in smart grid-Characteristics of big data for smart grid-Pattern of big data volume in electric utilities- Smart grid frame work with key stages of big data analytics-Scope of big data analytics in smart grids-Key challenges to apply big data analytics to smart grids- Performance Analysis Tools to Manage Big Data- Transforming Big Data for High Value Action- potential applications of big data analytics in smart grids.

Unit No	Module	Micro content
5. Big Data Applications for Smart Grid	**Big Data Applications for Smart Grid**	Need of data analytics in smart grid
		Characteristics and Patterns of big data for smart grid
		Key stages and Scope of big data analytics in smart grids
		Key challenges and Performance Analysis Tools of big data analytics to smart grids.
		Transforming Big Data for High Value Action
		Applications of big data analytics in smart grids.

Module Coordinator **BOS** **HOD**

IV- Year I- Semester	Name of the Course	L	T	P	C
	Cyber Security (Open Elective III)	3	0	0	3

PRE-REQUISITES: NIL

Course objectives: The student should be able

1. To familiarize various types of cyber-attacks and cyber-crimes.
2. To give an overview of the cyber laws and cyber forensic.
3. To study the defensive techniques against these attack in mobile and wireless devices.
4. To understand the security and privacy implications in organization.
5. To know the data privacy issues.

Syllabus		
Unit No	**Contents**	**Mapped CO**
I	**Introduction to Cyber Security:** Basic Cyber Security Concepts, layers of security, Vulnerability, threat, Harmful acts, Internet Governance – Challenges and Constraints, Computer Criminals, CIA Triad, Assets and Threat, motive of attackers, active attacks, passive attacks, Software attacks, hardware attacks, Cyber Threats-Cyber Warfare, Cyber Crime, Cyber terrorism, Cyber Espionage, etc., Comprehensive Cyber Security Policy.	**CO1**
II	**Cyberspace and the Law & Cyber Forensics:** Introduction, Cyber Security Regulations, Roles of International Law. The INDIAN Cyberspace, National Cyber Security Policy. Introduction, Historical background of Cyber forensics, Digital Forensics Science, The Need for Computer Forensics, Cyber Forensics and Digital evidence, Forensics Analysis of Email, Digital Forensics Lifecycle, Forensics Investigation, Challenges in Computer Forensics.	**CO2**
III	**Cybercrime: Mobile and Wireless Devices:** Introduction, Proliferation of Mobile and Wireless Devices, Trends in Mobility, Credit card Frauds in Mobile and Wireless Computing Era, Security Challenges Posed by Mobile Devices, Registry Settings for Mobile Devices, Authentication service Security, Attacks on Mobile/Cell Phones, Organizational Security Policies and Measures in Mobile Computing Era, Laptops.	**CO3**
IV	**Cyber Security: Organizational Implications:** Introduction, cost of cybercrimes and IPR issues, web threats for organizations, security and privacy implications, social media marketing: security risks and perils for organizations, social computing and the associated challenges for organizations.	**CO4**
V	**Privacy Issues:** Basic Data Privacy Concepts: Fundamental Concepts, Data Privacy Attacks, Data linking and profiling, privacy policies and their specifications, privacy policy languages, privacy in different domains- medical, financial, etc.	**CO5**
Content Beyond the syllabus:		

Cyber security: Spectrum of attacks, Taxonomy of various attacks, IP spoofing, Methods of defense, Security Models, risk management. **Cybercrime and Cyber terrorism:** Introduction, intellectual property in the cyberspace, the ethical dimension of cybercrimes the psychology, mindset and skills of hackers and other cyber criminals.

Course Outcomes	
Upon successful completion of the course, the student will be able	
CO1	To understand cyber-attacks.
CO2	To know the cyber laws and cyber forensic.
CO3	To protect them self and ultimately the entire Internet community from such attacks.
CO4	To understand the security and privacy implications in organization.
CO5	To know the data privacy issues.

Learning Resources
Text books:
1. Nina Godbole and Sunit Belpure, Cyber Security Understanding Cyber Crimes, Computer Forensics and Legal Perspectives, Wiley 2. B. B. Gupta, D. P. Agrawal, Haoxiang Wang, Computer and Cyber Security: Principles, Algorithm, Applications, and Perspectives, CRC Press, ISBN 9780815371335, 2018.
Reference books:
1. Cyber Security Essentials, James Graham, Richard Howard and Ryan Otson, CRC Press. 2. Introduction to Cyber Security, Chwan-Hwa(john) Wu,J. David Irwin, CRC Press T&F Group
e- Resources & other digital material **1.** https://onlinecourses.swayam2.ac.in/nou19_cs08/preview

Micro-Syllabus- Cyber Security

Unit – 1: Introduction to Cyber Security: (13 hrs) Basic Cyber Security Concepts, layers of security, Vulnerability, threat, Harmful acts, Internet Governance – Challenges and Constraints, Computer Criminals, CIA Triad, Assets and Threat, motive of attackers, active attacks, passive attacks, Software attacks, hardware attacks, Cyber Threats-Cyber Warfare, Cyber Crime, Cyber terrorism, Cyber Espionage, etc., Comprehensive Cyber Security Policy.

Unit No	Module	Micro content
1a.Cyber Security	**Cyber Security**	Basic Cyber Security Concepts
		layers of security
		Vulnerability, threat, Harmful acts, Internet Governance – Challenges and Constraints
		CIA Triad, Assets and Threat, motive of attackers, active attacks, passive attacks
		Software attacks, hardware attacks
1b.Cyber Crime	**Cyber Crime**	Cyber Threats-Cyber Warfare
		Cyber Crime

		Cyber terrorism, Cyber Espionage, etc.,
		Comprehensive Cyber Security Policy.
Unit-2. Cyberspace and the Law & Cyber Forensics: : (11 hrs) Introduction, Cyber Security Regulations, Roles of International Law. The INDIAN Cyberspace, National Cyber Security Policy. Introduction, Historical background of Cyber forensics, Digital Forensics Science, The Need for Computer Forensics, Cyber Forensics and Digital evidence, Forensics Analysis of Email, Digital Forensics Lifecycle, Forensics Investigation, Challenges in Computer Forensics.		
Unit No	**Module**	**Micro content**
2a. Cyberspace and the Law	**Cyberspace and the Law**	Cyber Security Regulations
		Roles of International Law
		The INDIAN Cyberspace
		National Cyber Security Policy
2b. Cyber Forensics	**Cyber Forensics**	Historical background of Cyber forensics
		Digital Forensics Science
		The Need for Computer Forensics
		Cyber Forensics and Digital evidence
		Forensics Analysis of Email, Digital Forensics Lifecycle,
		Forensics Investigation, Challenges in Computer Forensics.
Unit-3:Cybercrime: Mobile and Wireless Devices: : (11 hrs) Introduction, Proliferation of Mobile and Wireless Devices, Trends in Mobility, Credit card Frauds in Mobile and Wireless Computing Era, Security Challenges Posed by Mobile Devices, Registry Settings for Mobile Devices, Authentication service Security, Attacks on Mobile/Cell Phones, Organizational Security Policies and Measures in Mobile Computing Era, Laptops.		
Unit No	**Module**	**Micro content**
Unit-3:Cybercrime: Mobile and Wireless Devices	**Cybercrime: Mobile and Wireless Devices**	Proliferation of Mobile and Wireless Devices,
		Trends in Mobility, Credit card Frauds in Mobile and Wireless Computing Era
		Security Challenges Posed by Mobile Devices,
		, Registry Settings for Mobile Devices
		Authentication service Security,
		, Attacks on Mobile/Cell Phones,
		Attacks on Mobile/Cell Phones
		Organizational Security Policies and Measures in Mobile Computing Era, Laptops.

Unit-4: Cyber Security: Organizational Implications: : (10 hrs) Introduction, cost of cybercrimes and IPR issues, web threats for organizations, security and privacy implications, social media marketing: security risks and perils for organizations, social computing and the associated challenges or organizations

Unit No	Module	Micro content
Unit-4: Cyber Security: Organizational Implications	**Organizational Implications**	Introduction
		cost of cybercrimes and IPR issues
		web threats for organizations
		security and privacy implications
	Social media marketing	social media marketing: security risks and perils for organizations
		social computing and the associated challenges for organizations

Unit-5: Privacy Issues: : (10 hrs)Basic Data Privacy Concepts: Fundamental Concepts, Data Privacy Attacks, Data linking and profiling, privacy policies and their specifications, privacy policy languages, privacy in different domains- medical, financial, etc.

Unit No	Module	Micro content
Unit-5: Privacy Issues	**Privacy Issues**	Basic Data Privacy Concepts
		Fundamental Concepts
		Data Privacy Attacks
		Data linking and profiling
		privacy policies and their specifications
		privacy policy languages
		privacy in different domains- medical, financial, etc.

CO-PO mapping Table

Contribution of Course Outcomes towards achievement of Program Outcomes & Strength of correlations **(High: 3, Medium: 2, Low: 1)**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO-1	PSO-2
CO1	2													
CO2	3					2							2	
CO3	2					1								
CO4	3							1					2	
CO5	2											2	2	

Module Coordinator **BOS** **HOD**

IV- Year I - Semester	Name of the Course	L	T	P	C
	ROBOTICS (Open Elective III)	3	0	0	3

PRE-REQUISITES: Nil

Course objectives: The student should be able to

1. To understand the concepts of automation
2. To understand the concepts of robot kinematics, Dynamics, Trajectory planning.
3. Mathematical approach to explain how the robotic arm motion can be described.
4. To understand the functioning of sensors and actuators and their applications
5. To understand the applications of robotics in manufacturing

Syllabus		
Unit No	**Contents**	**Mapped CO**
I	**INTRODUCTION:** Automation and Robotics, types of automation, assembly automation equipment, material handling systems, feed systems, Automated Guided Vehicles, Automated storage and retrieval systems, Flexible Manufacturing Systems, Computer Aided Process Planning Systems, Computer Aided manufacturing. CAD/CAM and Robotics – An over view of Robotics – present and future applications – classification by coordinate system and control system. **COMPONENTS OF THE INDUSTRIAL ROBOTICS**: Function line diagram representation of robot arms, common types of arms. Components, Architecture, number of degrees of freedom – Requirements and challenges of end effectors, determination of the end effectors, comparison of Electric, Hydraulic and Pneumatic types of locomotion devices.	**CO1**
II	**MOTION ANALYSIS:** Homogeneous transformations as applicable to rotation and translation – problems. **MANIPULATOR KINEMATICS:** Specifications of matrices, D-H notation joint coordinates and world coordinates Forward and inverse kinematics – problems.	**CO2**
III	Differential transformation and manipulators, Jacobians – problems Dynamics: Lagrange – Euler and Newton – Euler formulations – Problems.	**CO3**
IV	General considerations in path description and generation. Trajectory planning and avoidance of obstacles, path planning, Skew motion, joint integrated motion –straight line motion – Robot programming, languages and software packagesdescription of paths with a robot programming language.	**CO4**
V	**ROBOT ACTUATORS AND FEED BACK COMPONENTS:** Actuators: Pneumatic, Hydraulic actuators, electric & stepper motors. Feedback components: position sensors – potentiometers, resolvers, encoders – Velocity sensors. **ROBOT APPLICATIONS IN MANUFACTURING:** Material Transfer - Material handling, loading and unloading- Processing - spot and continuous arc welding & spray	**CO5**

	painting - Assembly and Inspection.	

Course Outcomes	
Upon successful completion of the course, the student will be able to	
CO1	**Recognize** the characteristics of machine learning, binary classification **{Understand level, KL2} {Analyze level, KL4}**
CO2	**Solve** classification problems using multiclass classification and concept learning **{Evaluate level, KL5}**
CO3	**Apply** Tree based and Rule based learning models to real world problems **{Apply level, KL3}**
CO4	**Apply** Linear models and Distance based classification and clustering algorithms **{Apply level, KL3}**
CO5	**Analyze** Bayesian classifiers and **Understand** the concept behind neural networks for learning non-linear functions **{Understand level, KL2} {Analyze level, KL4}**

Learning Resources
Text books:
1. Machine Learning: The art and Science of algorithms that make sense of data, Peter Flach, Cambridge University Press, 2012. 2. Tom M. Mitchell, Machine Learning, India Edition 2013, McGraw Hill Education. 3. Chris Albon : Machine Learning with Python Cookbook , O’Reilly Media, Inc.2018.
Reference books:
1. Stephen Marsland, “Machine Learning – An Algorithmic Perspective”, Second Edition, Chapman and Hall/CRC Machine Learning and Pattern Recognition Series, 2014. 2. Ethem Alpaydın, Introduction to machine learning, second edition, MIT press. 3. T. Hastie, R. Tibshirani and J. Friedman, “Elements of Statistical Learning”, Springer Series , 2nd edition.
e- Resources & other digital material
1. Kevin Murphy, “Machine Learning: A Probabilistic Perspective”, MIT Press, 2012, https://www.cs.ubc.ca/~murphyk/MLbook/pml-intro-5nov11.pdf
2. Professor S. Sarkar , IIT Kharagpur “Introduction to machine learning”, https://www.youtube.com/playlist?list=PLYihddLFCgYuWNL55Wg8ALkm6u8U7gps
3. Professor Carl Gustaf Jansson, KTH, Video Course on Machine Learning https://nptel.ac.in/noc/individual_course.php?id=noc19-cs35
4. Tom Mitchell, “Machine Learning”, http://www.cs.cmu.edu/~tom/10701_sp11/lectures.shtml

Micro-Syllabus

Unit – 1: The ingredients of machine learning, Tasks: (08 hrs)

The problems that can be solved with machine learning, Looking for structure, Evaluating performance on a task, **Models: the output of machine learning:** Geometric models, Probabilistic models, Logical models, Grouping and grading, **Features:** The workhorses of machine learning, Two uses of features, Feature construction and transformation.

Binary classification and related tasks: (06 hrs)

Classification, Assessing classification performance, Visualizing classification performance, Class probability estimation, Assessing Class probability estimates.

<table>
<tr><th>Unit No</th><th>Module</th><th>Micro content</th></tr>
<tr><td rowspan="8">1a. The ingredients of machine learning, Tasks</td><td rowspan="3">The ingredients of machine learning, Tasks</td><td>The problems that can be solved with machine learning</td></tr>
<tr><td>Looking for structure</td></tr>
<tr><td>Evaluating performance on a task</td></tr>
<tr><td rowspan="2">Models: the output of machine learning</td><td>Geometric models, Probabilistic models</td></tr>
<tr><td>Logical models, Grouping and grading</td></tr>
<tr><td rowspan="3">Features</td><td>The workhorses of machine learning</td></tr>
<tr><td>Two uses of features</td></tr>
<tr><td>Feature construction and transformation</td></tr>
<tr><td rowspan="5">1b. Binary classification and related tasks</td><td rowspan="5">Binary classification and related tasks</td><td>Classification</td></tr>
<tr><td>Assessing classification performance</td></tr>
<tr><td>Visualizing classification performance</td></tr>
<tr><td>Class probability estimation</td></tr>
<tr><td>Assessing Class probability estimates</td></tr>
</table>

Unit-2: Beyond binary classification: (07 hrs)

Handling more than two classes, Multi class classification, Multi class scores and probabilities, Regression, Unsupervised and descriptive learning, Predictive and descriptive clustering.

Concept learning: (07 hrs)

The hypothesis space, Least general generalization, Internal disjunction, Paths through the hypothesis space, Most general consistent hypotheses, Closed concepts, Beyond conjunctive concepts.

<table>
<tr><th>Unit No</th><th>Module</th><th>Micro content</th></tr>
<tr><td rowspan="6">2a. Beyond binary classification</td><td rowspan="6">Beyond binary classification</td><td>Handling more than two classes</td></tr>
<tr><td>Multi class classification</td></tr>
<tr><td>Multi class scores and probabilities</td></tr>
<tr><td>Regression</td></tr>
<tr><td>Unsupervised and descriptive learning</td></tr>
<tr><td>Predictive and descriptive clustering</td></tr>
<tr><td rowspan="4">2b. Concept learning</td><td rowspan="4">Concept learning</td><td>The hypothesis space</td></tr>
<tr><td>Least general generalization</td></tr>
<tr><td>Internal disjunction</td></tr>
<tr><td>Paths through the hypothesis space</td></tr>
</table>

<table>
<tr><td rowspan="3"></td><td rowspan="3"></td><td>Most general consistent hypotheses</td></tr>
<tr><td>Closed concepts</td></tr>
<tr><td>Beyond conjunctive concepts</td></tr>
<tr><td colspan="3">Unit-3: Tree models: (06 hrs)
Decision trees, Ranking and probability estimation trees, Tree learning as variance reduction.
Rule models: (06 hrs)
Learning ordered rule lists, Learning unordered rule sets, Descriptive rule learning, First-order rule learning.</td></tr>
<tr><th>Unit No</th><th>Module</th><th>Micro content</th></tr>
<tr><td rowspan="3">3a. Tree models</td><td rowspan="3">Tree models</td><td>Decision trees</td></tr>
<tr><td>Ranking and probability estimation trees</td></tr>
<tr><td>Tree learning as variance reduction</td></tr>
<tr><td rowspan="4">3b. Rule models</td><td rowspan="4">Rule models</td><td>Learning ordered rule lists</td></tr>
<tr><td>Learning unordered rule sets</td></tr>
<tr><td>Descriptive rule learning</td></tr>
<tr><td>First-order rule learning</td></tr>
<tr><td colspan="3">Unit-4: Linear models: (07 hrs)
The least-squares method, multivariate linear regression, regularized regression, using least-squares regression for classification, Support vector machines, Soft margin SVM.
Distance Based Models: (07 hrs)
Ways of measuring distance, Neighbours and exemplars, Nearest Neighbours classification, Distance based clustering, k means algorithm, Clustering around mediods, Silhouettes, Hierarchical Clustering.</td></tr>
<tr><th>Unit No</th><th>Module</th><th>Micro content</th></tr>
<tr><td rowspan="6">4a. Linear models</td><td rowspan="6">Linear models</td><td>The least-squares method</td></tr>
<tr><td>multivariate linear regression</td></tr>
<tr><td>regularized regression</td></tr>
<tr><td>using least-squares regression for classification</td></tr>
<tr><td>Support vector machines</td></tr>
<tr><td>Soft margin SVM</td></tr>
<tr><td rowspan="8">4b. Distance Based Models</td><td rowspan="8">Distance Based Models</td><td>Ways of measuring distance</td></tr>
<tr><td>Neighbours and exemplars</td></tr>
<tr><td>Nearest Neighbours classification</td></tr>
<tr><td>Distance based clustering</td></tr>
<tr><td>k means algorithm</td></tr>
<tr><td>Clustering around mediods</td></tr>
<tr><td>Silhouettes</td></tr>
<tr><td>Hierarchical Clustering</td></tr>
<tr><td colspan="3">Unit-5: Bayesian Learning: (06 hrs)
Introduction, Bayes Theorem, Bayes Optimal Classifier, Gibbs Algorithm, Naïve Bayes Classifier, Learning to classify Text.
Artificial Neural Networks: (06 hrs)</td></tr>
</table>

Introduction, Neural network representation, appropriate problems for neural network learning, Multilayer networks and the back propagation algorithm.		
Unit No	**Module**	**Micro content**
5a. Bayesian Learning	**Bayesian Learning**	Introduction
		Bayes Theorem, Bayes Optimal Classifier
		Gibbs Algorithm
		Naïve Bayes Classifier, Learning to classify Text
5b. Artificial Neural Networks	**Artificial Neural Networks**	Introduction
		Neural network representation
		appropriate problems for neural network learning
		Multilayer networks and the back propagation algorithm

CO-PO mapping Table

Contribution of Course Outcomes towards achievement of Program Outcomes & Strength of correlations **(High: 3, Medium: 2, Low: 1)**														
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO-1	PSO-2
CO1	1	1	1	1										
CO2	2	1	2	2										
CO3	2	1	2	2										
CO4	2	1	2	2										
CO5	2	1	2	2										

Module Coordinator **BOS** **HOD**

IV- Year I- Semester	Name of the Course	L	T	P	C
	NEURAL NETWORKS & FUZZY LOGIC (OPEN ELECTIVE IV)	3	0	0	3

Pre-requisites: Not Required

Course Objectives:

- To introduce the concept of artificial neuron models
- To study various neural network architectures and learning strategies
- To explain ANN paradigms and application of ANN to Electrical Engineering problems.
- To introduce fuzzy set operations and relations.
- To study the design of fuzzy logic system

Syllabus		
Unit	**Contents**	**Mapped CO**
I	**Introduction to Neural Networks: (12hrs)** **Introduction: (5hrs)** Introduction, Organization of the Brain – Biological Neuron, Humans and Computers – Knowledge representation. **Artificial Neurons: (7hrs)** Artificial Neuron model, Activation functions, MC Culloch-pitts neuron model, Hodgkin-Huxley Neuron Model, Integrate-and-Fire Neuron Model, Design of basic logic gates using single artificial neuron.	**CO1**
II	**Essentials of Artificial Neural Networks: (12hrs)** **Artificial Neural Network Architectures: (7hrs)** ANN Architectures, Taxonomy of ANN, Characteristics and Historical Developments of ANN, Single layer feed forward networks: Perceptron, Learning algorithm for perceptron- limitations of Perceptron model. **Learning strategies: (5hrs)** Learning methods (Supervised, Unsupervised and Reinforced), Learning rules (Rosenblatt's Perceptron learning rule, Delta rule, Hebbian rule, Competitive learning rule, Gradient Descent learning rule).	**CO2**
III	**ANN Paradigm and its applications: (10hrs)** **ANN Paradigms: (6hrs)** Multi-layer feed-forward network (based on Back propagation algorithm)– Radial-basis function networks- Recurrent networks (Hopfield networks). **Applications of ANN: (4hrs)** Load Forecasting using ANN, Economic Load Dispatch.	**CO3**
IV	**Classical and Fuzzy set Theory (14hrs)** **Classical set Theory: (7hrs)** Introduction to classical sets - properties, Operations and relations, Verification of Demorgan's Law.	**CO4**

	Fuzzy set Theory: (7hrs) Fuzzy sets – Membership – Uncertainty – Operations – Properties – Fuzzyrelations – Cardinalities – Membership functions.	
V	**Fuzzy Logic System Design and Applications (12hrs)** **Fuzzy Logic System Design: (7hrs)** Fuzzification – Membership value assignment- Development of rule base and decision making system – Defuzzification to crisp sets – Defuzzification methods. **Fuzzy Logic Control Applications: (5hrs)** Load Frequency Control, Automatic Voltage Regulator.	**CO5**

Content beyond syllabus:
Hybrid controller: Adaptive Neuro fuzzy system (ANFIS) information [Elementary Treatment Only]
Evolutionary programming: Basic genetic programming concepts and applications [Elementary Treatment Only]

Course Outcomes	
Upon successful completion of the course, the student will be able to	
CO1	Understand the concept of artificial neuron.**(Understand KL2, Analyze KL4)**
CO2	Know various ANN architectures and learning strategies. **(Understand KL2, Analyze KL4, Apply KL3)**
CO3	Understand ANN paradigm and its application to solve Electrical Engineering problems. **(Understand KL2, Apply KL3)**
CO4	Understand fuzzy set theory and membership functions. **(Understand KL2)**
CO5	Design Fuzzy Logic System for Electrical Engineering problems. **(Understand KL2, Apply KL3)**

Learning Resources

Text Books:
1. Neural Networks, Fuzzy logic, Genetic algorithms: synthesis and applications by S.Rajasekaran and G.A. VijayalakshmiPai – PHI Publication.
2. Fuzzy logic with fuzzy applications- by T.J. Ross, TMH.

Reference Books:
1. Introduction to Artificial Neural Systems – Jacek M. Zurada, Jaico Publishing House, 1997.
2. Fundamentals of Neural Networks Architectures, Algorithms and Applications - by laureneFausett, Pearson.
3. Neural Networks, Algorithms, Applications and programming Techniques by James A. Freeman, David M. Skapura.
4. Introduction to Neural Networks using MATLAB 6.0 by S N Sivanandam, S Sumathi, S N Deepa TMGH

e- Resources & other digital material

1. https://archive.nptel.ac.in/courses/127/105/127105006/
2. https://www.youtube.com/watch?v=IZWTduVCrf8&list=PLBEDalwGmREACEgLEgEefy6PXRN5aZCW

Micro Syllabus

Unit-I: Introduction to Neural Networks (12hrs)

Introduction:

Introduction, Organization of the Brain – Biological Neuron, Humans and Computers – Knowledge representation.

Artificial Neurons:

Artificial Neuron model, Activation functions, MC Culloch-pitts neuron model, Hodgkin-Huxley Neuron Model, Integrate-and-Fire Neuron Model, Design of basic logic gates using single artificial neuron.

Unit	Module	Micro content
1.a	Biological Neuron	Human brain Organization, Biological neuron and its parts, comparison between Humans and Computers, Knowledge Representation.
1.b	Artificial Neuron Models	Artificial Neuron model,MC Culloch-pitts neuron model
		Hodgkin-Huxley Neuron Model, Integrate-and-Fire Neuron Model.
	Design of Logic Gates	Activation Functions, Design of basic logic gates using single artificial neuron (AND, OR and NOT Gates Only).

UNIT-II: Essentials of Artificial Neural Networks:(12hrs)

Artificial Neural Network Architectures:

ANN Architectures, Taxonomy of ANN, Characteristics and Historical Developments of ANN, Single layer feed forward networks: Perceptron, Learning algorithm for perceptron- limitations of Perceptron model.

Learning strategies:

Learning methods (Supervised, Unsupervised and Reinforced), Learning rules (Rosenblatt's Perceptron learning rule, Delta rule, Hebbian rule, Competitive learning rule, Gradient Descent learning rule).

Unit	Module	Micro content
2.a	ANN Architectures	ANN Architectures (Single layer Feed Forward Network, Multi-layer Feed Forward Network and Recurrent Networks) [Elementary Treatment Only], Taxonomy of ANN, Characteristics and Historical Developments of ANN.

<table>
<tr><td></td><td>Perceptron</td><td>Rosenblatt's Perceptron Theory, Perceptron learning algorithm, perceptron as Classifier limitations of Perceptron model.</td></tr>
<tr><td rowspan="2">2.b</td><td rowspan="2">Learning Strategies</td><td>Learning methods (Supervised, Unsupervised and Reinforced) Only.</td></tr>
<tr><td>Learning rules (Rosenblatt's Perceptron learning rule, Delta rule, Hebbian rule, Competitive learning rule, Gradient Descent learning rule).</td></tr>
<tr><td colspan="3">UNIT-III: ANN Paradigm and its applications: (10hrs)
ANN Paradigms:
Multi-layer feed-forward network (based on Back propagation algorithm)– Radial-basis function networks- Recurrent networks (Hopfield networks).
Applications of ANN:
Load Forecasting using ANN, Economic Load Dispatch.</td></tr>
<tr><td>Unit</td><td>Module</td><td>Micro content</td></tr>
<tr><td rowspan="2">3.a</td><td rowspan="2">ANN Paradigms</td><td>Multi-layer feed-forward network (based on Back propagation algorithm), Back Propagation algorithm step by step procedure.</td></tr>
<tr><td>Radial-basis function networks, Different Basis Functions- Recurrent networks (Hopfield networks).</td></tr>
<tr><td rowspan="2">3.b.</td><td rowspan="2">Applications of ANN</td><td>Neural Networks applications in Load Forecasting</td></tr>
<tr><td>ANN based Economic load dispatch.</td></tr>
<tr><td colspan="3">UNIT – IV: Classical and Fuzzy set Theory (14hrs)
Classical set Theory:
Introduction to classical sets - properties, Operations and relations, Verification of Demorgan's Law.
Fuzzy set Theory:
Fuzzy sets – Membership – Uncertainty – Operations – Properties – Fuzzyrelations – Cardinalities – Membership functions.</td></tr>
<tr><td>Unit</td><td>Module</td><td>Micro content</td></tr>
<tr><td>4.a.</td><td>Classical set Theory</td><td>Introduction to classical sets, Fuzzy Vs Classical Set Theory- Basic Definitions: Set, Single ton set, Null</td></tr>
</table>

		set, Power set, sub set Super set.
		Classical set properties, Operations and relations, Verification of Demorgan's Law.
4.b	**Fuzzy set Theory**	Fuzzy sets – Membership (Both Continuous type and Discrete type)– Uncertainty – Operations – Properties
		Fuzzyrelations – Cardinalities – Membership functions.

UNIT V: Fuzzy Logic System Design and Applications (12hrs)

Fuzzy Logic System Design:

Fuzzification – Membership value assignment- Development of rule base and decision making system – Defuzzification to crisp sets – Defuzzification methods.

Fuzzy Logic Control Applications:

Load Frequency Control, Automatic Voltage Regulator.

Unit	**Module**	**Micro content**
5.a	**Fuzzy Logic System Design**	Fuzzification – Membership value assignment- Development of rule base and decision making system – Defuzzification to crisp sets
		Defuzzification methods (Centroid method, Centre of sums method and Mean of Maxima Method Only).
5.b	**Fuzzy Logic Control Applications**	Fuzzy Logic based Controller for load frequency control problem.
		Fuzzy Logic based Controller for Automatic Voltage Regulation.

CO PO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	1										1
CO2	3	2										1
CO3	2	3										2
CO4	3	3										2
CO5	3	3										2

Module Coordinator **BOS** **HOD**

IV- Year I- Semester	Name of the Course	L	T	P	C
	Linear IC Applications (OPEN ELECTIVE IV)	3	0	0	3

PRE-REQUISITES: Basics of Electronic Devices, KCL, KVL& Network Theorems

Course objectives:

- To understand the basic operation and performance parameters of differential amplifier and operational amplifier.
- To learn the linear and non-linear applications of operational amplifier.
- To understand the analysis &design of different types of active filters using Op-Amps.
- To learn the internal structure, operation and applications of different IC's.
- To understand the various types of Digital to Analog and Analog to Digital converters

Syllabus		
Unit No	**Contents**	**Mapped CO**
I	**Differential Amplifier and Operational Amplifier Characteristics: [13 hours]** Analysis of Differential Amplifier using BJTs: DC & AC analysis of all the four configurations, Types of Integrated circuits: packages, temperature ranges and power supplies. Basic block diagram of Operational Amplifier, Symbol of operational amplifier, operational amplifier ideal characteristics and specifications of IC 741, DC & AC characteristics of operational Amplifier: input bias current, input offset current, input offset voltage, Drift, Slew rate, CMRR, PSRR; pin diagram of IC 741, equivalent diagram of operational amplifier.	**CO1**
II	**Linear and Non-Linear applications of Operational Amplifier: [13 hours]** Inverting and Non-inverting amplifier, Integrator and differentiator, Difference amplifier, Instrumentation amplifier, AC amplifier, V to I, I to V converters, Log and Anti log Amplifiers, Precision rectifiers.	**CO2**
III	**Active Filters and Analog Multipliers:** Design & Analysis of Butter worth active filters –1storder, 2ndorder LPF, HPF filters. Band pass, Band reject and all pass filters. Four Quadrant Multiplier, Sample & Hold circuits.	**CO3**
IV	**Timers & Phase Locked Loops:** Introduction to 555 timer, functional diagram, Monostable and Astable operations and applications, Schmitt Trigger. PLL- introduction, block schematic, Principles and description of individual blocks,565 PLL, Applications of PLL-Frequency Multiplication, frequency translation, Applications of VCO (566).	**CO4**
V	**Data Converters and Applications:** Introduction, basic DAC techniques, weighted resistor DAC, R-2R ladder DAC, inverted R-2R DAC, and IC 1408 DAC, Sample and Hold circuit, Different types of ADCs - parallel comparator type ADC, counter type ADC, successive	**CO5**

	approximation ADC and dual slope ADC. DAC and ADC Specifications, illustrative problems on resolution of ADC and DAC.	

Course Outcomes	
Upon successful completion of the course, the student will be able to	
CO1	**Explain** the DC and AC analysis of Differential Amplifier, and performance parameters of OP-Amp.**{Understand level, KL2}**
CO2	**Demonstrate** the usage of operational amplifier in various applications**{Apply level, KL3}**
CO3	**Explain** the working principles of Active filters and Multipliers using Op-Amp.**{Understand level, KL2}**
CO4	**Learn** the internal structure, pin diagrams and operations of different IC's **{Apply level, KL3}**
CO5	**Learn** the circuits of data converters and **Compare** among them in terms of Parameters **{ Apply level, KL3Analyze level, KL4}**

Learning Resources

Text books:

1. Linear Integrated Circuits – D. Roy Choudhury, New Age International (p) Ltd, 2nd Edition,2003.
2. Op-Amps & Linear ICs - Ramakanth A. Gayakwad, PHI,1987.
3. Linear Integrated Circuits by Salivahan-3rd-Edition, McGrawHill,2018.

Reference books

1. Operational Amplifiers & Linear Integrated Circuits –Sanjay Sharma;SKKataria&Sons;2nd Edition,2010
2. Design with Operational Amplifiers & Analog Integrated Circuits – Sergio Franco, McGraw Hill, 1988.
3. Operational Amplifiers & Linear ICs – David A Bell, Oxford Uni. Press, 3rd Edition,2011.
4. J. V. Wait, L. P. Huelsman and G. A. Korn, "Introduction to Operational Amplifier theory and applications", McGraw Hill U. S., 1992.

Micro-Syllabus

Unit – 1: Differential Amplifier and Operational Amplifier Characteristics: Analysis of Differential Amplifier using BJTs: DC & AC analysis of all the four configurations, Types of Integrated circuits: packages, temperature ranges and power supplies.

Basic block diagram of Operational Amplifier, Symbol of operational amplifier, operational amplifier ideal characteristics and specifications of IC 741, DC & AC characteristics of operational Amplifier: input bias current, input offset current, input offset voltage, Drift, Slew rate, CMRR, PSRR; pin diagram of IC 741, equivalent diagram of operational amplifier.

Unit	Module	Micro content

1a	Differential Amplifier	Terms and definitions of Differential Amplifier
		Modes of Operation and Types of Differential Amplifiers, DC & AC analysis of all the four configurations.
1b	Integrated circuits	Classification of Integrated circuits –based on inputs, power supply, Temperature range, IC package type and no of active devices.
2a	Operational Amplifier	Basic block diagram of Operational Amplifier.
		Ideal and practical Op-amp, Voltage transfers Characteristics.
2b	DC & AC characteristics of operational Amplifier	DC Characteristics of Op Amp (input bias current, input offset current, input offset voltage, Thermal Drift)
		AC Characteristics of Op Amp (Slew Rate) –Simple Numerical problems
	IC 741	Pin diagram of IC 741& its specifications
		Equivalent diagram of operational amplifier.

Unit-2: Linear and Non-Linear applications of Operational Amplifier:

Inverting and Non-inverting amplifier, Integrator and differentiator, Difference amplifier, Instrumentation amplifier, AC amplifier, V to I, I to V converters, Log and Anti log Amplifiers, Precision rectifiers.

Unit	Module	Micro content
3a.	Linear and Non-linear applications of Op-amp	Inverting and Non-inverting amplifier-Simple numerical problems
		Voltage Follower, Summing Amplifier, Difference Amplifier, Simple Numerical problems.
3b	Linear and Non-linear applications of Op-amp	Ideal, Practical Integrator and ideal, partial Differentiator, Simple Numerical problems.
4a	Linear and Non-linear applications of Op-amp	Instrumentation amplifier
		AC amplifier
		V to I, I to V converters,
4b	Linear and Non-linear	Log and Anti log Amplifiers

	applications of Op-amp	Precision rectifiers
Unit-3: Active Filters, Analog Multipliers and Modulators: Design & Analysis of Butter worth active filters –1storder, 2ndorder LPF, HPF filters. Band pass, Band reject and all pass filters. Four Quadrant Multiplier, Sample & Hold circuits.		
Unit	Module	Micro content
5a.	Active Filters	Classifications of Filters
		Design procedure for 1^{st} order and 2nd order LPF simple numerical problems.
5b	Active Filters	Design procedure for 1^{st} order and 2nd order HPF, simple numerical problems.
6a	Active Filters	Design procedure for Band Pass (WBP, NBP) and Band Reject (WBR,NBR) filters - simple numerical problems
		Design of All pass filters
6b	Analog Multipliers	Sample & Hold circuits Analysis
		Analog voltage Multiplier, Analog voltage Divider Circuits analysis, Four Quadrant Multiplier.
Unit-4:Timers & Phase Locked Loops: Introduction to 555 timer, functional diagram, Monostable and Astable operations and applications, Schmitt Trigger. PLL- introduction, block schematic, Principles and description of individual blocks,565 PLL, Applications of PLL-Frequency Multiplication, frequency translation, Applications of VCO (566).		
Unit	Module	Micro content
7a.	Timers	Introduction to 555 timer, functional diagram
		Monostable multi vibrator using 555 timer and applications.
7b	Timers	Astable multi vibrator using 555 timer and applications.
		Schmitt trigger using 555 timer and applications
8a.	Phase Locked Loops	Block diagram and operation of PLL
		Terms and Derivation of Lock range, Capture Range related to PLL
		Applications of PLL(Frequency multiplier, Frequency

		translator)
8b	Phase Locked Loops	Operation of Monolithic PLL(IC 565)
		Operation of Voltage controlled Oscillator(IC 566)
		Analog and Digital Phase detectors

Unit-5: Data Converters and Applications:

Introduction, basic DAC techniques, weighted resistor DAC, R-2R ladder DAC, inverted R-2R DAC, and IC 1408 DAC, Sample and Hold circuit, Different types of ADCs - parallel comparator type ADC, counter type ADC, successive approximation ADC and dual slope ADC. DAC and ADC Specifications, illustrative problems on resolution of ADC and DAC.

Unit	Module	Micro content
9a	DAC techniques	Introduction ,Basic DAC techniques
		Weighted resistor DAC,
		R-2R ladder DAC,
9b	ADC techniques	Parallel comparator type ADC
		Successive approximation ADC
10a.	DAC techniques	Inverted R-2R DAC,
		Counter type ADC,
10b	ADC techniques	IC 1408 DAC,
		Dual slope ADC

CO-PO mapping Table

Contribution of Course Outcomes towards achievement of Program Outcomes & Strength of correlations **(High: 3, Medium: 2,Low: 1)**

Mapping	P01	P02	P03	P04	P05	P06	P07	P08	P09	P010	P011	P012	PS01	PSO2
C01	3	2											3	--
C02		3		2									2	2
C03	2	3											2	--
C04	2			3									3	2
C05	2				2								2	2

Module Coordinator **BOS** **HOD**

IV- Year I- Semester	Name of the Course	L	T	P	C
	Nano Technology (Open Elective –IV)	3	0	0	3

PRE-REQUISITES:

1. Basic knowledge on materials.

Course objectives: The student should be able

1. To have the knowledge of fundamentals of nano technology.
2. To understand different structures of nano materials.
3. To study the structures of nano carbon, nano thermal and nano semiconductor materials.
4. To have a thorough knowledge of nano sensors.
5. To study the applications of nano technology in different engineering fields.

Syllabus		
Unit No	**Contents**	**Mapped CO**
I	**Introduction and classification (12 hrs)** Summary of electronic properties of atoms and solids, effects of Nano meter length scales, fabrication methods, preparation, safety and storage issues.	**CO1**
II	**Nano Structures(12 hrs)** Importance of Nano-technology, Bottom-up and Top-down approaches, Zero Dimensional Nano-structures - Nano particles through homogenous nucleation and heterogeneous nucleation; One Dimensional Nano-structures - Nano wires and Nano rods, Spontaneous growth, Evaporation and condensation growth, Two dimensional Nano-structures - Fundamentals of film growth. Physical vapour Deposition (PVD) and Chemical Vapour Deposition (CVD):	**CO2**
III	**Carbon Nano Structures(12 hrs)** DLCs, Fullerenes, C60, C80 SWNT and MWNT; Properties: Mechanical, Optical and Electrical properties. **Thermo Electric Materials** Concept of phonon, Thermal conductivity, Specific heat, Exothermic & Endothermic processes. **Nano Semiconductors**: Nano scale electronic devices including CMOS, Potentiometric sensors etc., MRAM devices	**CO3**
IV	**Nano sensors(12 hrs)** Introduction to sensors. Characteristics and terminology - Fundamentals of sensors, Sensors for aerospace and defense. Organic and inorganic Nano sensors. Sensor for bio-medical applications, Bioelectronics, Nanoparticle-biomaterial hybrid systems for sensing applications. Gas sensor. Biosensors: Principles, DNA and nucleotide-based biosensors, Protein-based biosensors,	**CO4**

V	**Application of Nanotechnology(12 hrs)** Consumer goods, Cosmetics, Nano catalyst, paints, food and agriculture industries, Nanotechnology for waste reduction and improved energy efficiency, nanotechnology based water treatment strategies. Nano-toxicology. Use of Nano-particles for environmental remediation and water treatment.	**CO5**

Course Outcomes	
Upon successful completion of the course, the student will be able to	
CO1	Know the fundamentals, properties and fabrication methods of Nano components
CO2	Know the structures of zero, one and two dimensional Nano components
CO3	Know the structures of carbon, thermal and semiconductor materials
CO4	Have the knowledge of Nano sensors and their applications
CO5	Apply the Nano technology in different engineering and other fields.

Learning Resources

Text books:

1. Encyclopedia of Nanotechnology- Hari Singh Nalwa
2. Introduction to Nano technology by Charles P. Poole Jr and Frank J. Owens, Wiley-Inter science, 2003

Reference books

1. Springer Handbook of Nanotechnology - Bharat Bhusan
2. Handbook of Semiconductor Nanostructures and NanodevicesVol 1-5- A. A. Balandin, K. L. Wang.
3. Nanostructures and Nanomaterials - Synthesis, Properties and Applications - Cao, Guozhong.

Micro Syllabus

Unit 1: Introduction and classification(12 hrs)

Summary of electronic properties of atoms and solids, effects of Nano meter length scales, fabrication methods, preparation, safety and storage issues.

Unit No	Module	Micro content
1.	**Introduction and classification**	Summary of electronic properties of atoms and solids,
		Effects of nano meter length scales
		Introduction to fabrication methods,
		Preparation of nano materials
		Safety and storage issues related to nano technology
		Summary of electronic properties of atoms and solids,
		Effects of nano meter length scales
		Introduction to fabrication methods,
		Preparation of nano materials
		Safety and storage issues related to nano technology

Unit-2: Nano Structures(12 hrs)

Importance of Nano-technology, Bottom-up and Top-down approaches, Zero Dimensional Nano-structures - Nano particles through homogenous nucleation and heterogeneous nucleation; One

Dimensional Nano-structures - Nano wires and Nano rods, Spontaneous growth, Evaporation and condensation growth, Two dimensional Nano-structures - Fundamentals of film growth. Physical vapour Deposition (PVD) and Chemical Vapour Deposition (CVD):		
Unit No	**Module**	**Micro content**
2.	Introduction	Importance of Nano-technology
		Bottom-up and Top-down approaches
	Zero Dimensional Nano-structures	Nano particles through homogenous nucleation and heterogeneous nucleation;
	One Dimensional Nano-structures	Nano wires and nano rods, Spontaneous growth, Evaporation and condensation growth,
	Two dimensional nano-structures	Fundamentals of film growth, Physical vapour Deposition (PVD) and Chemical Vapour Deposition (CVD)
Unit-3: Carbon Nano Structures(12 hrs) DLCs, Fullerenes, C60, C80 SWNT and MWNT; Properties: Mechanical, Optical and Electrical properties. **Thermo Electric Materials** Concept of phonon, Thermal conductivity, Specific heat, Exothermic & Endothermic processes. **Nano Semiconductors**: Nano scale electronic devices including CMOS, Potentiometric sensors etc., MRAM devices		
Unit No	**Module**	**Micro content**
3.	**Carbon Nano Structures**:	DLCs, Fullerenes, C_{60}, C_{80} SWNT and MWNT; Properties: Mechanical, Optical and Electrical properties.
	Thermo Electric Materials:	Concept of phonon, Thermal conductivity, Specific heat, Exothermic & Endothermic processes.
	Nano Semiconductors	Nanoscale electronic devices including CMOS, Potentiometric sensors and MRAM devices
Unit-4: Nano sensors(12 hrs) Introduction to sensors. Characteristics and terminology - Fundamentals of sensors, Sensors for aerospace and defense. Organic and inorganic Nano sensors. Sensor for bio-medical applications, Bioelectronics, Nanoparticle-biomaterial hybrid systems for sensing applications. Gas sensor. Biosensors: Principles, DNA and nucleotide-based biosensors, Protein-based biosensors.		
Unit No	**Module**	**Micro content**
4.a.	Sensors	Introduction to sensors
		Characteristics and terminology - Fundamentals of sensors, Sensors for aerospace and defense Organic and inorganic nanosensors

		Sensor for bio-medical applications, Bioelectronics, Nanoparticle-biomaterial hybrid systems for sensing applications,
	Sensors	Gas sensor
		Biosensors: Principles, DNA and nucleotide-based biosensors, Protein-based biosensors.

Unit-5: Application of Nanotechnology(12 hrs)

Consumer goods, Cosmetics, Nano catalyst, paints, food and agriculture industries, Nanotechnology for waste reduction and improved energy efficiency, nanotechnology based water treatment strategies. Nano-toxicology. Use of Nano-particles for environmental remediation and water treatment.

Unit No	Module	Micro content
5.a	Application of Nanotechnology	Consumer goods, Cosmetics, Nano catalyst, paints, food and agriculture industries,
		Nanotechnology for waste reduction and improved energy efficiency,
		Nanotechnology based water treatment strategies.
		Nano-toxicology
		Use of Nano-particles for environmental remediation and water treatment
		Consumer goods, Cosmetics, Nano catalyst, paints, food and agriculture industries,
5.b	Application of Nanotechnology	Nanotechnology for waste reduction and improved energy efficiency,
		Nanotechnology based water treatment strategies.
		Nano-toxicology
		Use of Nano-particles for environmental remediation and water treatment
		Nanotechnology for waste reduction and improved energy efficiency,

CO-PO mapping Table

Contribution of Course Outcomes towards achievement of Program Outcomes & Strength of correlations **(High: 3, Medium: 2,Low: 1)**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO-1	PSO-2
CO1	3	1	3	2	3	2	1	0	0	1	0	2	3	2
CO2	3	1	3	2	3	2	1	0	0	1	0	2	3	2
CO3	3	1	3	2	3	2	1	0	0	1	0	2	3	2
CO4	3	1	3	2	3	2	1	0	0	1	0	2	3	2
CO5	3	1	3	2	3	3	3	0	0	1	0	2	3	2

Module Coordinator **BOS** **HOD**

IV- Year I- Semester	Name of the Course	L	T	P	C
	Digital Signal Processing (Open Elective IV)	3	0	0	3

PRE-REQUISITES: 1) Signals & Systems
2) Mathematics,
3) Concept of Communications

Course objectives: The student should be able to

1. Analyze the Discrete Time Signals and Systems
2. Know the importance of FFT algorithm for computation of Discrete Fourier Transform
3. Learn the FIR and IIR Filter design procedures
4. Able to realize the digital filters with different structures
5. Know the need of Multirate Processing & Learn the concepts of DSP Processors

Syllabus		
Unit No	**Contents**	**Mapped CO**
I	**Introduction to Discrete Time Signals & Systems. (12 Hrs.)** Introduction to Digital Signal Processing, Discrete time Signals, Signal Processing, Discrete time Systems, Linear Shift Invariant Systems, Condition for Stability. Linear Constant Coefficient Difference Equations, Discrete Time Fourier Transformation and its Properties, Linear Convolution, Review of Z-Transforms –Solutions of Difference Equations using Z-Transforms, Stability Criteria in Z-Transform	**CO1**
II	**DFT & FFT (14 Hrs.)** DFS, Properties of DFS, DFT, Properties of DFT, DFT as Linear Transformation, Circular Convolution, Sectional Convolution-Overlap Add and Overlap Save Methods , Linear Convolution using Circular Convolution. Introduction to FFT, Efficient Computation of DFT, Radix-2 Algorithms- Decimation in Time and Decimation in Frequency Algorithms, Inverse DFT using FFT .	**CO2**
III	**Design And Realization of IIR filters (12Hrs.)** Introduction to Digital Filters, Analog Filter Approximations-Butterworth &Chebyshev, Digital IIR Filters Design from Analog filters, Analog and Digital frequency transformations. Basic structures of IIR systems, Transposed forms	**CO3**
IV	**Design And Realization of FIR filters (14 Hrs.)** Introduction to FIR Filters, Characteristics of FIR Filters, Frequency Response, Design of FIR Filters- Fourier Series Method , Frequency Sampling method and Window Method. Basic structures of FIR systems, Lattice structures, Lattice-ladder structures.	**CO4**
V	**Multirate Digital Signal Processing & Introduction to DSP processors (12 Hrs.)** Introduction, Down Sampling, Decimation, Spectrum of Down Sampling, Up Sampling, Interpolation, Spectrum of Up Sampling, Cascading Sample Rate Converters, Sampling	**CO5**

	Rate Conversion, Applications of Multirate DSP. **(6 Hrs.)** Introduction to DSP processors, Basic architecture of TMS320 6713 DSP processor, Applications of DSP processors - Detection of QRS complex of ECG signals, Generation and detection of DTMF signals, Speech compression using Linear Predictive Coding. **(6 Hrs.)**	

Content Beyond the syllabus:
Discrete Cosine Transformation: Formulas for Discrete Cosine and Inverse Discrete Cosine Transformation, Properties and Applications.
Speech Processing Technologies: How to develop speech processing algorithms
Medical Applications of Digital Signal Processing.

Course Outcomes	
Upon successful completion of the course, the student will be able to	
CO1	**Analyze** the Discrete Time Signals and Systems & Apply the difference equations concept in the analysis of Discrete time systems. **{Apply level, KL1,3}**
CO2	**Know** the importance of FFT algorithm for computation of Discrete Fourier Transform &**Use** the FFT algorithm for **solving** the DFT of a given signal**{Apply level, KL1,2}**
CO3	**Design** a Digital filter (FIR&IIR) from the given specifications **{Analyze level, KL6}**
CO4	**Realize** the digital filters. **{Evaluate level, KL5}**
CO5	**Compare** different types of Multirate Processing and **Understand**the concepts of DSP Processors. **{Apply level, KL1,4}**

Learning Resources

Text books:

1. Digital Signal Processing, Principles, Algorithms, and Applications: John G. Proakis, Dimitris
2. G.Manolakis,Pearson Education / PHI, 2007..
3. Discrete Time Signal Processing – A.V.Oppenheim and R.W. Schaffer, PHI Private Limited.
4. Digital Signal Processors – Architecture, Programming and Applications,, B.Venkataramani, M.Bhaskar, TATA McGraw Hill, 2002
5. Digital Signal Processing – K Raja Rajeswari, I.K. International Publishing House

Reference books:

1. Digital Signal Processing: Andreas Antoniou, TATA McGraw Hill , 2006.
2. Digital Signal Processing: MH Hayes, Schaum's Outlines, TATA Mc-Graw Hill, 2007..
3. Digital Signal Processing – Ramesh babu, Sci Tech publications
4. Digital Signal Processing – Alan V. Oppenheim, Ronald W. Schafer, PHI Ed., 2006

Micro-Syllabus

Introduction to Discrete Time Signals & Systems.
Introduction to Digital Signal Processing, Discrete time Signals, Signal Processing, Discrete time Systems, Linear Shift Invariant Systems, Condition for Stability. Linear Constant Coefficient Difference Equations, Discrete Time Fourier Transformation and its Properties, Linear Convolution, Review of Z-Transforms –Solutions of Difference Equations using Z-Transforms, Stability Criteria in Z-Transform.

Unit No	Module	Micro content
1. Discrete Time Signals and Systems	**Signals, System and Processing**	DSP Introduction , Difference between ASP & DSP, Block diagram of DSP, Advantages , Drawbacks and Applications
		Basic discrete time signals , classification of DT signals , Problems
		Time scaling time reversal , time shifting , addition and multiplication etc
		Classification of systems and problems related
		Solutions of Difference Equations , natural response , forced response and total response
	Transformations	Fourier transform and its inverse , properties , Frequency response
		Matrix method , table method and graph method
		Review of Z-Transforms, relation between Z and DTFT
		Solutions using Z-Transform
		Stability criteria , Poles and Zeroes

DFT & FFT

DFS, Properties of DFS, DFT, Properties of DFT, DFT as Linear Transformation, Circular Convolution, Sectional Convolution-Overlap Add and Overlap Save Methods , Linear Convolution using Circular Convolution.

Introduction to FFT, Efficient Computation of DFT, Radix-2 Algorithms- Decimation in Time and Decimation in Frequency Algorithms, Inverse DFT using FFT .

Unit No	Module	Micro content
2a. DFT	**DFS**	DFS and properties of DFS
	DFT	Introduction , Properties , relation with Z, DTFT
		DFT as Linear Transformation
	Circular Convolution	Types , Problems
	Sectional Convolution	Overlap Add and Overlap Save method
		Linear convolution using circles and matrix method
2b. FFT	**Fast Fourier Transformation**	Introduction , Diff. between DFT and FFT
		Derivation of DIT and DIF, Problems
		Inverse using Radix 2 DIT and DIF

Design And Realization of IIR filters

Introduction to Digital Filters, Analog Filter Approximations-Butterworth & Chebyshev, Digital IIR Filters Design from Analog filters, Analog and Digital frequency transformations. Basic structures of IIR systems, Transposed forms

Unit No	Module	Micro content
3a. IIR Design	**Introduction**	Comparison between analog and digital filters.

		Frequency response characteristics
	Analog Filter Approximations	Butterworth filter, steps to find transfer function , problems
		Chebyshev filter, steps to find transfer function , problems
	Digital IIR Filters Design	Mapping techniques , design examples of Impulse Invariant Transformation Method
		Design examples of Bilinear Transformation Method
3b. IIR Realization	**Types of Structures**	Direct form I and II realizations , Transposed forms
		Cascade and Parallel form realizations

Design And Realization of FIR filters

Introduction to FIR Filters, Characteristics of FIR Filters, Frequency Response, Design of FIR Filters-Fourier Series Method , Frequency Sampling method and Window Method. Basic structures of FIR systems, Lattice structures, Lattice-ladder structures.

Unit No	Module	Micro content
4a. FIR Design	**Introduction and Characteristics of FIR Filters**	Introduction to FIR Filters
		Characteristics of FIR Filters, Comparison of IIR & FIR filters
	Frequency Response of FIR filters	Symmetric & N Even, Symmetric & N Odd, Asymmetric& N Even, Asymmetric& N Odd
	Design of FIR Filters	Fourier Series Method
		Window Method
		Frequency Sampling method
4b. FIR Realization	**Structures**	Direct form, cascade form, Linear phase realizations
		Lattice structure
		Lattice-Ladder structure
		Comparison between DC and AC distribution systems.

Unit-5:Multirate Digital Signal Processing & Introduction to DSP processors

Introduction, Down Sampling, Decimation, Spectrum of Down Sampling, Up Sampling, Interpolation, Spectrum of Up Sampling, Cascading Sample Rate Converters, Sampling Rate Conversion, Applications of Multirate DSP.

Introduction to DSP processors, Basic architecture of TMS320 6713 DSP processor, Applications of DSP processors - Detection of QRS complex of ECG signals, Generation and detection of DTMF signals, Speech compression using Linear Predictive Coding.

Unit No	Module	Micro content

5a. Multirate Digital Signal Processing	**Introduction**	Multirate DSP Definition and examples
	Decimation	Down sampling and Decimation
		Frequency Spectrum of Decimation
	Interpolation	Up Sampling and Interpolation
		Spectrum of Up Sampling
	Cascading Sample Rate Converters	Cascading procedure with examples
	Sampling Rate Conversion	Sampling rate conversion procedure with block diagrams
	Applications of Multirate DSP	Advantages and Applications
5b. DSP processors	**Introduction to DSP processors**	Comparison with general purpose microprocessors and advantages
	Basic architecture of TMS320 6713 DSP processor	Basic architecture of TMS320 6713 DSP processor
	Applications of DSP processors	Applications of DSP processors, Detection of QRS complex of ECG signals, Generation and detection of DTMF signals, Speech compression using Linear Predictive Coding

CO-PO mapping Table

Contribution of Course Outcomes towards achievement of Program Outcomes & Strength of correlations **(High: 3, Medium: 2, Low: 1)**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO-1	PSO-2
CO1	3		2				2							
CO2	3		1				1						1	
CO3	3		2				1							
CO4	3		2				1							1
CO5	3		1				1							1

Module Coordinator **BOS** **HOD**

IV- Year I- Semester	Name of the Course	L	T	P	C
SAC4101	**POWER BI** (Skill Advanced Course-2)	1	0	2	2

PRE-REQUISITES: Prior knowledge of Excel and SQL.

Preamble: The Skill Advanced course -Power business intelligence (BI)is a course about the new paradigm of objects interacting with business intelligence, with information systems, and with other objects. The course will focus on creative dash boards, DAX commands, Services, Apps and on hands-on project development.

Course objectives: The main objectives are

1. Understand Power BI Desktop layouts, BI reports and relationships in your data model and learn data visualization.
2. Apply transformations and Prepare data for analysis.
3. Analyse the Reports in Power BI Using DAX commands and functions.
4. Evaluate the results generated in the Reports.
5. Implementing Power Apps for Mobile and Tablet.

Syllabus		
Unit No	**Contents**	**Mapped CO**
I	**Introduction to Power BI (12 hrs)** Concept and significance of Power BI, Power BI Installation, Components of Power BI-Power BI Desktop, Power BI Services and Power BI App, Comparisons of Power BI Desktop and Power BI Services, Power BI Architecture, Sample Reports and Visualization Controls and Report Properties. Canvas, Visualizations, Get Data, Power BI Model, Filters: Page Filters, Report Filters, Visualization Filters. Hierarchies, Drilldown, Drill -through.	**CO1**
II	**Power Query:(Tables matrices)(10hrs)** Power Query Architecture and Extract Transform Load(ETL), Data Types, Table & Column Transformations, Text & Number Transformations, Replace Nulls: Fill Up, Fill Down, PIVOT, UNPIVOT Transformations, Move Column and Split Column, Merge and Append Transformations, Date: Deriving Year, Quarter, Month, Day Transformations.	**CO2**
III	**Data Analysis eXpressions (DAX)(10 hrs)** Introducing DAX, Understanding DAX Calculations, DAX Functions: Aggregation functions, Logical functions, Mathematical function, Trigonometric functions, Date and time functions, Relational functions, Time intelligence functions.	**CO3**
IV	**Power BI Service(10hrs)** Introduction to Power BI Services, Report Publish Options and Verifications, Working with Power BI Cloud Interface & Options, Navigation Paths with “My Workspace”	**CO4**

	Screens, FILE, VIEW, EDIT, REPORTS, ACCESS, DRILLDOWN, Saving Reports into pdf, pptx, etc. Report Embed.	
V	**Power BI Apps(8hrs)** Introduction, Environment Setup, Basic PowerApps Concepts, Beginner Canvas Apps.	**CO5**

List of Experiments:

1. Grouping the different types of Common charts with power BI
2. Grouping the specific charts / Visuals with power BI
3. (a) How to fill gaps in source data in power BI
   (b) How to SPLIT column data in Power BI
4. (a) Transform excel data using power query.
   (b) How to transform date to week number
5. (a) How to join tables/ Merge tables using power query.
   (b) How to find AGE from birthdates column using power query.
6. (a) Write a program calculated column /Measure in power BI
   (b) Write a program ROW context/Filter context in DAX
7. (a) Write a program SUM,SUMX in DAX
   (b) Write a program Time intelligence function MTD/QTD/YTD in DAX
8. Experimenting to view power BI reports in (mobile/Tabs) devices.
9. Experimenting to EMBED power BI reports in webpage
10. Create an APPS in power BI services

Course Outcomes	
Upon successful completion of the course, the student will be able to	
CO1	Understand Power BI Desktop layouts, BI reports and relationships in your data model and learn data visualization. **{understand level, KL2}**
CO2	Apply transformations and Prepare data for analysis**{Apply level, KL3}**
CO3	Analyze the reports in Power BI Using DAX commands and functions.**{ Analyze level, KL4}**
CO4	Evaluate the results generated in the Reports. **{ Evaluate level, KL5}**
CO5	Implementing Power Apps for Mobile and Tablet**{Apply level, KL3}**

Learning Resources

Text books:

1. Collect, Combine, and Transform Data Using Power Query in Excel and Power BI by Gil Raviv
2. The Definitive Guide to DAX: Business intelligence with Microsoft Power BI, SQL Server Analysis Services, and Excel by Marco Russo and Alberto Ferrari
3. Microsoft Power BI documentation Original pdf
4. Mastering Microsoft Power Bi: Expert techniques for effective data analytics and business intelligence. Brett Powell.

Reference books:

1. Microsoft Power BI Quick Start Guide: Bring your data to life through data modelling, visualization, digital storytelling, and more, 2nd Edition. Devin Knight.
2. Analyzing Data with Microsoft Power BI and Power Pivot for Excel by Alberto Ferrari and Marco Russo
3. Power BI labs by b-concepts consulting services
4. DAX Cookbook by Greg Deckler

e- Resources & other digital material

1. https://docs.microsoft.com/en-us/power-bi/
2. https://www.youtube.com/c/AnalyticswithNags/playlists?view=50&sort=dd&shelf_id=3
3. https://www.youtube.com/@AnalyticswithNags/playlists

Micro-Syllabus

Unit-1:Introduction to Power BI (12 hrs)

Concept and significance of Power BI, Power BI Installation, Components of Power BI-Power BI Desktop, Power BI Services and Power BI App, Comparisons of Power BI Desktop and Power BI Services, Power BI Architecture, Sample Reports and Visualization Controls and Report Properties. Canvas, Visualizations, Get Data, Power BI Model, Filters: Page Filters, Report Filters, Visualization Filters. Hierarchies, Drilldown, Drill -through.

Unit No	Module	Micro content
1.a .Introduction to Power BI	Introduction to Power BI	Concept and significance of Power BI
		Power BI Installation.
		Components of Power BI-Power BI Desktop, Power BI Services and Power BI App
		Comparisons of Power BI Desktop and Power BI Services
		Power BI Architecture
1.b .Power BI Visualization	Charts/Visuals and Filters	Sample Reports and Visualization Controls and Report Properties
		Canvas, Visualizations, Get Data, Power BI Model
		Filters: Page Filters, Report Filters, Visualization Filters. Hierarchies, Drilldown, Drill -through.

Unit-2:PowerQuery:(Tablesmatrices) (10hrs)

Power Query Architecture and Extract Transform Load(ETL), Data Types, Table & Column Transformations, Text & Number Transformations, Replace Nulls: Fill Up, Fill Down, PIVOT, UNPIVOT Transformations, Move Column and Split Column, Merge and Append Transformations, Date: Deriving Year, Quarter, Month, Day Transformations.

Unit No	Module	Micro content
2.a.Power Query Transforms	Transformations	Power Query Architecture and Extract Transform Load(ETL)
		Data Types, Table & Column Transformations,
		Text & Number Transformations
		PIVOT, UNPIVOT Transformations

		Merge and Append Transformations
2.b. Power query columns	Power query columns	Replace Nulls: Fill Up, Fill Down
		Move Column and Split Column
		Date: Deriving Year, Quarter, Month, Day Transformations
Unit-3: Data Analysis eXpressions (DAX)(10 hrs) Introducing DAX, Understanding DAX Calculations, DAX Functions: Aggregation functions, Logical functions, Mathematical function, Trigonometric functions, Date and time functions, Relational functions, Time intelligence functions.		
Unit No	**Module**	**Micro content**
3.a.Introduction to DAX	DAX	Introducing DAX
		Understanding DAX Calculations
3.b.Challenges in DAX	DAX functions	Aggregation functions, Logical functions
		Mathematical function, Trigonometric functions.
		Date and time functions
		Relational functions and Time intelligence functions.
Unit-4: Power BI Service(10hrs)) Introduction to Power BI Services, Report Publish Options and Verifications, Working with Power BI Cloud Interface & Options, Navigation Paths with “My Workspace” Screens, FILE, VIEW, EDIT, REPORTS, ACCESS, DRILLDOWN, Saving Reports into pdf, pptx, etc. Report Embed.		
Unit No	**Module**	**Micro content**
4.a.Introduction to Power BI service	Reports in workspace	Introduction to Power BI Services
		Report Publish Options and Verifications
		Working with Power BI Cloud Interface & Options
		Navigation Paths with “My Workspace” Screens
		FILE, VIEW, EDIT, REPORTS, ACCESS, DRILLDOWN
4.b .Power BI Reports	Saving reports	Saving Reports into pdf, pptx, etc
		Report Embed
Unit-5: Power BI Apps(8hrs) Introduction, Environment Setup, Basic Power Apps Concepts, Beginner Canvas Apps.		
Unit No	**Module**	**Micro content**
5.Power BI Apps	Power BI Apps	Introduction to power BI App
		Environment Setup
		Basic Power Apps Concepts
		Beginner Canvas Apps

CO-PO mapping Table

Contribution of Course Outcomes towards achievement of Program Outcomes & Strength of correlations **(High: 3, Medium: 2, Low: 1)**														
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO-1	PSO-2
CO1	2	3			3						2	2		2
CO2	2	3			3						3	2	1	
CO3	2	3			3						2	2	2	1
CO4	2	3			3						2	2		2
CO5	2	3			3						2	2	2	

Module Coordinator **BOS** **HOD**

IV- Year I- Semester	Name of the Course	L	T	P	C
SAC4101	**Amazon Web services** (Skill Advanced Course-2)	1	0	2	2

PRE-REQUISITES: Prior knowledge of Linux.

Preamble: The Skill Advanced course -Amazon Web services(AWS)is a course about the new paradigm of objects interacting with Cloud, creating an IAM User and with other objects. The course will focus on Launching instances ,different types of storages, Services, security

Course objectives: The main objectives are

1. Understand the different types of clouds.
2. Implementing the cloud storage technioques while creating an instance'
3. Creating S3 bucket with IP addresses for the storage purpose and EBS Block
4. Implementing different types of cloud monitoring instance
5. Implementing auto scaling methods for accesing website more number of users at a time.

Syllabus		
Unit No	**Contents**	**Mapped CO**
I	**Introduction toCLOUD: (12 hrs)** Concept and significance ofcloud computing, how to access aws website and creating credentials to access web site,different services of aws cloud , comparison of difffernt clouds,Public cloud,private cloud ,hybrid cloud,know the basic commands of linux,creating a EC2-instance in AWS CLOUD,Understanding Identity Access management,and creating roles and responsibilities by IAM role	**CO1**
II	**AWS STORAGES:(10 hrs)** Know the different cloud storages, introduction to S3 Bucket, Glacier, Comparision between these storages and cost of memory usage .Amazon EFS and Amazon EBS. Entering and deleting Data into EBS,S3 bucket ,Glacier, EFS. Maintaining Back-up in EBS. Storage of Screen shots in EBS.	**CO2**
III	**EBS AND S3 BUCKET:(10 hrs)** Create EBS volumes, Deleting EBS volumes, attach and detach EBS Volume with EC2 instance. understanding S3 bucket durability and sustainability, introduction to S3 bucket,S3 transfer acceleration,How S3 uploading works and how to Download.how to give S3 Permissions.	**CO3**
IV	**AWS SECURITY MANAGEMENT:(10hrs)** Importance AWS shared responsibilities and securities, introduction to cloud watch, CLOUD trail, knowledge on cloud watch a monitor service, How to perform setting	**CO4**

	threshold and configuring actions, creating cloud watch alarm, monitoring other AWS services, configuring Notifications	
V	**Auto scaling and load balancing:(8 hrs)** Introduction to VPC, VPC advantage.. introduction to AUTO SCALING and load balancer techniques.Introduction to Scaling,ELB(Elastic Load Balancer),Components and types of load balancing,Dynamic Scaling,The lifecycle of autoscaling,Policies of autoscaling	**CO5**

List of Experiments:

1. How to create IAM USER
2. Launch the AWS instance by using putty
3. Launch the AWS instance by using Mobaxterm
4. Creating a S3 Bucket in cloud .
5. Importing and Exporting Data
    a. a)S3 BUCKET
    b. b)GLACIER
6. Configuring BACK-UP in RDS manager
7. Configuring VPC network in AWS CLOUD.
8. Creating EBS Volumes in EC2 Instance.
9. Entering and Deleting snapshots in EBS Volumes.
10. How to monitor the instance in cloud.
11. How to Auto scale the instance In CLOUD
12. How to give permissions to the user

Course Outcomes	
Upon successful completion of the course, the student will be able to	
CO1	Know the different types of cloud. **{understand level, KL1}**
CO2	Implementing the cloud storage techniques while creating an instance'**{Apply level, KL3}**
CO3	Creating S3 bucket with IP addresses for the storage purpose and EBS Block.**{ Analyze level, KL5}**
CO4	Implementing different types of cloud monitoring instance. **{ Evaluate level, KL5}**
CO5	Implementing auto scaling methods for accesing website more number of users at a time. **{ Evaluate level, KL5}**

Learning Resources

Text books:

1. cloud computing for dummies for the authors Judith S. Hurwitz and Daniel Kirsch, who wrote this second edition .
2. AWS: The Complete Beginner's Guide authorized bi Stephen baron.
3. Cloud Computing: Concepts, Technology & Architecture by ERL THOMAS
4. Explain the Cloud Like I'm 10 by TODD HOFF
5. Amazon Web Services in action by Andreas Wittig and Michael Wittig are the authors

Reference books:
1. Start Amazon Web Services by cloud GURUS **2. AWS The Ultimate Guide From Beginners To Advanced For The Amazon Web Services Theo H. King** **3. AWS Cookbook: Recipes for Success on AWS by Shroff/O'Reilly.**
e- Resources & other digital material
1. https://youtu.be/eykIMY1zsrA
2.https://youtu.be/yv4YIVNfAb0
3 .https://youtu.be/RCFwxgPxh-E

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IV- Year I- Semester	Name of the Course	L	T	P	C
	ETAP Software (Skill Oriented Course)	1	0	2	2

PRE-REQUISITES: 1) Power system Analysis ,

Course objectives: The student should be able to

1. Study the various parameters in ETAP Software.
2. Perform the load flow analysis of power system.
3. Perform the short circuit analysis of power system
4. Analyse the transient stability of power system
5. study the coordination protective devices in power system

Syllabus		
Unit No	**Contents**	**Mapped CO**
I	**Introduction: (4hrs)** Modelling, programming features one diagram features presentations, ETAP Wizard , study wizard, project wizard, Libraries	**CO1**
II	**Load Flow Analysis (4 hrs):** Load Flow Example ,Multi Generator Load Sharing, Load List & Transformer Sizing	**CO2**
III	**Short Circuit Analysis & Harmonics(4 hrs)** SC General Notes , IEC-60909 Short Circuit study ,IEC-61363 Short Circuit study, Harmonic Analysis	**CO3**
IV	**Transient stability Analysis (4 hrs)** Introduction to Transient stability, Creating single line diagram, Analysis of transient stability, Generator transient stability , Motor Transient Stability	**CO4**
V	**Protective Device Coordination (4 hrs)** Star-Relay Co-ordination Example ,Auto Evaluation, Multi Parallel Sources Co-ordination ,Voltage Dependent Relay Co-ordination ,Ring Main Co-ordination , Distance Protection	**CO5**

List of Experiments :

1. Creating New Project file and Single line diagram
2. Load flow analysis of Power System
3. Short Circuit study of IEC-60909
4. Short Circuit study of IEC-61363
5. Harmonic Analysis
6. Generator Transient stability Analysis
7. Power system Transient stability Analysis
8. Study the Protective device coordination

Course Outcomes	
Upon successful completion of the course, the student will be able to	
CO1	**Understand** the various parameters of ETAP software **{Understand level, KL2}**
CO2	**Analyse**the perform of the power system with load flow analysis**{Analyze level, KL3}**
CO3	**Analyze** the performance of power system with short circuit studies **{Analyze level, KL3}**
CO4	**Analyze** Transient stability of power system **{Analyze level, KL3}**
CO5	**Understand** the coordination of protective devices in power system**{Understand level, KL2}**

Learning Resources
Text books:
1. ETAP 115 pages workshop notes 2. ETAP 14.0.0 Demo getting started.
e- Resources & other digital material
1. https://www.udemy.com/course/practical-etab/?
2. https://www.udemy.com/etap/online-course
3. https://www.youtube.com/watch?v=jWS0vpVhnb0

CO-PO mapping Table

Contribution of Course Outcomes towards achievement of Program Outcomes & Strength of correlations **(High: 3, Medium: 2, Low: 1)**														
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO-1	PSO-2
CO1	1											1		1
CO2			1	1									1	
CO3			1	1									1	
CO4			1	1									1	
CO5			1	1									1	

Module Coordinator **BOS** **HOD**

IV- Year I- Semester	Name of the Course	L	T	P	C
	ENTREPRENEURIAL SKILL DEVELOPMENT (Mandatory Course)	2	0	0	0

Prerequisites: Basic Sciences and Humanities

Course Objective:

1. To provide an intensive & in-depth learning to the students in field of entrepreneurship.
2. To encourage students to opt for self-employment as an alternative career option.
3. To enable students to appreciate the dynamic changes happening in the economy.
4. To acquaint the students about the role of Entrepreneurship in the growth and economic development of the nation.
5. To analyze the role of government and non government institutions in supporting entrepreneurial activities.

Course Outcomes:

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

CO 1: The basics of entrepreneurship skills for better understanding of the scenario of Entrepreneurial activity in India.

CO 2: Understand the basic plan and the various components of business plan.

CO 3: Understand the role of entrepreneurs as problem solvers and the various marketing strategies used in a business.

CO 4: Understand the concept of growth & development of an enterprise and to identify entrepreneurial opportunities for women and analyze Entrepreneurship development in rural area.

CO 5: Understand government role supporting entrepreneurship.

Unit 1:

Entrepreneurship and Entrepreneurial opportunity: 12Hrs

Entrepreneurship – Concept, Advantage and Limitations of Entrepreneurship -Myths about Entrepreneurship -Why Entrepreneurship -Functions and Need of Entrepreneurship Types of Entrepreneurs- Why be an Entrepreneur- –Process of Entrepreneurship- Entrepreneurship-Indian Scenario. Intrapreneur: Meaning and Importance.

Sensing Entrepreneurial Opportunities, Environment Scanning, Problem Identification, Idea fields, Spotting Trends, Creativity and Innovation, Selecting the Right Opportunity.

Unit 2

Entrepreneurship Journey & Entrepreneur Planning: 12 Hrs

Feasibility Study and opportunity-Idea generation -Business Plan: meaning, purpose and elements, Business Plan: concept, Execution of Business Plan.

Components: Organizational plan; Operational plan; Production plan; Financial plan; Marketing plan; Human Resource planning.

Unit 3

Entrepreneurship as Innovation and Problem Solving, Enterprise Marketing: **12 Hrs**

Entrepreneurs as problem solvers , Innovations and Entrepreneurial Ventures– Global and Indian ,Role of Technology – E-commerce and Social Media, Social Entrepreneurship – Concept. Marketing and Sales Strategy, Branding, Logo, Tagline, Promotion Strategy.

Unit 4

Enterprise Growth Strategies and Women & Rural Entrepreneurship: **12 Hrs**

Mergers and Acquisition: Concept, reasons and types -Angel Investor: Features -Venture Capital: Features, funding.

Women Entrepreneurship: Meaning- need, scope, growth and problems of women entrepreneurs, Special Schemes for Women Entrepreneurs.

Rural Entrepreneurship-Meaning-Need-Scope-Problems faced by Rural Entrepreneurs-Entrepreneurship development in rural area-Special Schemes for Rural Entrepreneurs.

Unit 5

Institutions Supporting Entrepreneurship **12 Hrs**

A brief overview of financial institutions in India- Central level and state level institutions-SIDBI-NABARD-IDBI-SIDCO-Indian Institute of Entrepreneurship -DIC-Single Window-Latest Industrial Policy of Government of India.

Project work:

Option 1: Wadhwani Program by IUCEE.

Option 2: Students have to do one project in the entire academic session.

TOPICS FOR THE PROJECT:

1. Business Plan
2. Market Survey

Note: 1. Project work /IUCEE programme is not mandatory for credit course.

2. Project work /IUCEE programme is mandatory for non credit course so students should complete any one of the projects above, and attends the project review for the same.

TEXT BOOKS:

1. Entrepreneurial Development - S.S. Khanka
2. Entrepreneurial Development - Satish Taneja & Dr.S.L. Gupta
3. Entrepreneurial Development - P.C. Shejwalkar
4. Fundamental of Entrepreneurship – Dr. A.K. Gavai
5. Khanna, S. S., Entrepreneurial Development, S. Chand, New Delhi.
6. Entrepreneurship Development and Small Business Enterprises, Poornima M. Charantimath, 2e, Pearson, 2014.
7. P.Narayana Reddy, Entreprenurship, Cengage Learning, New Delhi,2010.

8. Arya Kumar: “Entrepreneurship”, Pearson, Publishing House, New Delhi, 2012.
9. VSP Rao, Kuratko: “Entrepreneurship’, Cengage Learning, New Delhi, 2011.
10. K.Ramachandran: “Entrepreneurship Development”, TMH, New Delhi, 2012.

REFERENCE BOOKS:

1. Entrepreneurship, Arya Kumar, 4 e, Pearson 2015.
2. Entrepreneurship, a South – Asian Perspective, D.F. Kuratko and T. V. Rao, 3e, Cengage, 2012.
3. The Dynamics of Entrepreneurial Development and Management, Vasant Desai, Himalaya Publishing House, 2015.
4. AnajanRai Chaudhuri, Managing new ventures, concepts and cases, Prentice Hall International, 2010.
5. Rajeev Roy: Entrepreneurship, Oxford university press, New Delhi, 2010.

Web Resources:

1. https://nptel.ac.in/courses/110105067/50
2. http://www.yourarticlelibrary.com/project-management/5-methods-of-project-appraisalexplained/40771
3. https://springhouse.in/government-schemes-every-entrepreneur/
4. http://nptel.ac.in/courses
5. https://www.tutorialspoint.com/
6. https://www.ediindia.org/
7. http://www.quickmba.com/entre/

Micro syllabus

UNIT I

Entrepreneurship and Entrepreneurial opportunity:

Entrepreneurship – Concept, Advantage and Limitations of Entrepreneurship -Myths about Entrepreneurship -Why Entrepreneurship -Functions and Need of Entrepreneurship Types of Entrepreneurs- Why be an Entrepreneur- –Process of Entrepreneurship- Entrepreneurship-Indian Scenario. Intrapreneur: Meaning and Importance.

Sensing Entrepreneurial Opportunities, Environment Scanning, Problem Identification, Idea fields, Spotting Trends, Creativity and Innovation, Selecting the Right Opportunity.

Unit	Module	
		What is Entrepreneurship?
		The concept of Entrepreneurship
		Definitions of an Entrepreneur
	Entrepreneurship	Entrepreneur versus Entrepreneurship
		Functions of an Entrepreneur
		Need for an Entrepreneurship
		Advantages and disadvantages of
	Myths about	Myths of Entrepreneurship

Unit I	Entrepreneurship	
	Process of Entrepreneurship	Process of Entrepreneurship
	An Entrepreneur	Types of Entrepreneurs
		Why be an Entrepreneur?
	Intrapreneurship	What is Intrapreneurship
		Importance, why is intraprenuer necessary?
	Entrepreneurship-Indian Scenario.	Entrepreneurship-Indian Scenario.
	Sensing Entrepreneurial Opportunities	What is a business Opportunity?
		Elements of a business opportunity.
		Exploring opportunities in the environment.
		Perceiving and sensing opportunities.
		Factors involved in sensing opportunities.
		Ability to perceive and preserve basic ideas.
		Ability to harness different sources of information.
		Vision and creativity.
	Environment Scanning	What is environmental scanning?
		Why do we need to scan environment?
		Importance of environment
		SWOT Analysis frame work
		Analysis of environment
		Environmental factors
		The PESTEL Model
	Problem Identification	Objectives of Problem Identification
		Uses of Problem Identification
		Idea generation
	Idea fields	Various sources of idea fields
		Product identification
		Transformation of ideas into opportunities
		Idea and opportunity assessment
	Spotting trends	Ways in which an entrepreneur spot trends
	Creativity and Innovation	The creative process
		Elements in the innovation process
		Selecting the right opportunity

UNIT - II

Entrepreneurship Journey & Entrepreneur Planning:

Feasibility Study and opportunity-Idea generation -Business Plan: meaning, purpose and elements, Business Plan: concept, Execution of Business Plan.

Components: Organizational plan; Operational plan; Production plan; Financial plan; Marketing

plan; Human Resource planning.		
Unit II	Feasibility Study	Definition of Feasibility Study
		Types, features
	Opportunity Assessment	Meaning of a business plan
		Preparation of a business plan
		Purpose of a business plan
		Elements of a business plan
	Business plan Execution	Keys to success and why many plans fail
		Difference between Feasibility Study and business plan
	Business plan	What is business plan?
		Factors considered business plan
		Importance of the business plan
		Formats of business plan
	Organizational plan	What is Organizational plan?
	Production plan	What is production plan?
	Operational plan	What is Operational plan?
		Elements of Operational plan
	Financial Plan	What is financial plan?
		Components of financial plan
	HR or Man power Planning	What is manpower planning
	Marketing plan	What is Marketing plan
		Steps in preparing the marketing plan.
Unit III **Entrepreneurship as Innovation and Problem Solving, Enterprise Marketing:** Entrepreneurs as problem solvers , Innovations and Entrepreneurial Ventures– Global and Indian ,Role of Technology – E-commerce and Social Media, Social Entrepreneurship – Concept. Marketing and Sales Strategy, Branding, Logo, Tagline, Promotion Strategy.		
Unit III	Entrepreneurs as problem solvers	Who is Entrepreneur? Why they are called problem solvers?
		Solving problems to meet the needs and wants of people
	Innovations and Entrepreneurial Ventures	Innovations leading to Entrepreneurial Ventures- Indian and global
	Role of Technology	Role of Technology & social media in creating new forms of business
		Role of E-commerce
	Social Entrepreneurship	What is Social Entrepreneurship?
		Who is Social Entrepreneur?

		Characteristics of Social Entrepreneurs
		What is the difference between Entrepreneurship and social Entrepreneurship
	Marketing Strategy	What is Marketing Strategy?
		What does the marketing strategy of a company include
		Components of marketing mix
	Sales Strategy	What is Sales Strategy?
		Significance, types, components
	Branding	Introduction, branding as a concept
		Various terms relating to banding
		Qualities of a good brand, entrepreneurs perspective on brand name
	Logos and Taglines	What is logo and Tagline, purpose
	Promotion Strategy	What is Promotion Strategy?
		Various approaches a company can use to promote its products 1. Above-The-Line 2. Below-The-Line 3. Through-The-Line
Unit IV **Enterprise Growth Strategies and Women & Rural Entrepreneurship:** Mergers and Acquisition: Concept, reasons and types -Angel Investor: Features -Venture Capital: Features, funding. Women Entrepreneurship: Meaning- need, scope, growth and problems of women entrepreneurs, Special Schemes for Women Entrepreneurs. Rural Entrepreneurship-Meaning-Need-Scope-Problems faced by Rural Entrepreneurs-Entrepreneurship development in rural area-Special Schemes for Rural Entrepreneurs.		
UNIT IV	Mergers and Acquisition	What is merger? types
		What is Acquisition? types
		Reasons for Mergers and Acquisition
	Angel Investors	features
	Venture capital	Features, funding
	Women Entrepreneurship	Meaning, need, scope, growth and problems of women entrepreneurs, special schemes for women entrepreneurs.
	Rural Entrepreneurship	Meaning-Need-Scope-Problems faced by Rural Entrepreneurs-Entrepreneurship development in rural area-Special Schemes for Rural Entrepreneurs.
Unit V		

Institutions Supporting Entrepreneurship A brief overview of financial institutions in India- Central level and state level institutions-SIDBI-NABARD-IDBI-SIDCO-Indian Institute of Entrepreneurship -DIC-Single Window-Latest Industrial Policy of Government of India.		
Unit V	Financial institutions in India	Overview of financial institutions in India
		Need for and importance of financial institutions in India
		Types of financial institutions- national level and state level
		Brief about SIDBI, NABARD, IDBI, SIDC, etc.
	Indian Institute of Entrepreneurship	Objectives , functions, activities
	DIC	Role, functions, activities
	Single Window	Concept, benefits
	Latest Industrial Policy of Government of India.	Objectives, various industrial policy introduced by the Indian government

Module Coordinator **BOS** **HOD**

IV- Year I- Semester	Name of the Course	L	T	P	C
	Advanced Power Converters (Honors Course)	3	0	2	4

PRE-REQUISITES: 1) Basics of Electronic Devices.
Course objectives: The student should be able to

1. Study the types of various Power factor correction converters.
2. Study the principle of Non-Isolated DC to DC Converters.
3. Understand the importance of Isolated Converters.
4. Know the Different Modulation Techniques for PWM Inverters.
5. Study the use of Multi level and Resonant Inverters.

Syllabus		
Unit No	**Contents**	**Mapped CO**
I	**Power Factor Correction Converters: (10hrs)** Single-phase single stage boost power factor corrected rectifier, power circuit principle of operation, and steady state- analysis, three phase boost PFC converter **Multi Pulse Converter:**12,18,24 Pulse converters and Phase shifting Transformer	**CO1**
II	**Non Isolated DC-DC converter:(10hrs)** Buck,Boost,Buck-Boost,Cuk,SEPIC and Zeta Converters in DCM and CCM.	**CO2**
III	**Isolated DC-DC converter:(10hrs)** Forward, Flyback, Half-Bridge, Full-Bridge, Push-Pull &Zeta Converters in DCM and CCM.	**CO3**
IV	**PWM Inverters: (8hrs)** Principle of operation-Voltage control of single-phase inverters - sinusoidal PWM – modified PWM – phase displacement Control – Trapezoidal, staircase, stepped, harmonic injection and delta modulation. Voltage Control of Three-Phase Inverters-Sinusoidal PWM- 60^0 PWM- Third Harmonic PWM- Space Vector Modulation-Comparison of PWM Techniques.	**CO4**
V	**MULTILEVEL INVERTERS:(12hrs)** Types and operation of multi level inverters – Diode clamped, Flying capacitor and cascade; Comparison of multilevel inverters. **RESONANT INVERTERS:** Types - Series and parallel resonant inverters; Voltage control of resonant inverters	**CO5**

List of Experiments :

1. Analysis of Voltage source inverter.
2. Analysis of Series resonant inverter.
3. Analysis of Parallel resonant inverter.
4. Simulation of three level three phase NPC inverter.
5. Simulation of 3-level flying capacitor inverter & evaluation of capacitor voltage balanced methods.

6. Simulation of 5-level inverter using carrier based PWM methods.

Course Outcomes	
Upon successful completion of the course, the student will be able to	
CO1	**Understand** the various forms of energy and types of energy storage system**{Understand level, KL2}**
CO2	**Analyze**the working of electro chemical energy storage system and various accumulators**{Analyze level, KL3}**
CO3	**Explain** the performance of flywheel storage mechanism **{Explain level, KL4}**
CO4	**Understand** theGeneration phenomenon of electricity from hydrogen gas and storage system**{Understand level, KL2}**
CO5	**Analyze** the working of super capacitors and its performance**{Apply level, KL4}**

Learning Resources
Text books:
1. Rashid M.H., "Power Electronics Circuits, Devices and Applications", Prentice Hall of India, 3rd edition, New Delhi, 2004. 2. Mohan, Ned. et.al, "Power Electronics Converters, Applications and Design", Wiley India Pvt. Ltd., New Delhi, 3rd edition 2007.
Reference books:
1. B. Jayant Baliga, "Fundamentals of Power Semiconductor Devices", Springer-Verlag Publication, New Delhi, 1st edition, 2008 2. Power Electronics: Converters, Applications, and Design- Ned Mohan, Tore M. Underland, William P. Robbins, John Wiley& Sons, 2nd Edition, 2003. 3. Power Converter Circuits – William Shepherd & Li Zhang-Yes Dee CRC Press, 2004.
e- Resources & other digital material
1. https://archive.nptel.ac.in/courses/108/108/108108035/
2. https://www.coursera.org/learn/magnetics-for-power-electronic-converters-v2
3. https://archive.nptel.ac.in/courses/117/108/117108124/
4. https://archive.nptel.ac.in/courses/108/102/108102157/
5. https://en.wikipedia.org/wiki/Power_inverter

Micro-Syllabus

Unit-1: Power Factor Correction Converters: (10 hrs)
Single-phase single stage boost power factor corrected rectifier, power circuit principle of operation, and steady state- analysis, three phase boost PFC converter
Multi Pulse Converter: 12,18,24 Pulse converters and Phase shifting Transformer

Unit	Module	Micro content
1a. Power Factor Correction Converters	Power Factor Correction Converters	Need for power factor correction
		Single phase PFC
		Three phase PFC
		Steady state Analysis
1b. Multi Pulse Converter	Multi Pulse Converter	Principle behind multiple pulse converter
		Need for Phase shifting transformer
		12 pulse converter
		18 & 24 Pulse converters.

Unit-2: Non Isolated DC-DC converter: (10 hrs)
Buck, Boost, Buck-Boost, Cuk, SEPIC and Zeta Converters in DCM and CCM.

Unit	Module	Micro content
2a. Operation of Non-Isolated DC-DC converter	Operation of Non-Isolated DC-DC converter	Operation of Buck converter
		Operation of Boost converter
		Operation of Buck-Boost converter
		Operation of Cuk converter
		Operation of SEPIC converter
		Operation of Zeta converter
2b. Analysis of Non-Isolated DC-DC converter	Analysis of Non-Isolated DC-DC converter	Analysis of converters in DCM
		Analysis of converters in CCM

Unit-3: Isolated DC-DC converter: (10 hrs)
Forward, Flyback, Half-Bridge, Full-Bridge, Push-Pull & Zeta Converters in DCM and CCM.

Unit	Module	Micro content
3a. Operation of Isolated DC-DC converter	Operation of Isolated DC-DC converter	Operation of Forward converter
		Operation of Flyback converter
		Operation of Half-Bridge converter
		Operation of Full-Bridge converter
		Operation of Push-Pull converter
3b. Analysis of Isolated DC-DC converter	Analysis of Isolated DC-DC converter	Analysis of converters in DCM
		Analysis of converters in CCM

Unit-4: PWM Inverters: (8 hrs)

Principle of operation-Voltage control of single-phase inverters - sinusoidal PWM – modified PWM – phase displacement Control – Trapezoidal, staircase, stepped, harmonic injection and delta modulation. Voltage Control of Three-Phase Inverters- Sinusoidal PWM- 60^0 PWM- Third Harmonic PWM- Space Vector Modulation- Comparison of PWM Techniques.

Unit	Module	Micro content
4a. Voltage control of single-phase inverters	Voltage control of single-phase inverters	Sinusoidal PWM control
		Modified PWM control
		phase displacement Control
		Trapezoidal, staircase, stepped, harmonic injection and delta modulation
4b. Voltage control of Three-phase inverters	Voltage control of Three-phase inverters	Sinusoidal PWM
		60^0 PWM
		Third Harmonic PWM
		Space Vector Modulation
		Comparison of PWM Techniques

Unit-5: MULTILEVEL INVERTERS:(12 hrs)

Types and operation of multi level inverters – Diode clamped, Flying capacitor and cascaded; Comparison of multilevel inverters.

RESONANT INVERTERS: Types - Series and parallel resonant inverters; Voltage control of resonant inverters

Unit	Module	Micro content
5a. Multilevel Inverters	Multilevel Inverters	Need for Multi level inverter
		Diode clampedmultilevel inverters.
		Flying capacitormultilevel inverters.
		Cascadedmultilevel inverters.
		Comparison of multilevel inverters.
5b. Resonant Inverters	Resonant Inverters	Principle of Resonant inverter
		Series resonant inverters
		Parallel resonant inverters
		Voltage control of resonant inverters

CO-PO mapping Table with Justification

Contribution of Course Outcomes towards achievement of Program Outcomes & Strength of correlations **(High: 3, Medium: 2, Low: 1)**														
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO-1	PSO-2
CO1	2											1		1
CO2	1													
CO3	2													
CO4	1			2										
CO5	2			2									2	

Module Coordinator **BOS** **HOD**

IV- Year I- Semester	Name of the Course	L	T	P	C
	Hybrid Electrical Vehicle (Honors Course)	3	0	2	4

PRE-REQUISITES: 1) Electrical circuit analysis, Electrical Machines, Engineering Mathematics

Course objectives: The student should be able

1. To familiarize the students with the need and advantages of electric and hybrid electric vehicles.
2. To know various architectures of hybrid electric vehicles.
3. To understand the power management of plug in electric vehicles.
4. To study and understand different power converters used in electrical vehicles.
5. To familiarize with different batteries and other storage systems.

Syllabus		
Unit No	**Contents**	**Mapped CO**
I	**Introduction: (10Hrs)** Fundamentals of vehicle - components of conventional vehicle and propulsion load; Drive cycles and drive terrain; Concept of electric vehicle and hybrid electric vehicle; History of hybrid vehicles - advantages and applications of Electric and Hybrid Electric Vehicles.	**CO1**
II	**Hybridization of Automobile : (10 Hrs)** Architectures of HEVs - series and parallel HEVs - complex HEVs. Plug-in hybrid vehicle(PHEV) - constituents of PHEV - comparison of HEV and PHEV; Extended range hybrid electric vehicles(EREVs) - blended PHEVs - Fuel Cell vehicles and its constituents.	**CO2**
III	**Special Machines for EV and HEVs : (10 Hrs)** Characteristics of traction drive - requirement of electric motors for EV/HEVs. Induction Motor drives - their control and applications in EV/HEVs. Permanent magnet Synchronous motor: configuration - control and applications in EV/HEVs. Brushless DC Motors: Advantages - control of application in EV/HEVs. Switch reluctance motors: Merits limitations - converter configuration - control of SRM for EV/HEVs.	**CO3**
IV	**Power Electronics in HEVs : (12Hrs)** Boost and Buck-Boost converters - Multi Quadrant DC-DC converters - DC-AC Inverter for EV and HEV applications - Three Phase DC-AC inverters - Voltage control of DC-AC inverters using PWM - EV and PHEV battery chargers. Electricity, Efficiency.	**CO4**
V	**Energy Sources for HEVs : (12 Hrs)** Energy Storage - Battery based energy storage and simplified models of battery - fuel cells - their characteristics and simplified models - super capacitor based energy	**CO5**

	storage - its analysis and simplified models - flywheels and their modeling for energy storage in EV/HEV - Hybridization of various energy storage devices.	

List of Experiments :

1. Performance characteristics of battery storage system
2. Performance characteristics of hydrogen fuel cell
3. Performance of power converter in HEV
4. Performance of Voltage control of DC-AC inverters using PWM
5. Determination of relation between Torque and Power

Course Outcomes	
Upon successful completion of the course, the student will be able to	
CO1	**Understand**the concept of electric vehicles and hybrid electric vehicles. **{Understand level, KL2}**
CO2	**Analyze**Familiar with different configuration of hybrid electric vehicles. **{Analyze level, KL3}**
CO3	**Choose** an effective motor for EV and HEV application **{Explain level, KL4}**
CO4	**Understand** the power converters used in hybrid electric vehicles **{Understand level, KL2}**
CO5	**Analyze**different batteries and other energy storage systems. **{Apply level, KL4}**

Learning Resources

Text books:

1. Ali Emadi - Advanced Electric Drive Vehicles - CRC Press - 2014.
2. Iqbal Hussein - Electric and Hybrid Vehicles: Design Fundamentals - CRC Press - 2003.

Reference books:

1. MehrdadEhsani - YimiGao - Sebastian E. Gay - Ali Emadi - Modern Electric - Hybrid Electric and Fuel Cell Vehicles: Fundamentals - Theory and Design - CRC Press - 2004.
2. James Larminie - John Lowry - Electric Vehicle Technology Explained - Wiley - 2003.
3. H. Partab: Modern Electric Traction - DhanpatRai& Co - 2007.

e- Resources & other digital material

1. https://onlinecourses.nptel.ac.in/noc23_ee01/preview
2. https://nptel.ac.in/courses/108106170
3. https://onlinecourses.nptel.ac.in/noc20_ee99/preview
4. https://en.wikipedia.org/wiki/Hybrid_electric_vehicle

Micro-Syllabus

Unit – 1: Introduction: (10 Hrs)

Fundamentals of vehicle - components of conventional vehicle and propulsion load; Drive cycles and drive terrain; Concept of electric vehicle and hybrid electric vehicle; History of hybrid vehicles - advantages and applications of Electric and Hybrid Electric Vehicles.

Unit	Module	Micro content
1a. Fundamentals of vehicle	Fundamentals of vehicle	components of conventional vehicle
		propulsion load
		Drive cycles and drive terrain
		Concept of EV & HEV
1bHistory of hybrid vehicles	History of hybrid vehicles	Advantages and Disadvantages
		applications of HEV

Hybridization of Automobile : (10 Hrs)

Architectures of HEVs - series and parallel HEVs - complex HEVs. Plug-in hybrid vehicle(PHEV) - constituents of PHEV - comparison of HEV and PHEV; Extended range hybrid electric vehicles(EREVs) - blended PHEVs - Fuel Cell vehicles and its constituents.

Unit	Module	Micro content
2a. Architectures of HEVs	Architectures of HEVs	Introduction Architectures of HEVs
		series and parallel HEVs
		complex HEVs. Plug-in hybrid vehicle(PHEV)
		constituents of PHEV
2b. Comparison of HEV and PHEV	Comparison of HEV and PHEV	Extended range hybrid electric vehicles(EREVs)
		Blended PHEVs
		FuelCell vehicles and its constituents

Special Machines for EV and HEVs : (10 Hrs)

Characteristics of traction drive - requirement of electric motors for EV/HEVs. Induction Motor drives - their control and applications in EV/HEVs. Permanent magnet Synchronous motor: configuration - control and applications in EV/HEVs. Brushless DC Motors: Advantages - control of application in EV/HEVs. Switch reluctance motors: Merits limitations - converter configuration - control of SRM for EV/HEVs.

Unit	Module	Micro content
3a. Characteristics of traction drive	Characteristics of traction drive	Introduction
		Requirement of electric motors for EV/HEVs
		Induction Motor drives - their control and applications in EV/HEVs
		Permanent magnet Synchronous motor: configuration
3bcontrol and applications in EV/HEVs	control and applications in EV/HEVs	control and applications in EV/HEVs
		Advantages - control of application in EV/HEVs
		converter configuration - control of SRM for EV/HEVs

Unit-4:Power Electronics in HEVs : (12 Hrs)

Boost and Buck-Boost converters - Multi Quadrant DC-DC converters - DC-AC Inverter for EV and HEV applications - Three Phase DC-AC inverters - Voltage control of DC-AC inverters using PWM - EV and PHEV battery chargers. Electricity, Efficiency.

Unit	Module	Micro content
4a. Boost and	Boost and Buck-Boost	Introduction

Buck-Boost converters	converters	Boost and Buck-Boost converters
		Multi Quadrant DC-DC converters
		DC-AC Inverter for EV and HEV applications
		Three Phase DC-AC inverters
4b. Voltage control of DC-AC inverters	Voltage control of DC-AC inverters	Voltage control of DC-AC inverters using PWM
		EV and PHEV battery chargers
		Electricity
		Efficiency.

Unit-5Energy Sources for HEVs : (12 Hrs)

Energy Storage - Battery based energy storage and simplified models of battery - 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 EV/HEV - Hybridization of various energy storage devices.

Unit	**Module**	**Micro content**
5a. Energy Storage for HEV	Energy Storage for HEV	Introduction
		Battery based energy storage
		simplified models of battery
		fuel cells - their characteristics
		super capacitor based energy storage
5b. Analysis and simplified models	Analysis and simplified models	flywheels and their modeling for energy storage in EV/HEV
		Hybridization of various energy storage devices.

CO-PO mapping Table

Contribution of Course Outcomes towards achievement of Program Outcomes & Strength of correlations **(High: 3, Medium: 2, Low: 1)**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO-1	PSO-2
CO1	2											1		
CO2	2													
CO3	2													
CO4	1			2									1	
CO5	2			2									1	

Module Coordinator **BOS** **HOD**

IV- Year I- Semester	Name of the Course	L	T	P	C
	Modern Control Theory (Honors Course)	3	0	2	4

PRE-REQUISITES: 1) Control Systems

Course objectives: The student should be able to

1. Study the state variable representation of systems.
2. Study the controllability and observability of system.
3. Understand design of state feedback controllers.
4. Know the analysis of non-linear systems.
5. Study the stability of non-linear systems.

Syllabus		
Unit No	**Contents**	**Mapped CO**
I	**State variable description and solution of state equation: (7 hrs)** Concept of State – Derivation of State Space models for Linear Continuous time Systems from Schematic models, Differential equations, Transfer functions and block diagrams – Solution of state equations – State transition matrix, Complete response of continuous time systems.	**CO1**
II	**Controllability and Observability: (5 hrs)** Tests for controllability and observability for continuous time systems – Time varying case, minimum energy control, time invariant case, principle of Duality, Controllability and observability of state models in Jordan canonical form and other canonical forms, effects of state feedback on controllability and observability.	**CO2**
III	**State feedback controllers and observers: (10 hrs)** Design of State feedback Controllers through pole placement, full order observer and reduced order observer, State estimation through Kalman's filters.	**CO3**
IV	**Analysis of nonlinear systems: (12 hrs)** Introduction to non-linear systems, types of nonlinearities, concept of describing functions, Derivation of describing functions for Dead zone, Saturation, backlash, relay with dead zone and hysteresis, jump resonance, introduction to phase plane analysis, Method of isoclines for Constructing Trajectories, Singular points, phase plane analysis of nonlinear control systems.	**CO4**
V	**Stability analysis: (12 hrs)** Stability in the sense of Lyapunov, Lyapunov's stability and Lypanov's instability theorems, Direct method of Lyapunov for Linear and nonlinear continuous time autonomous systems.	**CO5**

Course Outcomes	
Upon successful completion of the course, the student will be able to	
CO1	**Understand** the various forms of state representation of a system **{Understand level, KL2}**

CO2	**Test** the controllability and observability of a system **{Test level, KL3}**
CO3	**Explain** the design of controllers and observers **{Explain level, KL4}**
CO4	**Understand** the non linear systems**{Understand level, KL2}**
CO5	**Analyze** the stability of non linear systems **{Apply level, KL4}**

Learning Resources

Text books:

1. Modern control engineering by K.Ogatta, Prentice Hall, 5th edition, 2010.
2. Modern Control systems theory by M.Gopal, New age international publishers, revised, second edition, 2005.

Reference books:

1. Control systems engineering IJ Nagrath and M.Gopal, New age international P Ltd, 4h edition.
2. Modern control engineering by D.Roy Chowdary, PHI learning P Ltd, 2015.

e- Resources & other digital material

1. https://onlinecourses-archive.nptel.ac.in/noc18_ph16

Micro-Syllabus

Unit-1State variable description and solution of state equation:

Concept of State – Derivation of State Space models for Linear Continuous time Systems from Schematic models, Differential equations, Transfer functions and block diagrams – Solution of state equations – State transition matrix, Complete response of continuous time systems.

Unit	Module	Micro content
1a. Concept of State – Derivation of State Space models for Linear Continuous time Systems from Schematic models, Differential equations, Transfer functions and block diagrams	Concept of State – Derivation of State Space models for Linear Continuous time Systems from Schematic models, Differential equations, Transfer functions and block diagrams	Concept of State
		Derivation of State Space models for Linear Continuous time Systems from Schematic models
		Differential equations, Transfer functions and block diagrams
		Transfer functions and block diagrams
1b. Solution of state equations –	Solution of state equations – State transition matrix,	Solution of state equations
		State transition matrix

<table>
<tr><td>State transition matrix, Complete response of continuous time systems.
systems</td><td>Complete response of continuous time systems.</td><td>Complete response of continuous time systems.</td></tr>
<tr><td colspan="3">Unit-II
Controllability and Observability:
Tests for controllability and observability for continuous time systems – Time varying case, minimum energy control, time invariant case, principle of Duality, Controllability and observability of state models in Jordan canonical form and other canonical forms, effects of state feedback on controllability and observability.</td></tr>
<tr><th>Unit</th><th>Module</th><th>Micro content</th></tr>
<tr><td rowspan="5">2a. Tests for controllability and observability for continuous time systems – Time varying case, minimum energy control, time invariant case, principle of Duality</td><td rowspan="5">Tests for controllability and observability for continuous time systems – Time varying case, minimum energy control, time invariant case, principle of Duality</td><td>Tests for controllability and observability for continuous time systems</td></tr>
<tr><td>Time varying case</td></tr>
<tr><td>minimum energy control</td></tr>
<tr><td>time invariant case</td></tr>
<tr><td>principle of Duality</td></tr>
<tr><td rowspan="2">2b. Controllability and observability of state models in Jordan canonical form and other canonical forms, effects of state feedback on controllability and observability.</td><td rowspan="2">Controllability and observability of state models in Jordan canonical form and other canonical forms, effects of state feedback on controllability and observability.</td><td>Controllability and observability of state models in Jordan canonical form and other canonical forms</td></tr>
<tr><td>Effects of state feedback on controllability and observability</td></tr>
<tr><td colspan="3">Unit-3: State feedback controllers and observers:
Design of State feedback Controllers through pole placement, full order observer and reduced order observer, State estimation through Kalman’s filters.</td></tr>
<tr><th>Unit</th><th>Module</th><th>Micro content</th></tr>
<tr><td>3a.</td><td>Design of State feedback Contr</td><td>Design of State feedback Controllers through p</td></tr>
</table>

Design of State feedback Controllers through pole placement	ollers through pole placement	ole placement
3b. **F**ull order observer and reduced order observer, State estimation through Kalman's filters.	Full order observer and reduced order observer, State estimation through Kalman's filters.	Full order observer and reduced order observer State estimation through Kalman's filters.

Unit-4: Analysis of nonlinear systems:
Introduction to non-linear systems, types of nonlinearities, concept of describing functions, Derivation of describing functions for Dead zone, Saturation, backlash, relay with dead zone and hysteresis, jump resonance, introduction to phase plane analysis, Method of isoclines for Constructing Trajectories, Singular points, phase plane analysis of nonlinear control systems.

Unit	**Module**	**Micro content**
4a Non-linear systems, types of nonlinearities	Non-linear systems, types of nonlinearities	Non-linear systems, types of nonlinearities
4b. concept of describing functions, Derivation of describing functions for Dead zone, Saturation, backlash, relay with dead zone and hysteresis, jump resonance	concept of describing functions, Derivation of describing functions for Dead zone, Saturation, backlash, relay with dead zone and hysteresis, jump resonance	concept of describing functions, Derivation of describing functions for Dead zone, Saturation, backlash, relay with dead zone and hysteresis, jump resonance introduction to phase plane analysis, Method of isoclines for Constructing Trajectories, Singular points, phase plane analysis of nonlinear control systems.

Unit-5: Stability analysis:
Stability in the sense of Lyapunov, Lyapunov's stability and Lypanov's instability theorems, Direct method of Lyapunov for Linear and nonlinear continuous time autonomous systems.

Unit	**Module**	**Micro content**
5a. Stability in the sense of Lyapunov, Lyapunov's stability and Lypanov's instability theorems	Stability in the sense of Lyapunov, Lyapunov's stability and Lypanov's instability theorems	Stability in the sense of Lyapunov, Lyapunov's stability Lypanov's instability theorems
5b. Direct method of Lyapunov for Linear	Direct method of Lyapunov for Linear and nonlinear	Direct method of Lyapunov for Linear and nonlinear continuous time autonomous

and nonlinear continuous time autonomous systems.	continuous time autonomous systems.	systems.

CO-PO mapping Table

Contribution of Course Outcomes towards achievement of Program Outcomes & Strength of correlations **(High: 3, Medium: 2, Low: 1)**														
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO-1	PSO-2
CO1	2											1		1
CO2	1													
CO3	2			2										
CO4	1			2									2	
CO5	2			2									2	

Module Coordinator **BOS** **HOD**

IV- Year I- Semester	Name of the Course	L	T	P	C
	Power System Operation and Deregulation (Honors Course)	3	0	2	4

PRE-REQUISITES: 1) Power system analysis
2) Power systems Transmission & Distribution

Course objectives: The student should be able to

1. Find OPF with security constraints.
2. Generalize modeling of load frequency control of a power system
3. Compute reactive power control of a power system.
4. Apply the concept of deregulation and ATC.

Syllabus		
Unit No	**Contents**	**Mapped CO**
I	**Optimal Power flow: (10hrs)** Introduction- Solution to the optimal power flow-gradient method-Newton's method-Linear sensitivity analysis- Linear programming methods- Security constrained OPF-Interior point algorithm- Bus incremental costs	**CO1**
II	**Power System Security: (10hrs)** Introduction –Factors affecting power system security-Contingency analysis-Detection of network problems-Linear sensitivity analysis-AC power flow methods contingency selection-concentric relaxation-Bounding area method	**CO2**
III	**State Estimation in Power Systems:(10hrs)** Introduction- Power system state estimation- Maximum likelihood Weighted Least squares estimation-Matrix formulation- State estimation of AC network State estimation by orthogonal decomposition- detection and identification of Bad measurements Estimation of quantities not being measured- Network observability and pseudo measurements.	**CO3**
IV	**Power System Deregulation: (10hrs)** Introduction- motivation for restructuring of power systems- Electricity market entities model-benefits of deregulation- terminology-deregulation in Indian power sector Operations in power markets-power pools-transmission networks and electricity markets.	**CO4**
V	**Available Transfer Capability: (10hrs)** Introduction methods: of determination of ATC – ATC calculation considering the effect of contingency analysis- Transmission open access and pricing-cost components of transmission system- transmission pricing methods-Incremental cost based transmission pricing.	**CO5**

Course Outcomes	
Upon successful completion of the course, the student will be able to	
CO1	**Know** the optimal scheduling of power plants **{Understand level, KL2}**
CO2	**Analyze** the power system security **{Analyze level, KL3}**
CO3	**Estimate** the steady state behavior of the power system **{Explain level, KL4}**
CO4	**Understand** the basic concepts in deregulation**{Understand level, KL2}**
CO5	**Analyze** the power system scheduling with ATC **{Apply level, KL4}**

Learning Resources
Text books:
1. J. Wood & B.F. Woollenberg- John Wiley Power Generation, "Operation and Control"-2nd edition. 2. P. Venkatesh. B. V. Manikandan, S. Charles Raja- A. Srinivasan, "Electrical power systems: Analysis, security, Deregulation"– PHI 2012
Reference books:
1. Bhattacharya, Kankar, Bollen, Math, Daalder, Jaap E. "Operation of Restructured Power System", 2001, Springer. 2. Venkatesh P. , Manikandan B. V., Raja S. Charles , Srinivasan A. Electrical Power Systems: Analysis, Security And Deregulation, Phi Learning Pvt Ltd 3. Loi Lei Lai, "Power System Restructuring and Deregulation", 1 st edition, John Wiley & Sons Ltd., 2012. 4. Mohammad Shahidepour and Muwaffaqalomoush, "Restructured Electrical Power Systems", 1 st Edition, Marcel Decker Inc., 2001.
e- Resources & other digital material
1. NPTEL Course on Restructured Power Systems available at: https://nptel.ac.in/courses/108101005/

Micro-Syllabus

Unit-I

Optimal Power flow: (10hrs)

Introduction- Solution to the optimal power flow-gradient method-Newton's method-Linear sensitivity analysis- Linear programming methods- Security constrained OPF-Interior point algorithm-Bus incremental costs

Unit	Module	Micro content
Optimal Power flow	**Solution to the optimal power flow**	Introduction
		gradient method
		Newton's method
		Linear sensitivity analysis

		Linear programming methods Security constrained OPF-Interior point algorithm-Bus incremental costs

Unit-II

Power System Security: (10hrs)

Introduction –Factors affecting power system security-Contingency analysis-Detection of network problems-Linear sensitivity analysis-AC power flow methods contingency selection-concentric relaxation-Bounding area method.

Unit	Module	Micro content
Power System Security	Power System security	Factors affecting power system security
		Contingency analysis
		Detection of Network problem

Unit-III

State Estimation in Power Systems:(10hrs)

Introduction- Power system state estimation- Maximum likelihood Weighted Least squares estimation-Matrix formulation- State estimation of AC network State estimation by orthogonal decomposition- detection and identification of Bad measurements Estimation of quantities not being measured- Network observability and pseudo measurements.

Unit	Module	Micro content
State Estimation in Power Systems	**State Estimation in Power Systems**	Introduction
		Maximum likelihood Weighted Least squares estimation
		Matrix formulation
		State estimation of AC network State estimation by orthogonal decomposition- detection and identification of Bad measurements Estimation of quantities not being measured
		Network observability and pseudo measurements

Unit-IV

Power System Deregulation: (10hrs)

Introduction- motivation for restructuring of power systems- Electricity market entities model-benefits of deregulation- terminology-deregulation in Indian power sector Operations in power markets-power pools-transmission networks and electricity markets.

Unit	Module	Micro content
Power System Deregulation	**Power System Deregulation**	Introduction
		Motivation for restructuring of power systems
		Electricity market entities model
		Benefits of deregulation
		Terminology
		Deregulation in Indian power sector Operations in

		power markets
		Power pools-transmission networks and electricity markets.

Unit-V

Available Transfer Capability: (10hrs)

Introduction methods: of determination of ATC – ATC calculation considering the effect of contingency analysis- Transmission open access and pricing-cost components of transmission system-transmission pricing methods-Incremental cost based transmission pricing.

Unit	Module	Micro content
Available Transfer Capability	**Available Transfer Capability**	Introduction
		ATC calculation considering the effect of contingency analysis
		Transmission open access and pricing-cost components of transmission system- transmission pricing methods-Incremental cost based transmission pricing.

Module Coordinator **BOS** **HOD**

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