ACADEMIC REGULATIONS
COURSE STRUCTURE
AND
DETAILED SYLLABUS

ELECTRICAL & ELECTRONICS ENGINEERING

B.Tech - Four Year Degree Course

(Applicable for the Batches Admitted from 2020-21)

R-20

(Choice Based Credit System)

NEC
NARASARAOPETA
ENGINEERING COLLEGE
(AUTONOMOUS)

Kotappakonda Road, Yellamanda (P),
Narasaraopet - 522 601, Guntur Dist.,
Andhra Pradesh, INDIA.

NARASARAOPETA ENGINEERING COLLEGE (AUTONOMOUS)

Academic Regulations, Course Structure and Syllabus

(R20 Regulations)

B.TECH.
Electrical and Electronics Engineering
(4 Year Program)
(Applicable for the Batches admitted from 2020-21)

NARASARAOPETA ENGINEERING COLLEGE (AUTONOMOUS)

Kotappakonda Road, Yellamanda (Post), Narasaraopet – 522601, Guntur District, AP
Approved by AICTE, New Delhi and Permanently affiliated to JNTUK, Kakinada, Code: 47,
Accredited by NBA and NAAC, RTA Approved Pollution test Centre, ISO 9001: 2015 Certified Institution
Phone: 08647-239905 **Website: www.nrtec.in**

CURRICULAR FRAMEWORK FOR REGULAR , MINORS AND HONORS B.TECH PROGRAMMES OF ALL BRANCHES

1. PREAMBLE

The rapid transformation in every sphere of life is augmenting the need to prepare the present fast-paced generation to adapt to the changing knowledge & skill requirement on a life-long basis, in the fields of science, engineering, technology and humanities to influence society positively. The future looks up to multi-disciplinary, competent leaders who are Information and Communication Technology ready and driven by strong ethical values.

NEC envisions to nurture knowledge, skills, and attitude and values of the aspiring youth to enable them to become global citizens and towards that process, the institution has evolved a flexible integrated academic curriculum.

NEC introduced Outcome Based Education (OBE) and Choice Based Credit System (CBCS), which emphasized on honing the skills and knowledge of the graduates.

The Engineering curriculum is revised with an objective to fill the gaps in the existing curriculum with reference to skill development. The revised curriculum underwent a reorganization making the engineering education enshrined with skill development ecosystem to suit the industry's needs and to ensure the graduates employability.

The curriculum mandates students to take up five skill courses, Out of the five skill courses two shall be skill-oriented courses from the same domain and shall be completed in second year. Of the remaining 3 skill courses, one shall be necessarily be a soft skill course and the remaining 2 shall be skill-advanced courses either from the same domain or Job oriented skill courses, which can be of inter disciplinary nature. The students are also given the option of choosing between skill courses offered by the college and a certificate course offered by industry, a professional body, APSSDC or any other accredited body.

Another major change brought in the curriculum is the introduction of B.Tech with Honors or a B.Tech. with a Minor. This is to give an opportunity for the fast learners to earn additional credits either in the same domain or in a related domain, making them more proficient in their chosen field of discipline or be a graduate with multidisciplinary knowledge and job ready skills.

2. PROGRAMS OFFERED BY THE COLLEGE

Narasaraopeta Engineering College (NEC) offers a 4-year (8 semesters) **Bachelor of Technology** (B.Tech.) degree programme, under Choice Based Credit System (CBCS) for the following branches of Engineering.

S. No.	Name of the Program	Program Code
1.	Civil Engineering	01
2.	Electrical and Electronics Engineering	02
3.	Mechanical Engineering	03
4.	Electronics and Communication Engineering	04
5.	Computer Science and Engineering	05
6.	Information Technology	12
7.	CSE (Artificial Intelligence and Machine Learning)	42
8.	CSE (Artificial Intelligence)	43
9.	CSE(Data Science)	44
10.	CSE (Cyber Security)	46

3. ELIGIBILITY FOR ADMISSION

The total seats available as per the approved intake are grouped into two categories viz. category A and Category B with a ratio of 70:30 as per the state government guidelines vide G.O No.52.

The admissions for category A and B seats shall be as per the guidelines of Andhra Pradesh State Council for Higher Education (APSCHE) in consonance with government reservation policy.

a. Under Category A: 70% of the seats are filled through EAPCET counselling.
b. Under Category B: 30% seats are filled based on 10+2 merits in compliance with guidelines of APSCHE

Eligibility for Admission - Under Lateral Entry Scheme (LES)

Students with diploma qualification have an option of direct admission into 2nd year B. Tech. (Lateral Entry Scheme). Under this scheme 10% seats of sanctioned intake will be available in each course as supernumerary seats. Admissions to this three-year B.Tech. Lateral entry Programme will be through ECET.

4. **AWARD OF THE DEGREE:**

For Regular and LES(Lateral Entry Scheme) **students**

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

(a) Pursues a course of study in not less than four and not more than eight academic years for regular students. For LES students, pursue a course of study for not less than three academic years and not more than six academic years counted from the academic year of admission.

(b) He/she shall forfeit their seat in B. Tech course and their admission stands cancelled after eight academic years for regular students and six academic years for LES students starting from the academic year of admission.

(c) Registers for 160 credits and must secure all the 160 credits for Regular students. Registers for 121 credits and must secure all the 121 credits for LES students

(d) 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 160/121 credits and meet other specified requirements in the appropriate section of this document.

(e) A student shall be permitted to register either for Honors or for Minor and not for both simultaneously.

Academic Calendar

For all the eight/six semesters a common academic calendar shall be followed in each semester by having sixteen weeks of instruction, one week for the conduct of practical exams and with two weeks for theory examinations. Dates for registration, sessional and end semester examinations shall be notified in the academic calendar of every semester. The schedule for the conduct of all the curricular and co-curricular activities shall be notified in the planner.

4. Assigning of Credits:

1 Hr. Lecture (L) per week - 1 credit

1 Hr. Tutorial (T) per week - 1 credit

1 Hr. Practical (P) per week - 0.5 credits

2 Hours Practical (Lab)/week - 1 credit

5. Induction Program

When new students enter an institution, they come with diverse thoughts, backgrounds and preparations. It is important to help them adjust to the new environment and inculcate in them the ethos of the institution with a sense of larger purpose. Its purpose is to make the students feel comfortable in their new environment, open them up, set a healthy daily routine, create bonding in the batch as well as between faculty and students, develop awareness, sensitivity and understanding of the self, people around them, society at large, and nature.

A three-week induction program for first year B.Tech students is to be held in zero semester. Regular classes will start after the induction program.

The objectives of the program are as follows:

1. Assimilation in the ethos and culture of the institution
2. Exposure to a larger vision of life
3. Bonding among students and teachers
4. Learning a creative skill in arts
5. Regular lifestyle and professional discipline
6. Special assistance for needy students for improving proficiency in English and Mathematics

The above objectives will be achieved through the following activities:

1. Physical activity: Yoga, Mild Exercise, Games and sports etc.
2. Creative arts: Painting, Photography, music, dance etc.
3. Literary activity: General reading, writing summaries, debating, enacting a play etc.
4. Human Values: Discussion/Lectures in small groups of students with a faculty member
5. Lectures by eminent people: From industry, entrepreneurs, public life, social activists, alumni .
6. Exposure to department/branch, Innovation, Exploring Engineering.

6. DISTRIBUTION AND WEIGHTAGE OF MARKS

The performance of a student in each semester shall be evaluated subject – wise with a maximum of 100 marks for Theory and 50 marks for Mini Project/Practical Training/Internship/ Research Project/ Community Service Project. The Project Work shall be evaluated for 200 marks.

THEORY

For all theory subjects consisting of 5 units of syllabus in each subject, the assessment shall be for 30 marks through internal evaluation and 70 marks through external end semester examination of 3 hours duration.

INTERNAL EVALUATION

Internal evaluation is based on two **Cycles** of examinations. Each **Cycle** consists of three components.

1) **Assignment Test – 1 (A1)**:

   A1 will be conducted after the completion of 1st unit of syllabus. 5 or 6 questions will be given to students before 1 week of the commencement of the test. On the day of the test, each student will be given two questions at random. A1 will be evaluated for 05 marks.

2) **Quiz - 1(Q1)**:

   After the completion of the first two and half Units of syllabus (first half of the syllabus), along with the descriptive test, an online quiz test will be conducted for 20 marks and scaled down to 10 marks.

3) **Descriptive Test – 1(D1)**:

   Along with the Q1, a descriptive test will be conducted for 25 marks and scaled down to 15 marks. Two 10 marks questions from each of Unit-1 & Unit-2, and one 5 marks question from the first half of 3rd unit will be given.

Cycle–I final marks = A1 (05 marks) + Q1 (10 marks) + D1 (15 marks) = 30 marks

In the similar manner, Cycle–II Examination will be conducted as follows:

A2 test will be conducted after 3.5 units of syllabus (covering syllabus from 2.5 to 3.5 units)

After the completion of the 5th unit of Syllabus, Q2 and D2 will be conducted. For D2, one 5 marks question will be given from the second half of the third unit, two 10 marks questions will be given each from units 4 and 5.

Cycle–II final marks = A2 + Q2 + D2 = 30 Marks.

Final internal marks will be computed as **80 % of best cycle marks + 20% of least cycle marks.**

EXTERNAL EVALUATION

The semester end examinations will be conducted for 70 marks consisting of five questions carrying 14 marks each. Students have to answer all the questions. One question from each of the 5 units 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.

PRACTICALS

INTERNAL EVALUATION

For practical subjects there shall be continuous evaluation during the semester for 15 internal marks and 35 end examination marks. The internal 15 marks shall be awarded as follows:

Day to day work - 5 marks,

Record-5 marks and

Internal laboratory test -5 marks.

EXTERNAL EVALUATION

For practical subjects there shall be an external examination at the end of the semester for 35 marks in the presence of an external examiner. The examination duration is 3 hours.

DRAWING SUBJECTS

For the subject having design and / or drawing, (such as Engineering Graphics, Engineering Drawing, Machine Drawing etc.,) and estimation, the distribution shall be 30 marks for Internal Evaluation and 70 marks for End Examination. There shall be two internal tests in a semester. The 30 internal marks will be evaluated as follows:

Cycle–I:
Internal Test : 15 marks. (1½ hour duration)
Day – to – day work: 15 marks (evaluation of charts)

In the Similar manner, **Cycle–II examination will be conducted for 30 marks**

The sum of 80% of the best and 20% of the least of two internal tests shall be considered.

Mandatory Course (M.C): Environmental Sciences/NSS/NCC, 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 college 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 SATISFACTORY(S)/NOT-SATISFACTORY (F) will be specified.

- There shall be 05 Professional Elective courses and 04 Open Elective courses. All the Professional & Open Elective courses shall be offered for 03 credits, wherever lab component is involved it shall be (2-0-2) and without lab component it shall be (3-0-0) or (2-1-0) and for all minors /honors, it shall be (4-0-0). 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.

- All Open Electives are offered to students of all branches in general. However, a student shall choose an open Elective 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.

- Students shall undergo mandatory summer Internship/Community Service Project for a minimum of 4 to 8 weeks duration at the end of second and third year of the Programme.

- There shall be 05 skill-oriented courses offered during III to VII semesters. Among the five skill courses, four courses shall focus on the basic and advanced skills related to the domain courses and the remaining one shall be a soft skills course.

- Undergraduate Degree with Honors/Minor shall be issued by the Institute to the students who fulfill all the academic eligibility requirements for the B.Tech program and Honors/Minor program. The objective is to provide additional learning opportunities to academically motivated students. The regulations/guidelines are separately provided. Registering for Honors/Minor is optional.

Assessment: The performance of a student in each semester shall be evaluated subject wise with a maximum of 100 marks for theory, 50 marks for practical subject. The distribution shall be 30% marks for Internal Evaluation and 70% marks for the End Semester Examinations. A student has to secure not less than 35% of marks in the end semester

- examination and minimum 40% of marks in the sum total of internal and end semester examination marks to earn the credits allotted to each course.
    - **Internship/ Community Service Project (1.5 Credits):**
    - It shall be completed in collaboration with local industries, Govt. Organizations, construction agencies, Industries, Hydal and thermal power projects and also in software MNCs in the area of concerned specialization of the UG programme.
    - Students shall pursue this course during summer vacation just before its offering as per course structure. The minimum duration of this course is at least 4 to 8 weeks. The student shall register for the course as per course structure after commencement of academic year. A supervisor/mentor/advisor has to be allotted from the institute to guide the students for taking up the summer internship. The supervisor shall monitor the attendance of the students while taking up the internship. 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; 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. A student shall secure a 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.
    - Internship/Community Service Project will be evaluated at the end of the semester for 50 marks (Record/Report: 20 marks and viva-voce: 30 marks) along with laboratory

end examinations in the presence of external and internal examiner. There are no internal marks for the Internship/Community Service Project.

- ***Major Project*** **(12 credits):**
- ***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 and is evaluated for 140 marks.

MOOCS (1.5 Credits):

Meeting with the global requirements, to inculcate the habit of self-learning and in compliance with AICTE/ UGC guidelines, MOOC (Massive Open Online Course) have been introduced. Students have to complete an on-line course to fulfill the academic requirement of B.Tech course. Students can start registering for the course from II Year I semester. The student must register for the MOOCs course as per the academic credit requirements mentioned in the Course structure offered by NPTEL with the approval of the Head of the Department. The student will be awarded the credits given in the curriculum only after the submission of the certificate. Students must submit the NPTEL Pass certificate with required credits before the end of 3rd Year 2nd Semester.

In case the student is unable to submit an NPTEL certificate with required credits by the end of 3rd Year 2nd Semester, the student is required to submit 2 MOOCs Certificates from the reputed organizations approved by the concerned HOD before the commencement of 4th Year 1st Semester examinations.

Skill Oriented Courses (2 Credits)

1. For skill oriented/skill advanced course, one theory and 2 practical hours or two theory hours may be allotted as per the decision of concerned BOS.
2. Out of the five skill courses two shall be skill-oriented courses from the same domain and shall be completed in second year. Of the remaining 3 skill courses, one shall be necessarily be a soft skill course and the remaining 2 shall be skill-advanced courses either from the same domain or Job oriented skill courses, which can be of inter disciplinary nature.

3. A pool of interdisciplinary job-oriented skill courses shall be designed by a common Board of studies by the participating departments/disciplines and the syllabus along with the pre requisites shall be prepared for each of the laboratory infrastructure requirements.

4. 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 as approved by the departmental committee.

5. The Board of Studies of the concerned discipline of Engineering shall review the skill advanced courses being offered by eligible external agencies and prepare a fresh list every year incorporating latest courses based on industrial demand.

6. 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, the credits shall be awarded to the student upon producing the Course Completion Certificate from the agency/professional bodies as approved by the departmental committee.

Evaluation: The job oriented skill courses may be registered at the college or at any accredited external agency as approved by departmental committee. A student shall submit a record/report on the on the 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 and internal examiner. There are no internal marks for the job oriented skill courses.

Curricular Framework for Honors Programme

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

2. 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 upto 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. An SGPA of 8 has to be maintained in the subsequent semesters without any backlog in order to keep the Honors Programme registration active.

3. 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.

4. In addition to fulfilling all the requisites of a Regular B.Tech Programme, 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).

5. 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 8/12weeks as recommended by the Departmental committee.

6. 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.

7. The concerned departmental committee 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 departmental committee. 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 departmental committee. 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 per the guidelines approved by the departmental committee. .

8. 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.

9. 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 be mentioned 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.

10. In case a student fails to meet the SGPA 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.

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

Curricular Framework for Minor Programme:

1. a) 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

b) 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.

2. 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.

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

4. There shall be no limit on the number of programs offered under Minor. The Institution 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.

5. 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.

6. A student shall be permitted to register for Minors program at the beginning of 4^{th} semester subject to a maximum of two additional courses per semester, provided that the

student must have acquired 8 SGPA (Semester Grade point average) upto 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 upto 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.

7. 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).

8. 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.

9. 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.

10. Student can opt for the Industry relevant minor specialization as approved by the concerned Departmental committee. Students 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 a course completion certificate. The Departmental committee 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.

11. A committee should be formed at the level of the College/department to evaluate the grades/marks given by external agencies to a student which are approved by the concerned Departmental committee. 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.

12. 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. None of the courses done under the dropped Minor will be shown in the transcript.

13. In case a student fails to meet the SGPA 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.

14. 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.

PASS MARK CRITERIA

A student shall be deemed to have satisfied the pass mark, if he secures not less than 35% of marks in the end examinations and a minimum of 40% of marks in the sum total of the internal evaluation and end examination taken together as detailed below.

On passing a course of a program, the student shall earn the credits as assigned to that course.

S.No	Category of Subject	Max. Marks	Internal Marks	External Marks	External pass %	External pass mark	Over all pass %	Over all pass mark
1	Theory/ Drawing	100	30	70	35	25	40	40
2	Practical	50	15	35	35	12	40	20
3	Internship/Skill development courses/Community service project	50	-	50	40	20	40	20
4	Project Work	200	60	140	35	49	40	80
5	MOOCs(Credit Course)	Certificate must be submitted before the end semester examinations of that semester in which MOOCS course is offered.						

11. Attendance Requirements:

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

b) Condonation of shortage of attendance in aggregate up to 10% (65% and above, and below 75%) may be granted by the College Academic Committee. However, this condonation concession is applicable only to any two semesters during the entire programme.

c) Shortage of Attendance below 65% in aggregate shall not be condoned.

d) A student who is short of attendance in a semester may seek re-admission into that semester when offered within 4 weeks from the date of commencement of class work.

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

f) A stipulated fee shall be payable towards condonation of shortage of attendance to the college. Students availing condonation on medical ground shall produce a medical certificate issued by the competent authority.

g) A student will be promoted to the next semester if he satisfies the (i) attendance requirement of the present semester and (ii) minimum required credits.

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

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

j) For non-credit mandatory courses the students shall maintain the attendance similar to credit courses

18. Promotion Rules:

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

b) A student will be promoted from II year to III year if he fulfills the academic requirement of 40% of credits up to 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.

c) A student shall be promoted from III year to IV year if he fulfills the academic requirements of 40% of the credits up to 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.

d) For LES, point C is only applicable

19. Grading:

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

Marks Range	Level	Letter Grade	Grade Point
≥ 90	Outstanding	A+	10
80-89	Excellent	A	9
70-79	Very Good	B	8
60-69	Good	C	7
50-59	Fair	D	6
40-49	Satisfactory	E	5
< 40	Fail	F	0
-	Absent	AB	-
-	Malpractice	MP	-

Calculation of Semester Grade Point Average (SGPA) and Cumulative Grade Point Average (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.

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

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

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.

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

Where 'Si' is the SGPA of the i^{th} 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. SGPA & CGPA will be calculated for those candidates who have passed all the subjects in that or up to that semester respectively.

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

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 Secured
First Class with Distinction	≥ 7.75 (With No subject failures)
First Class	≥ 6.75 (With subject failures)
Second Class	≥ 5.75 & < 6.75
Pass Class	≥ 5.0 & < 5.75

20. 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 institute 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.

REVALUATION

1. Students can submit the application for revaluation, along with the prescribed fee for revaluation of his answer script(s) of theory subject(s) as per the notification issued by the Controller of Examinations.
2. The Controller of Examinations shall arrange for revaluation of such answer script(s).

3. An evaluator, other than the first evaluator shall revaluate the answer script(s).

SUPPLEMENTARY EXAMINATIONS: A student who has failed to secure the required credits can appear for a supplementary examination, as per schedule announced by the College authorities.

MALPRACTICE IN EXAMINATIONS: Disciplinary action will be taken in case of malpractice during Mid/End examinations as per the rules framed by the College.

MINIMUM INSTRUCTION DAYS

The minimum instruction days for each semester shall be 90 working days.

There shall be no branch transfer after the completion of the admission process.

WITHHOLDING OF RESULTS

If the student has not paid the dues, if any, to the college or if any case of indiscipline is pending against him, the result of such a student will be kept withheld. His degree will be withheld in such cases.

TRANSITORY REGULATIONS

Discontinued or detained candidates are eligible for readmission as and when next offered. A candidate, who is detained or discontinued in a semester, on readmission shall be required to do all the subjects in the curriculum prescribed for the batch of students in which the student joins subsequently. However, exemption will be given to those candidates who have already passed such subjects in the earlier semester(s) he was originally admitted into and substitute subjects are offered in place of them as decided by the Board of Studies. However, the decision of the Board of Studies will be final.

A student who is following JNTUK curriculum and detained due to shortage of attendance at the end of the first semester of first year shall join the autonomous batch of first year first semester. Such students shall study all the subjects prescribed for the batch in which the student joins and considered on par with regular candidates of Autonomous stream and will be governed by the autonomous regulations.

A student who is following JNTUK curriculum, detained due to lack of credits or shortage of attendance at the end of the second semester of first year or at the subsequent semesters shall join with the autonomous batch in the appropriate semester. Such candidates shall be required

to pass in all the subjects in the program prescribed by the Board of Studies concerned for that batch of students from that semester onwards to be eligible for the award of degree. However, exemption will be given in the subjects of the semester(s) of the batch which he had passed earlier and substitute subjects will be offered in place of them as decided by the Board of Studies. The student has to clear all his backlog subjects up to previous semester by appearing for the supplementary examinations conducted by JNTUK for the award of degree will be sum of the credits up to previous semester under JNTUK regulations and the credits prescribed for the semester in which a candidate seeks readmission and subsequent semesters under the autonomous stream. The class will be awarded based on the academic performance of a student in the autonomous pattern.

Transfer candidates (from non-autonomous college affiliated to JNTUK)

A student who is following JNTUK curriculum, transferred from other college to this college in second year first semester or subsequent semesters shall join with the autonomous batch in the appropriate semester. Such candidates shall be required to pass in all the subjects in the program prescribed by the Board of Studies concerned for that batch of students from that semester onwards to be eligible for the award of degree. However, exemption will be given in the subjects of the semester(s) of the batch which he had passed earlier and substitute subjects are offered in their place as decided by the Board of Studies. The student has to clear all his backlog subjects up to previous semester by appearing for the supplementary examinations conducted by JNTUK for the award of degree. The total number of credits to be secured for the award of the degree will be the sum of the credits up to previous semester under JNTUK regulations and the credits prescribed for the semester in which a candidate joined after transfer and subsequent semesters under the autonomous stream. The class will be awarded based on the academic performance of a student in the autonomous pattern.

Transfer candidates (from an autonomous college affiliated to JNTUK)

A student who has secured the required credits up to previous semester as per the regulations of other autonomous institutions shall also be permitted to be transferred to this college.

A student who is transferred from the other autonomous colleges to this college in second year first semester or subsequent semesters shall join with the autonomous batch in the appropriate semester. Such candidates shall be required to pass in all the subjects in the program prescribed by the Board of Studies concerned for that batch of students from that semester onwards to be eligible for the award of degree.

However, exemption will be given in the subjects of the semester(s) of the batch which he had passed earlier and substitute subjects are offered in their place as decided by the Board of studies.

The total number of credits to be secured for the award of the degree will be the sum of the credits up to previous semester as per the regulations of the college from which he has transferred and the credits prescribed for the semester in which a candidate joined after transfer and subsequent semesters under the autonomous stream. The class will be awarded based on the academic performance of a student in the autonomous pattern.

Scope

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

1. In case of any doubt or ambiguity in the interpretation of the above rules, the decision of the Academic Council is final.
2. The college may change or amend the academic regulations, course structure or syllabi at any time, and the changes or amendments made shall be applicable to all students with effect from the date notified by the College Authorities.

MALPRACTICES RULES

DISCIPLINARY ACTION FOR / IMPROPER CONDUCT IN EXAMINATIONS

➢ The Principal shall refer the cases of Malpractices in Internal Assessment Test and Semester end examinations to a malpractice prevention committee constituted by him for the purpose. Such committee shall follow the approved levels of punishment. The Principal shall take necessary action against the students based on the recommendations of the committee.

➢ Any action by the candidate trying to get undue advantage in the performance or trying to help another, or derive the same through unfair means is punishable according to the provisions contained hereunder:

	Nature of Malpractices/ Improper conduct	**Punishment**
	If the candidate:	
1(a)	Possesses or keeps accessible in examination hall, any paper, note book, programmable calculators, Cell phones, pager, palm computers or any	Expulsion from the examination hall and cancellation of the performance in that subject only.

	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).	
1(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 college.
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 practicals and to 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 college 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	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

	answer book or additional sheet, during or after the examination.	semester/year. The candidate is also debarred for two consecutive semesters from class work and all college 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 person on duty in or outside the examination hall of any injury to his person or to any of his relations whether by words, either spoken or written or by signs or by visible representation, assaults the officer-in-charge, or any person on duty in or outside the examination hall or any of his relations, or indulges in any other act of misconduct or mischief which result in damage to or destruction of property in the examination hall or any part of the college campus or engages in any other act which in the opinion of the officer on duty amounts to use of unfair means or misconduct or has the tendency to disrupt the orderly conduct of the examination.	In case of students of the college, they shall be expelled from examination halls and cancellation of their performance in that subject and all other subjects the candidate(s) has (have) already appeared and shall not be permitted to appear for the remaining examinations of the subjects of that semester/year. The candidates also are 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 college 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 6to 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 college for further action to award suitable punishment.	

OTHER MATTERS:

1. Physically challenged candidates who have availed additional examination time and a scribe during their intermediate / EAMCET examinations will be given similar concessions on production of relevant proof / documents.
2. The Principal shall deal in an appropriate manner with any academic problem which is not covered under these rules and regulations, in consultation with the Heads of the departments and subsequently such actions shall be placed before the Academic Council for ratification. Any emergency modification of regulation, approved in the meetings of the Heads of the departments shall be reported to the Academic Council for ratification.

GENERAL:

1. The academic council may, from time to time, revise, amend or change the regulations, schemes of examinations and / or syllabi.
2. Where ever the words ‘’he’’ ‘’him’’ ‘’his’’, occur in the regulations, they include ‘’she’’, ’’her’’, ’’hers’’.
3. The academic regulation should be read as a whole for the purpose of any interpretation.
4. In the case of any doubt or ambiguity in the interpretation of the above rules, the decision of the Principal is final.

ANNEXURE-I

COMMUNITY SERVICE PROJECT

……Experiential learning through community engagement

As per the decision of the concerned department BoS

Introduction

- Community Service Project is an experiential learning strategy that integrates meaningful community service with instruction, participation, learning and community development
- Community Service Project involves students in community development and service activities and applies the experience to personal and academic development.
- Community Service Project is meant to link the community with the college for mutual benefit. The community will be benefited with the focused contribution of the college students for the village/ local development. The college finds an opportunity to develop social sensibility and responsibility among students and also emerge as a socially responsible institution.

Objective

Community Service Project should be an integral part of the curriculum, as an alternative to the 4 to 8 weeks of Summer Internships / Apprenticeships / On the Job Training, whenever there is an exigency when students cannot pursue their summer internships. The specific objectives are;

- To sensitize the students to the living conditions of the people who are around them,
- To help students to realize the stark realities of the society.
- To bring about an attitudinal change in the students and help them to develop societal consciousness, sensibility, responsibility and accountability
- To make students aware of their inner strength and help them to find new /out of box solutions to the social problems.
- To make students socially responsible citizens who are sensitive to the needs of the disadvantaged sections.
- To help students to initiate developmental activities in the community in coordination with public and government authorities.
- To develop a holistic life perspective among the students by making them study culture, traditions, habits, lifestyles, resource utilization, wastages and its management, social problems, public administration system and the roles and responsibilities of different persons across different social systems.

Implementation of Community Service Project

- Every student should put in a minimum of **180 hours** for the Community Service Project during the summer vacation.
- Each class/section should be assigned with a mentor.

- Specific Departments could concentrate on their major areas of concern. For example, Dept. of Computer Science can take up activities related to Computer Literacy to different sections of people like - youth, women, house-wives, etc
- A log book has to be maintained by each of the student, where the activities undertaken/involved to be recorded.
- The log book has to be countersigned by the concerned mentor/faculty incharge.

- Evaluation to be done based on the active participation of the student and grade could be awarded by the mentor/faculty member.
- The final evaluation to be reflected in the grade memo of the student.

- TheCommunity Service Project should be different from the regular programmes of NSS/NCC/Green Corps/Red Ribbon Club, etc.
- Minor project report should be submitted by each student. An internal Viva shall also be conducted by a committee constituted by the principal of the college.
- Award of marks shall be made as per the guidelines of Internship/apprentice/ on the job training

Procedure

- A group of students or even a single student could be assigned for a particular habitation or village or municipal ward, as far as possible, in the near vicinity of their place of stay, so as to enable them to commute from their residence and return back by evening or so.

- The Community Service Project is a twofold one –
    - First, the student/s could conduct a survey of the habitation, if necessary, in terms of their own domain or subject area. Or it can even be a general survey, incorporating all the different areas. A common survey format could be designed. This should not be viewed as a duplication of work by the Village or Ward volunteers, rather, it could be another primary source of data.
    - Secondly, the student/s could take up a social activity, concerning their domain or subject area. The different areas, could be like –
        - Agriculture
        - Health
        - Marketing and Cooperation
        - Animal Husbandry
        - Horticulture
        - Fisheries
        - Sericulture
        - Revenue and Survey

- Natural Disaster Management
- Irrigation
- Law & Order
- Excise and Prohibition
- Mines and Geology
- Energy
- Internet
- Free Electricity
- Drinking Water

EXPECTED OUTCOMES

BENEFITS OF COMMUNITY SERVICE PROJECT TO STUDENTS

Learning Outcomes

- Positive impact on students' academic learning
- Improves students' ability to apply what they have learned in "the real world"
- Positive impact on academic outcomes such as demonstrated complexity of understanding, problem analysis, problem-solving, critical thinking, and cognitive development
- Improved ability to understand complexity and ambiguity

Personal Outcomes

- Greater sense of personal efficacy, personal identity, spiritual growth, and moral development
- Greater interpersonal development, particularly the ability to work well with others, and build leadership and communication skills

Social Outcomes

- Reduced stereotypes and greater inter-cultural understanding
- Improved social responsibility and citizenship skills
- Greater involvement in community service after graduation

Career Development

- Connections with professionals and community members for learning and career opportunities

- Greater academic learning, leadership skills, and personal efficacy can lead to greater opportunity

Relationship with the Institution

- Stronger relationships with faculty
- Greater satisfaction with college
- Improved graduation rates

BENEFITS OF COMMUNITY SERVICE PROJECT TO FACULTY MEMBERS

- Satisfaction with the quality of student learning
- New avenues for research and publication via new relationships between faculty and community
- Providing networking opportunities with engaged faculty in other disciplines or institutions
- A stronger commitment to one's research

BENEFITS OF COMMUNITY SERVICE PROJECT TO COLLEGES AND UNIVERSITIES

- Improved institutional commitment
- Improved student retention
- Enhanced community relations

BENEFITS OF COMMUNITY SERVICE PROJECT TO COMMUNITY

- Satisfaction with student participation
- Valuable human resources needed to achieve community goals
- New energy, enthusiasm and perspectives applied to community work
- Enhanced community-university relations.

SUGGESTIVE LIST OF PROGRAMMES UNDER COMMUNITY

SERVICE PROJECT

The following is the recommended list of projects for Engineering students. The lists are not exhaustive and open for additions, deletions and modifications. Colleges are expected to focus on specific local issues for this kind of projects. The students are expected to carry out these projects with involvement, commitment, responsibility and accountability. The mentors of a group of students should take the responsibility of motivating, facilitating, and guiding the students. They have to interact with local leadership and people and appraise the objectives and benefits of this kind of projects. The project reports shall be placed in the college website for reference. Systematic, Factual, methodical and honest reporting shall be ensured.

For Engineering Students

1. Water facilities and drinking water availability
2. Health and hygiene
3. Stress levels and coping mechanisms
4. Health intervention programmes
5. Horticulture
6. Herbal plants
7. Botanical survey
8. Zoological survey
9. Marine products
10. Aqua culture
11. Inland fisheries

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY: KAKINADA

KAKINADA-533003, Andhra Pradesh (India)

For Constituent Colleges and Affiliated Colleges of JNTUK

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 & 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 of Emergency CALL TOLL FREE No. : 1800 - 425 - 1288

LET US MAKE JNTUK A RAGGING FREE UNIVERSITY

I B. Tech. - I SEMESTER

S. No.	Subject Code	Subject	Cat. Code	L	T	P	Internal Marks	External Marks	Total Marks	Credits
1	R20CC1101	Technical and Communicative English – I	HS	3	0	0	30	70	100	3
2	R20CC1102	Linear Algebra and Calculus	BS	2	1	0	30	70	100	3
	R20CC1105	Problem Solving Using C	ES	3	0	0	30	70	100	3
3	R20EE1109	Basics in Mechanical and Civil Engineering	ES	3	0	0	30	70	100	3
5	R20EE1110	Engineering Drawing and Design	ES	1	0	4	30	70	100	3
6	R20CC11L1	Soft Skills and Communication Skills Lab-1	HS	0	0	3	15	35	50	1.5
7	R20CC11L2	Problem Solving Using C Lab	ES	0	0	3	15	35	50	1.5
8	R20EE11L6	Basics in Mechanical and Civil Engineering Lab	ES	0	0	3	15	35	50	1.5
		Total		**12**	**1**	**13**	**195**	**455**	**650**	**19.5**

I B. Tech. – II SEMESTER

S. No.	Subject Code	Subject	Cat. Code	L	T	P	Internal Marks	External Marks	Total Marks	Credits
1	R20CC1201	Differential Equations and Vector Calculus	BS	2	1	0	30	70	100	3
2	R20CC1205	Applied Physics	BS	3	0	0	30	70	100	3
3	R20EE1209	Electronics Devices and Circuits	ES	3	0	0	30	70	100	3
4	R20EE1213	Electrical Circuit Analysis-I	PC	2	1	0	30	70	100	3
5	R20CC1210	Data Structures	ESC	3	0	0	30	70	100	3
6	R20EE12L9	Electronics Devices and Circuits Lab	ES	0	0	3	15	35	50	1.5
7	R20CC12L10	Applied Physics Lab	BS	0	0	3	15	35	50	1.5
8	R20CC12L11	Data Structures Lab	ES	0	0	3	15	35	50	1.5
9	R20CC12MC2	Constitution of India (Zero Credit Course)	MC	2	0	0	-	-	-	-
		Total		**15**	**2**	**9**	**195**	**455**	**650**	**19.5**

II B. Tech. - I SEMESTER

S. No.	Subject Code	Subject	Cat. Code	L	T	P	Internal Marks	External Marks	Total Marks	Credits
1	R20CC2101	Numerical Methods and Transformations	BS	2	1	0	30	70	100	3
2	R20EE2102	Electrical Circuit Analysis-II	PC	2	1	0	30	70	100	3
3	R20EE2103	Electrical Machines-I	PC	2	1	0	30	70	100	3
4	R20EE2104	Electromagnetic Fields	PC	2	1	0	30	70	100	3
5	R20EE2105	Analog Electronics	PC	3	0	0	30	70	100	3
6	R20EE21L1	Electrical Circuit Analysis Lab	PC	0	0	3	15	35	50	1.5
7	R20EE21L2	Electrical Machines-I Lab	PC	0	0	3	15	35	50	1.5
8	R20EE21L3	Analog Electronics Lab	PC	0	0	3	15	35	50	1.5
9	R20EE21SC1	PLC Automation Lab	SC	0	0	4	-	50	50	2
10	R20CC21MC1	Environmental Studies (Non-Credit Course)	MC	2	0	0	-	-	-	-
		Total		**13**	**4**	**13**	**195**	**505**	**700**	**21.5**

II B. Tech. - II SEMESTER

S. No.	Subject Code	Subject	Cat. Code	L	T	P	Internal Marks	External Marks	Total Marks	Credits
1	R20CC2201	Technical and Communicative English – II	HS	3	0	0	30	70	100	3
2	R20CC2202	Complex Variables Probability and Statistics	BS	2	1	0	30	70	100	3
3	R20EE2203	Control Systems	PC	2	1	0	30	70	100	3
4	R20EE2204	Electrical Machines-II	PC	2	1	0	30	70	100	3
5	R20EE2205	Digital Electronics	PC	3	0	0	30	70	100	3
6	R20EE22L1	Control System Lab	PC	0	0	3	15	35	50	1.5
7	R20EE22L2	Electrical Machines Lab-II	PC	0	0	3	15	35	50	1.5
8	R20EE22L3	Digital Electronics Lab	PC	0	0	3	15	35	50	1.5
9	R20EE22SC1	Numerical Techniques using MATLAB	SC	0	0	4	-	50	50	2
		Total		**12**	**3**	**13**	**195**	**505**	**700**	**21.5**

Honors/Minor Courses	**4**	**0**	**0**	**30**	**70**	**100**	**4**

Summer Internship/ Community Service (Mandatory)	To be evaluated in III-I

III B. Tech. - I SEMESTER

S. No.	Subject Code	Subject	Cat. Code	L	T	P	Internal Marks	External Marks	Total Marks	Credits
1	R20EE3101	Problem Solving with Python	PC	3	0	0	30	70	100	3
2	R20EE3102	Power Electronics	PC	3	0	0	30	70	100	3
3	R20EE3103	Power Generation and Transmission	PC	3	0	0	30	70	100	3
4	R20CC1OE03	**Open Elective-I** a. Micro Electro Mechanical System	OE	3	0	0	30	70	100	3
	R20CC1OE04	b. Fundamentals of Electrical Engineering								
5	R20EE3106	**Professional Elective-I** a. Digital Control System	PE	3	0	0	30	70	100	3
	R20EE3107	b. Signals and Systems								
	R20EE3108	c. Special Electrical Machines								
	R20EE3109	d. Energy Conservation and Auditing								
6	R20EE31L1	Problem Solving with Python Programming Lab	PC	0	0	3	15	35	50	1.5

7	R20EE31L2	Power Electronics Lab	PC	0	0	3	15	35	50	1.5
8	R20EE31SC3	Internet of Things	SC	1	0	2	-	50	50	2
9	R20CC31MC01	Professional Ethics and Human Values (MC)	MC	2	0	0	-	-	-	-
10	R20CC31IN	Summer Internship / Community Service Project	PROJ	0	0	0	0	50	50	1.5
Total				**18**	**-**	**8**	**180**	**520**	**700**	**21.5**
		Honors/Minor courses (The hours distribution can be 3-0-2 or 3-1-0 also)								**4**

III B. Tech. - II SEMESTER

S. No.	Subject Code	Subject	Cat. Code	L	T	P	Internal Marks	External Marks	Total Marks	Credits
1	R20EE3201	Microprocessor & Microcontrollers	PC	3	0	0	30	70	100	3
2	R20EE3202	Power System Analysis	PC	3	0	0	30	70	100	3
3	R20EE3203	Measurements & Instrumentation	PC	3	0	0	30	70	100	3
4	R20EE3204	**Professional Elective-II** a. Renewable and Distributed Energy System	PE	3	0	0	30	70	100	3
	R20EE3205	b. Electric Drives								
	R20EE3206	c. Utilization of Electrical Energy								
	R20EE3207	d. Big Data Analytics								
5	R20CC2OE03	**Open Elective-II** a. Hybrid Electric Vehicle	OE	3	0	0	30	70	100	3
	R20CC2OE04	b. Energy Audit and Conservation								
6	R20EE32L1	Microprocessors and Microcontrollers Lab	PC	0	0	3	15	35	50	1.5
7	R20EE32L2	Measurements and Instrumentation Lab	PC	0	0	3	15	35	50	1.5
8	R20EE32L3	Power System Simulation Lab	PC	0	0	3	15	35	50	1.5

9	R20CC32SC1	English Employability Skills	SC	1	0	2	-	50	50	2
10	R20CC32MC1	Essence of Indian Traditional Knowledge (MC)	MC	2	0	0	-	-	-	-
Total				**18**	**-**	**11**	**195**	**505**	**700**	**21.5**
		Honors/Minor courses (The hours distribution can be 3-0-2 or 3-1-0 also)								**4**

IV B. Tech. - I SEMESTER

S. No.	Subject Code	Subject	Cat. Code	L	T	P	Internal Marks	External Marks	Total Marks	Credits
1	R20EE4102	**Professional Elective-III** a. High Voltage Engineering	PE	3	0	0	30	70	100	3
	R20EE4103	b. Power System Stability								
	R20EE4104	c. Flexible AC Transmission Systems								
	R20EE4105	d. Smart Grid Technology								
2	R20EE4106	**Professional Elective-IV** a. Power Quality	PE	3	0	0	30	70	100	3
	R20EE4107	b. Electrical and Hybrid Vehicles								
	R20EE4108	c. Introduction to Embedded Systems								
	R20EE4109	d. Power System Operation and Control								
3	R20EE4110	**Professional Elective-V** a. HVDC Transmission	PE	3	0	0	30	70	100	3
	R20EE4111	b. Switchgear and Protection								
	R20EE4112	c. Electrical Machine Design								
	R20EE4113	d. AI Techniques to power System								
4	R20CC3OE03	**Open Elective-III** a. Concept of Smart Grid Technology	OE	3	0	0	30	70	100	3
	R20CC3OE04	b. Industrial Automation								

5	R20CC4OE03	**Open Elective-IV** a. Non-Conventional Energy Resources	OE	3	0	0	30	70	100	3
	R20CC4OE04	b. Electrical Safety								
6	R20CC4101	**Humanities and Social Science Elective** a. Business Management Concepts for Engineers	HSE	3	0	0	30	70	100	3
	R20CC4117	b. Entrepreneurship & Innovation								
7	R20EE41SC1	**Machine Learning with Python**	SC	1	0	2	-	50	50	2
8	R20CC41IN	Internship / Community Service Project	PROJ	0	0	0	0	50	50	1.5
9	R20CC41MC	MOOCs Course	PC	-	-	-	-	-	-	1.5
Total				**19**	**-**	**2**	**180**	**520**	**700**	**23**
		Honors/Minor courses (The hours distribution can be 3-0-2 or 3-1-0 also)								**4**

IV B. Tech. - II SEMESTER

S. No.	Subject Code	Subject	Cat. Code	L	T	P	Internal Marks	External Marks	Total Marks	Credits
1	R20CC42PW	Major Project and Internship	PROJ	0	0	0	-	-	-	12
		Total		-	-	-	-	-	-	**12**

LIST OF HONORS

POOL-1

Power Systems Engineering: (any four of the following subjects which are not chosen as professional electives are to be considered for Honors Degree)

S. No.	Subject Code	Subject	Cat. Code	L	T	P	Internal Marks	External Marks	Total Marks	Credits
1	R20EEHN01	Advanced Power System Protection	PC	3	1	0	30	70	100	4
2	R20EEHN02	Power system reliability	PC	3	1	0	30	70	100	4
3	R20EEHN03	Power Systems Dynamics and Stability	PC	3	1	0	30	70	100	4
4	R20EEHN04	Economic Operation of Power System	PC	3	1	0	30	70	100	4
5	R20EEHN05	Renewable Energy and Grid Integration	PC	3	1	0	30	70	100	4
In addition to any of the four subjects, MOOC/NPTEL Courses for 04 credits (02 courses @ 2 credits each) are compulsory in the domain of Electrical and Electronics Engineering										

POOL-2

Power Electronics and Drives: (any four of the following subjects which are not chosen as professional electives are to be considered for Honors Degree)

S. No.	Subject Code	Subject	Cat. Code	L	T	P	Internal Marks	External Marks	Total Marks	Credits
1	R20EEHN06	Analysis of Power Electronic Converters	PC	3	1	0	30	70	100	4
2	R20EEHN07	Advanced Electric Drives	PC	3	1	0	30	70	100	4
3	R20EEHN08	Analysis of Electrical Machines	PC	3	1	0	30	70	100	4
4	R20EEHN09	SMPS and UPS	PC	3	1	0	30	70	100	4
5	R20EEHN10	Power Electronics for Renewable Energy Systems	PC	3	1	0	30	70	100	4
In addition to any of the four subjects, MOOC/NPTEL Courses for 04 credits (02 courses @ 2 credits each) are compulsory in the domain of Electrical and Electronics Engineering										

POOL-3

Advanced Control Systems: (any four of the following subjects which are not chosen as professional electives are to be considered for Honors Degree)

S. No.	Subject Code	Subject	Cat. Code	L	T	P	Internal Marks	External Marks	Total Marks	Credits
1	R20EEHN11	Intelligent Controllers	PC	3	1	0	30	70	100	4
2	R20EEHN12	Non-Linear control	PC	3	1	0	30	70	100	4
3	R20EEHN13	Industrial Automation Systems	PC	3	1	0	30	70	100	4
4	R20EEHN14	Digital Instrumentation	PC	3	1	0	30	70	100	4
5	R20EEHN15	Control of Electrical Drives	PC	3	1	0	30	70	100	4
In addition to any of the four subjects, MOOC/NPTEL Courses for 04 credits (02 courses @ 2 credits each) are compulsory in the domain of Electrical and Electronics Engineering										

POOL-4

Electric Vehicle Technology: (any four of the following subjects which are not chosen as professional electives are to be considered for Honors Degree)

S. No.	Subject Code	Subject	Cat. Code	L	T	P	Internal Marks	External Marks	Total Marks	Credits
1	R20EEHN16	Electric Vehicle Mechanics and Control	PC	3	1	0	30	70	100	4
2	R20EEHN17	Electric Vehicle Dynamics	PC	3	1	0	30	70	100	4
3	R20EEHN18	Battery Technologies for Electric Vehicles	PC	3	1	0	30	70	100	4
4	R20EEHN19	Charging Infrastructure for EVs	PC	3	1	0	30	70	100	4
5	R20EEHN20	Hybrid Electric Vehicles	PC	3	1	0	30	70	100	4
In addition to any of the four subjects, MOOC/NPTEL Courses for 04 credits (02 courses @ 2 credits each) are compulsory in the domain of Electrical and Electronics Engineering										

GENERAL MINOR TRACKS

S. No.	Subject Code	Subject	Cat. Code	L	T	P	Internal Marks	External Marks	Total Marks	Credits
1	R20CCMN08	Fundamentals of Electrical Circuit	PC	3	1	0	30	70	100	4
2	R20CCMN09	Concepts of Electrical Measurements	PC	3	1	0	30	70	100	4
3	R20CCMN10	Energy Audit and Conservation	PC	3	1	0	30	70	100	4
4	R20CCMN11	Electrical Machines	PC	3	1	0	30	70	100	4
5	R20CCMN12	Renewable Energy Technologies	PC	3	1	0	30	70	100	4
In addition to any of the four subjects, MOOC/NPTEL Courses for 04 credits (02 courses @ 2 credits each) are compulsory in the domain of Electrical and Electronics Engineering										

I B. Tech. - I SEMESTER

S. No.	Subject Code	Subject	Cat. Code	L	T	P	Internal Marks	External Marks	Total Marks	Credits
1	R20CC1101	Technical and Communicative English – I	HS	3	0	0	30	70	100	3
2	R20CC1102	Linear Algebra and Calculus	BS	2	1	0	30	70	100	3
	R20CC1105	Problem Solving Using C	ES	3	0	0	30	70	100	3
3	R20EE1109	Basics in Mechanical and Civil Engineering	ES	3	0	0	30	70	100	3
5	R20EE1110	Engineering Drawing and Design	ES	1	0	4	30	70	100	3
6	R20CC11L1	Soft Skills and Communication Skills Lab-1	HS	0	0	3	15	35	50	1.5
7	R20CC11L2	Problem Solving Using C Lab	ES	0	0	3	15	35	50	1.5
8	R20EE11L6	Basics in Mechanical and Civil Engineering Lab	ES	0	0	3	15	35	50	1.5
		Total		**12**	**1**	**13**	**195**	**455**	**650**	**19.5**

I B. TECH I-SEMESTER	L	T	P	INTERNAL MARKS	EXTERNAL MARKS	TOTAL MARKS	CREDITS
	3	0	0	30	70	100	3
R20CC1101	TECHNICAL AND COMMUNICATIVE ENGLISH - I (Common to All Branches)						

COURSE OBJECTIVES

- To enable the engineering students develop their basic communication skills in English for academic and social purposes.
- To equip the students with appropriate oral and written communication skills.
- To inculcate the skills of listening, reading and critical thinking.
- To integrate English Language learning with employability skills and training.
- To enhance the students' proficiency in reading skills enabling them meet the academic demands of their course.

COURSE OUTCOMES

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

CO 1: Infer explicit and implicit meaning of a text, recognize key passages; raise questions and summarize it (Apply-3).

CO 2: Compose paragraphs, essays, emails, letters, reports, resume and transfer information into tables, Pie and bar diagrams. (Creating-5).

CO 3: Build grammatically correct sentences using a variety of sentence structures (Apply3).

CO 4: Enhance word power and usage of lexicons (Apply3).

TEACHING METHODOLOGY

The methodology of teaching will be chalk and talk, PPT, audio-visual, flipped class and activity based teaching.

UNIT-I: HOURS OF INSTRUCTION PER UNIT: 8

1. A Drawer full of Happiness

a. **Listening** : Dialogues, Task based listening activities.
b**. Speaking** : Asking and answering general questions.
c. **Reading** : Skimming, Scanning.
d. **Writing** : Punctuations, Paragraphs.
e. **Grammar & Vocabulary** : Nouns, Adjuncts, GRE Vocabulary, Technical Vocabulary.

UNIT-II: HOURS OF INSTRUCTION PER UNIT: 8

2. Nehru's Letter to daughter Indira on her Birthday

a. **Listening** : Individual and pair based listening to the audio track.
b**. Speaking** : Discussion in pairs / small groups on specific topics.
c. **Reading** : Identifying sequence of ideas; recognising verbal techniques.
d. **Writing** : Summarising, Paraphrasing.
e. **Grammar & Vocabulary** : Articles, Adjectives, Prepositions Verbal Competence,

Synonyms & Antonyms,
Analogy,
GRE Vocabulary,
Technical Vocabulary.

UNIT-III: HOURS OF INSTRUCTION PER UNIT: 8

3. Stephen Hawking- Positivity 'Benchmark'

a. **Listening** : Listening for global comprehension and summarising.

b**. Speaking** : Discussing specific topics in pairs (or) small groups and reporting the discussion, Complaining, Apologising.

c. **Reading** : Reading between the lines, Critical reading for evaluation.

d. **Writing** : Official Letter writing, E-Mail etiquette, General Netiquette, Covering Letter & Resume writing.

e. **Grammar & Vocabulary** : Phrasal verbs, Verbs, Tenses (Present, Past & Future), Concord: Subject-Verb Agreement,
Verbal reason,
Using equivalents,
Word associations,
GRE Vocabulary,
Technical Vocabulary.

UNIT-IV: HOURS OF INSTRUCTION PER UNIT: 8

4. like a Tree, Unbowed: Wangari Maathai- Biography

a. Listening : Making predictions while listening to conversations (or) transactional dialogues.

b. Speaking : Role plays for practice of conversational English in academic contexts (formal and informal) .

c. Reading : Information transfer (Tables, Bar Diagrams, Line Graphs, Pie Diagrams)

d. Writing : Interpreting visual information, Statement of Purpose (SOP)

e. **Grammar & Vocabulary** : Gender inclusive language (Gendered Noun, Gender-neutral Noun), Quantifying expressions, Adjectives, Adverbs, Degrees of comparison,
GRE Vocabulary,
Technical Vocabulary.

UNIT-V: HOURS OF INSTRUCTION PER UNIT: 8

5. "Stay Hungry, Stay Foolish"- Rushmi Bansal

a. **Listening** : Identifying key terms, understanding concepts, interpreting the concepts.

b**. Speaking** : Formal oral presentations on topics from academic contexts.

c. **Reading** : Reading comprehension, The RAP strategy for in-depth reading, Intensive reading and extensive reading.

d. **Writing** : Academic proposals, Poster presentation.

e. **Grammar & Vocabulary** : Reported Speech, Reporting verbs for academic purposes,
Corrections of sentences,
GRE Vocabulary,
Technical Vocabulary.

TEXT BOOKS

1. INFOTECH ENGLISH, Maruthi Publications, Guntur- 522001.

REFERENCE BOOKS

1. Raymond Murphy, *Murphy's English Grammar,* Cambridge University Press 2004
2. Meenakshi Raman, Sangeeta Sharma, *Technical Communication: English Skills for Engineers*, Oxford University Press, 2009
3. Michael Swan, *Practical English Usage,* Oxford University Press, 1996

WEB REFERENCES

1. www.enchantedlearning.com
2. https://www.englisch-hilfen.de/en/
3. https://www.bbc.co.uk/learningenglish/
4. https://in.usembassy.gov/education-culture/american-spaces/american-space-new-delhi/collection/
5. https://www.talkenglish.com/speaking/basics/speaking_basics_ii.aspx
6. https://www.englishclub.com/speaking/
7. https://agendaweb.org/listening-exercises.html
8. https://www.esolcourses.com/content/topicsmenu/listening.html
9. https://www.esl-lab.com/
10. https://www.eagetutor.com/eage-fluent-english-speaking-search-p.htm?gclid=EAIaIQobChMIpr-F5OzH7QIVChsrCh1kBAkzEAMYASAAEgINpfD_BwE
11. https://www.myenglishpages.com/site_php_files/reading.php
12. https://www.cambridgeenglish.org/learning-english/free-resources/write-and-improve/

I B.TECH I-SEMESTER	L	T	P	INTERNAL MARKS	EXTERNAL MARKS	TOTAL MARKS	CREDITS
	3	0	0	30	70	100	3
R20CC1102	LINEAR ALGEBRA & CALCULUS (Common to All Branches)						

COURSE OBJECTIVES

- Understanding basic concepts of linear algebra (systems of linear equations, matrix calculus).
- To become proficiency in solving computational problems of linear algebra.
- To acquire knowledge on mean value theorems in calculus.
- Familiarization about the techniques in calculus and multivariate analysis.

COURSE OUTCOMES

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

CO 1: Solve the system of linear equations. [Apply - K3]

CO 2: Analyze the applications of matrices in various fields and obtain Eigen values and Eigenvectors. [Analyzing-K4]

CO 3: Relate the results of mean value theorems in calculus to Engineering problems. [Understanding-K2]

CO 4: Apply the functions of several variables to evaluate the rates of change with respect to time and space variables in engineering. [Apply - K3]

CO 5: Identify the area and volume by interlinking them to appropriate double and triple integrals. [Apply - K3]

UNIT-I: LINEAR SYSTEMS OF EQUATIONS (10 hours)

Rank of a matrix - Echelon form, Normal form, Solution of linear systems, Direct Methods, Gauss elimination, Gauss Jordon and Gauss Seidal Methods. Solutions of linear simultaneous equations: LU decomposition.

Application: Finding the current in a electrical circuit, Traffic flow

UNIT – II: EIGENVALUES AND EIGENVECTORS (12 hours)

Eigenvalues, Eigenvectors, Properties, Cayley - Hamilton Theorem(without proof), Quadratic forms, Reduction of quadratic form to canonical form, Rank, Positive definite, negative definite, semi definite, index, signature.

Application: Finding powers and inverse of a square matrix using Cayley Hamilton's Theorem.

UNIT – III: MEAN VALUE THEOREMS (8 hours)

Review on limits and continuity, Mean Value theorems (without proofs): Rolle's Theorem, Lagrange's theorem, Cauchy's theorem, Taylor's (Generalized mean value) theorem, increasing and decreasing functions, Maxima and minima of function of single variable.

UNIT- IV: PARTIAL DIFFERENTION (8 hours)

Function of two or more variables, Partial derivatives, Total derivatives, change of variables, Jacobian - functional dependence, Taylor's theorem for Two variables. Maxima and Minima of functions of two variables, Lagrange's method of undetermined multipliers.

UNIT-V: MULTIPLE INTEGRALS **(10 hours)**

Double and triple integrals, Change of Variables, Change of order of Integration, volume. Application: Momenta of Inertia.

TEXT BOOKS

1. Dr. B.S. Grewal, "*Higher Engineering Mathematics*", 43rd Edition, Khanna Publishers, 2012.
2. B.V. Ramana, "Higher Engineering Mathematics", 32nd Edition, McGraw Hill Education, 2018.

REFERENCES

1. N.P. Bali, Bhavanari Satyanarayana, Indrani Promod Kelkar, "*Engineering Mathematics*", University Science Press, (An Imprint of Lakshmi Publications Pvt., Ltd) New Delhi, 2012.
2. Kreyszig E, "*Advanced Engineering Mathematics*", 8th Edition, John Wiley, Singapore, 2001.
3. Greenberg M D, "*Advanced Engineering Mathematics*", 2nd Edition, Pearson Education, Singapore, Indian Print, 2003.
4. Peter V. O'Neil, *"Advanced Engineering Mathematics"*, 7th Edition, Cengage Learning, 2011.
5. Bhavanari Satyanarayana, Pradeep Kumar T.V. & Srinivasulu D, "Linear Algebra and Vector Calculus", Studera Press, New Delhi, 2017.

I B.TECH I-SEMESTER	L	T	P	INTERNAL MARKS	EXTERNAL MARKS	TOTAL MARKS	CREDITS
	3	0	0	30	70	100	3
R20CC1105	PROBLEM SOLVING USING C (Common to All Branches)						

COURSE OBJECTIVE

- To know the basic problem-solving process using Flow Charts and algorithms.
- To understand the basic concepts of control structures in C.
- To learn concepts of arrays, functions, pointers and Dynamic memory allocation in C.
- To use the concepts of structures, unions, files and command line arguments in C.

COURSE OUTCOMES

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

CO1: Develop algorithms and flow charts for simple problems. [K3]
CO2: Utilize suitable control structures for developing code in C. [K3]
CO3: Make use of functions and arrays in developing modular programs. [K3]
CO4: Make use of structures and pointers to write well-structured programs. [K3]
CO5: Make use of file Operations in C programming for a given application. [K3]

UNIT-I: INTRODUCTION TO ALGORITHMS AND PROGRAMMING LANGUAGES

Algorithm – Key features of Algorithms – Some more Algorithms – Flow Charts – Pseudo code – Programming Languages – Generation of Programming Languages – Structured Programming Language. **Introduction to C:** Structure of C Program – Writing the first C Program -Compiling and Executing C Programs - Using Comments – Keywords – Identifiers – Basic Data Types in C – Variables – Constants – I/O Statements in C - Operators in C -Programming Examples – Type Conversion and Type Casting.

UNIT II: DECISION CONTROL AND LOOPING STATEMENTS

Introduction to Decision Control Statements – Conditional Branching Statements – Iterative Statements – Nested Loops – Break and Continue Statement – Goto Statement.

Functions: Introduction – using functions – Function declaration/ prototype – Function Definition – function call – return statement – Passing parameters – Scope of variables –Storage Classes – Recursive functions – Recursion vs Iteration.

UNIT III: ARRAYS

Introduction – Declaration of Arrays – Accessing elements of the Array – Storing Values in Array – Calculating the length of the Array – Operations on Array — Two Dimensional Arrays – Operations on Two Dimensional Arrays.

Strings: Introduction – Reading Strings – Writing Strings – String Manipulation functions -Array of Strings.

UNIT IV: POINTERS

Introduction to Pointers – declaring Pointer Variables – Pointer Expressions and Pointer Arithmetic – Null Pointers – Passing Arguments to Functions using Pointer, Dynamic Memory Allocation.

Structure, Union, and Enumerated Data Types: Introduction – Nested Structures –Arrays of Structures – Structures and Functions – Self-referential Structures – Union –Enumerated Data Types.

UNIT V: FILES

Introduction to Files – Using Files in C – Reading Data from Files – Writing Data To Files – Detecting the End-of-file – Error Handling during File Operations – Accepting Command Line Arguments – Functions for Selecting a Record Randomly - Remove –Renaming a File – Creating a Temporary File

TEXT BOOKS

1. Reema Thareja**, "**Programming in C**"**, First **edition,** OXFORD University Press 2018.

REFERENCE BOOKS

1. REEMA THAREJA, "Introduction to C programming" OXFORD UNIVERSITY PRESS
2. Rachhpal Singh, "Programming in C", kalyani publishers.
3. E Balagurusamy, "computing fundamentals & c programming", isbn 978-0-07- 066909-3, Tata McGraw-Hill, Second Reprint, 2008.
4. Ashok N Kamthane, "Programming with ANSI and Turbo C", Pearson Edition Publications, 2002.
5. Dennis Richie and Brian Kernighan, "The C programming Language", 2nd edition.

WEB REFERENCES

1. http://cprogramminglanguage.net/
2. http://lectures-c.blogspot.com/
3. http://www.coronadoenterprises.com/tutorials/c/c_intro.htm

http://vfu.bg/en/e-Learning/Computer-Basics--computer_basics2.pdf

I B.TECH I-SEMESTER	L	T	P	INTERNAL MARKS	EXTERNAL MARKS	TOTAL MARKS	CREDITS
	3	0	0	30	70	100	3
R20EE1109	BASICS IN MECHANICAL AND CIVIL ENGINEERING (for EEE)						

COURSE OBJECTIVES

- To provide required knowledge on joining, forming, welding & power transmissions.
- To provide required knowledge on power plants and gas turbines.
- To impart the overview of Civil Engineering and its measuring techniques.
- To familiarize the materials used in Civil Engineering.

COURSE OUTCOMES

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

1. Illustrate the types of power plants and applications
2. Estimate the flow parameters in various devices
3. Understand the basics elements and measurements of civil engineering.
4. Explain the usage and proper selection of construction materials.

UNIT-I: POWER PLANT ENGINEERING

Introduction, types of power plants, Steam power plant-Layout, applications. Diesel engine power plant-Layout, applications, Gas turbine power plant-simple gas turbine, components of a gas turbine, Types of fuels.

UNIT-II: POWER TRANSMISSION

Different types of power transmission-belt drives, rope drives, chain drives. Gears:-Classification of gears, applications.

UNIT-III: IMPACT OF JETS AND PUMPS

Impulse momentum equation, Impact of Jet on stationary and moving vanes (flat and curved). Pumps: Types of pumps, Centrifugal pumps: Main components, Working principle, Reciprocating Pumps: Components, Working principle

UNITS-1V: INTRODUCTION TO CIVIL ENGINEERING

Civil Engineering contributions to the welfare of Society-Specialized sub disciplines in Civil Engineering – Structural, Construction, Geotechnical, Environmental, Transportation and Water Resources Engineering- Classification of structures, buildings, towers, chimneys, bridges, water tanks, roads, railways.

Surveying: Objects-classification-principles-measurements of distances-angles-leveling-determination of areas-contours-examples.

UNIT- V: BUILDING MATERIALS

Stones – Classification of stones, Bricks – Composition & Classification and Cement - Basic ingredients, manufacturing process, grades of cement; Aggregates – fine aggregates, coarse aggregates, Timber, steel – structural steel, steel as a reinforcement

TEXT BOOKS

1. Mechanical Engineering Science K R Gopala Krishna, Subhas publications.
2. Elements of Mechanical Engineering, M.L. Mathur, F.S.Metha&R.P.Tiwari; Jain Brothers Publications, 2009.
3. Elements of Civil Engineering and Engineering Mechanics, R. V. Ravikar, PHI Learning Pvt. Ltd
4. Basic Civil Engineering, M S Palanichamy, Tata McGraw-Hill
5. Civil Engineering: Through Objective Type Questions, Gupta S.S., CBS Publishers and Distributors

REFERENCES

1. Power plant engineering, PK Nag, Tata McGraw Hill Publications
2. Gas turbines, V Ganeshan.
3. Fundamentals of Civil Engineering: An Introduction to the ASCE Body of Knowledge By Richard H. McCuen, Edna Z. Ezzell, Melanie K. Wong, CRC Press
4. Civil Engineer's Handbook of Professional Practice, Karen Hansen, Kent Zenobia

WEB REFERENCES

1. https://www.wileyindia.com/power-plant-engineering-as-per-aicte-theory-and-practice.html
2. https://www.classcentral.com/course/swayam-power-plant-engineering-17735

I B.TECH I-SEMESTER	L	T	P	INTERNAL MARKS	EXTERNAL MARKS	TOTAL MARKS	CREDITS
	1	0	4	30	70	100	3
R20EE1110	ENGINEERING DRAWING AND DESIGN						

COURCE OBJECTIVES

- The students to use drawing instruments and to draw polygons, engineering Curves & engineering scales.
- The students use to make orthographic projections, projections of points, simple lines & projections of the lines inclined to both the lines.
- The students use to draw the projections of the plane inclined to both the plane.
- The students use to draw the projections of solids & development of surfaces.
- The students use to draw conversion of isometric views to orthographic views vice versa and to learn basic drawing commands in auto cad.

COURSE OUTCOMES

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

CO1: Construct the geometrical shapes of regular polygons, Engineering Curves, and scales.
CO2: Illustrate the orthographic projections, projections of points, and lines inclined to both the planes.
CO3: Construct the projection of planes inclined to both the planes
CO4: Construct the projection of solids for engineering applications.
CO5: Analyse the conversion of isometric views to orthographic views vice versa.

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UNIT– I: THE BASIC CONCEPTS IN ENGINEERING DRAWING

Introduction to engineering drawing instruments, lettering and dimensioning practice. Geometrical constructions- Constructing regular polygons by general methods.

CURVES USED IN ENGINEERING PRACTICE: Introduction to conic sections, construction of ellipse, parabola, hyperbola by eccentricity method. Construction of ellipse by - Arcs of circles Method, Concentric Circles Method and Oblong Method, & parallelogram methods.

UNIT–II: ORTHOGRAPHIC PROJECTIONS

Introduction to type of projections, first angle and third angle projections.

PROJECTION OF POINTS: Principles of orthographic projection – Convention – First angle projections, projections of points.

PROJECTIONS OF STRAIGHT LINES:

Projections of straight lines parallel to both the planes, parallel to one plane and inclined to the other plane - Projections of straight lines inclined to both the planes- determination of true lengths, angle of inclination.

UNIT–III: PROJECTIONS OF PLANES

Regular planes perpendicular/parallel to one plane and inclined to the other reference plane; inclined to both the reference planes.

UNIT-IV: PROJECTIONS OF SOLIDS
Introduction to projections of solids, types of solids: prisms, pyramids, cones and cylinders –simple positions and the axis inclined to one of the plane.

UNIT-V: ISOMETRIC AND ORTHOGRAPHIC PROJECTIONS
Introduction of isometric views, isometric projections & orthographic projections. Conversion of isometric views to orthographic views and orthographic views to isometric views.
INTRODUCTION TO AUTO CAD: Practice on draw, edit & modify commands using auto CAD.

TEXT BOOKS
1. Engineering Drawing by N.D. Butt, Chariot Publications.
2. Engineering Drawing by K.L.Narayana & P. Kannaiah, Scitech Publishers.
3. Engineering Drawing & Graphics by K.Venu gopal, New age international Publishers.

REFERENCE BOOKS
1. Engineering Graphics for Degree by K.C. John, PHI Publishers.
2. Engineering Drawing by Basant Agarwal & CM. Agarwal, Tata McGraw Hill Publishers.

WEB REFERENCES
1. https://nptel.ac.in/courses/112103019/17

E-BOOKS
1. https://www.pdfdrive.com/textbook-of-engineering-drawing-e28918244.html

I B.TECH I-SEMESTER	L	T	P	INTERNAL MARKS	EXTERNAL MARKS	TOTAL MARKS	CREDITS
	0	0	3	15	35	50	1.5
R20CC11L1	SOFT SKILLS & COMMUNICATION SKILLS LAB-1 (Common to all branches)						

COURSE OBJECTIVES

1. To build confidence in the students to communicate effectively in English.
2. To strengthen the oral communication skills to enable them to interact with the people in various social situations.
3. To enable the learners improve pronunciation with the knowledge of phonetics.
4. To provide exposure to students to soft skills like Goal Setting, Time Management, Interpersonal Skills, and Intra Personal Skills.

COURSE OUTCOMES

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

CO1: Communicate effectively with good pronunciation, overcoming mother tongue influence in academic and professional environment.

CO 2: Listen and comprehend several accents of English Language

CO 3: Take part in various conversations/discourses using formal and informal expressions.

CO 4: Adapt soft skills successfully in personal and professional life.

UNIT– I

1. Introduction to Phonetics.
2. Listening - TEDx Talks (https://www.ted.com/talks/ashweetha_shetty_how-education-helped-me-rewrite-my-life?language-en#t-623369)
3. Self-Introduction

UNIT–II

1. Pronunciation Rules & Common Errors in Pronunciation.
2. Listening -TEDx Talks(https://www.youtube.com/watch?v=Dk20-E0yx_s)
3. Role Play

UNIT–III

1. Situational Dialogues (Inviting, Accepting and Declining Invitations)
2. Listening - TEDx Talks (https://www.youtube.com/watch?v=IgAnj6r1O48)
3. JAM

UNIT-IV

1. Situational Dialogues (Commands, Instructions and Requests)
2. Listening -TEDx Talks(https://youtu.be/SKvMxZ284AA)
3. Telephonic Etiquette.

UNIT-V

1. Time Management.
2. Goal Setting.
3. Interpersonal Skills & Intra personal skills.

TEXT BOOKS

1. "Strengthen Your Communication Skills", Maruthi Publications, 2013.

REFERENCE BOOKS

1. Meenakshi Raman, Sangeeta Sharma, Technical Communication: Principles and Practice, Oxford University Press, 2015
2. J.D.O Conner, Better English Pronunciation, Cambridge University Press 1980.
3. T.Balasubramanian, "A Text Book of English Phonetics for Indian Students", Macmillan,1981
4. Penny ur Grammar Practice Activities, Cambridge University Press, 2010.
5. Mark Hancock, Pronunciation in Use, Oxford University Press 2007.
6. K. R Lakshmi Narayanan, T. Murugavan, Managing Soft Skills,Scitech Publications, 2010.
7. K V S G Murali Krishna, K V K K Prasad, Placement and Personality Development, Second Edition, Reem Publications Pvt. Limited, 2012
8. Shiv Khera, You can Win, Bloomsbury Publication, 2014
9. Stephen R. Covey, The 7 Havits of Highly Effective People, Free Press, 1989

I B.TECH I-SEMESTER	L	T	P	INTERNAL MARKS	EXTERNAL MARKS	TOTAL MARKS	CREDITS
	0	0	3	15	35	50	1.5
R20CC11L2	PROBLEM SOLVING USING C LAB (Common to All Branches)						

COURSE OBJECTIVE

- The purpose of this course is to introduce to students to the field of language. The students will be able to enhance their analyzing and problem solving skills and use the same for writing programs in C.

COURSE OUTCOMES

After completion of this C Programming Lab, students would be able to

CO1: Study, analyze and understand logical structure of computer programming and different constructs to develop programs in C Language. [K4]

CO2: Compare and contrast various data types and operator precedence. [K2]

CO3: Analyze the use of conditional and looping statements to solve problems associated with conditions and repetitions. [K4]

CO4: Analyze simple data structures, use of pointers and dynamic memory allocation techniques [K4]

CO5: Make use of functions and file I/O operations in developing C Programs. [K3]

EXERCISE 1

Construct Flowcharts for the following through Raptor:

1. Develop a calculator to convert time, distance, area, volume and temperature from one unit to another.
2. Calculate simple and compound interest for various parameters specified by the user.
3. Calculate the average of n numbers.

EXERCISE 2

1. Write a C Program to calculate the area of triangle using the formula
2. Area = $\sqrt{(s * (s-a) * (s-b) * (s-c)}$where s= (a+b+c)/2
3. Write a C Program to find the largest of three numbers using ternary operator.
4. Write a C Program to swap two numbers without using a temporary variable.

EXERCISE 3

1. Write a C program to find the roots of a quadratic equation.
2. Write a C program, which takes two integer operands and one operator form the user, performs the operation and then prints the result. Consider the operators +,-,*, /, % and use Switch Statement.

EXERCISE 4

1. Write a C program to find the sum of individual digits of a positive integer and find the reverse of the given number.
2. Write a C program to generate all the prime numbers between 1 and n, where n is a value supplied by the user.

EXERCISE 5

1. Write a C Program to print the multiplication table of a given number n up to a given value, where n is entered by the user.
2. Write a C Program to enter a decimal number, and calculate and display the binary equivalent of that number.
3. Write a C Program to check whether the given number is Armstrong number or not.

EXERCISE 6

1. Write a C program to interchange the largest and smallest numbers in the array.
2. Write a C program to input two m x n matrices, check the compatibility and perform addition and multiplication of them.

EXERCISE 7

1. Write a C Program to find sum of following series for a given n value.

i. 1+(1+2)+(1+2+3)+(1+2+3+4)+(1+2+3+4+5)+...+(1+2+...+n).

ii. 1+(2+2)+(3+3+3)+(4+4+4+4)+…+(n+n+n+n..+n).

2. Write a C Program to display following patterns for a given n value

i.
```
        1
      2   2
    3   3   3    if n =3
```

i.
```
      1
    2  2
  3  3  3
    2  2
      1     if n=3.
```

EXERCISE 8

Draw a flow chart using Raptor and write C programs that use both recursive and non-recursive Functions for the following

1. To find the factorial of a given integer.
2. To find the GCD greatest common divisor of two given integers.

EXERCISE 9

1. Write a C Program to find Fibonacci sequence.
2. Write C programs illustrating call by value and call by reference concepts.

EXERCISE 10

Write C Programs for the following string operations without using the built in functions - to concatenate two strings

1. To append a string to another string
2. To compare two strings

EXERCISE 11

Write C Programs for the following string operations without using the built in functions

1. To find whether a given string is palindrome or not
2. Write a C Program to count number of occurrences of each character in a given string. Example:

if input 'APPLE' then output is 'A count 1, P count 2, L count 1, E count 1'

EXERCISE 12

Write a C program that uses functions to perform the following operations:

1. To insert a sub-string in to given main string from a given position.
2. To delete n Characters from a given position in a given string.
3. To replace a character of string either from beginning or ending or at a specified location

EXERCISE 13

1. Write a C Program to Implement Taylor series method
2. Write a C Program to Implement Euler's method
3. Write a C Program to Implement Runge Kutta method

EXERCISE 14

1. Write C Program to reverse a string using pointers
2. Write a C Program to compare two arrays using pointers
3. Write a C program to swap two numbers using pointers

EXERCISE 15

1. Write the following C Programs using Dynamic memory management functions.

a) Accept size of array from user then read n elements into two arrays and store sum of those two arrays in third array, display three arrays using pointers.

b) User will specify data type and data to store, use generic pointer to store that data and display given input.

EXERCISE 16

1. Examples which explores the use of structures, union and other user defined variables

EXERCISE 17

1. Write a C program which copies one file to another.
2. Write a C program to count the number of characters and number of lines in a file.
3. Write a C Program to merge two files into a third file. The names of the files must be entered using command line arguments.

EXERCISE 18

Virtual Lab: http://cse02-iiith.vlabs.ac.in/ /

Any three programs must be submitted with result from the above link.

*** At the end of the semester the student has to submit a Mini-Project on Computer Programming. The list of Mini-Projects is available in the department.**

TEXT BOOKS

1. Reema Thareja, "Programming in C", OXFORD.
2. The C programming Language by Dennis Richie and Brian Kernighan 2nd Ed.

REFERENCE BOOKS

1. Dr.E.Balaguruswamy, "Programming in ANSI C", Tata McGraw-Hill Education.
2. Hanly, "Problem Solving and Program Design in C", Koffman, 7th ed, PEARSON.
3. Forouzan, Gilberg, Prasad,"C Programming, A Problem Solving Approach", CENGAGE.
Programming in C, Second Edition by Ashok N.Kamthane, Pearson.

I B.TECH I-SEMESTER	L	T	P	INTERNAL MARKS	EXTERNAL MARKS	TOTAL MARKS	CREDITS
	0	0	3	15	35	50	1.5
R20EE11L6	BASICS IN MECHANICAL AND CIVIL ENGINEERING LAB						

COURSE OBJECTIVE

1. To impart practical exposure on the performance evaluation methods of various flow measuring equipment and hydraulic turbines and pumps.
2. To provide knowledge on various heat engines and compressors
3. To enable the students the basic principles of surveying.
4. Ability to communicate effectively the mechanical properties of materials.

COURSE OUTCOMES

After completion of the course students are able to

1. **Estimate** the discharge through flow measurement device
2. **Solve** the flow equations to estimate performance of the turbines and pumps
3. **Determine** the calorific value of fuel and to perform tests on engines and compressor
4. **Classify** and understand the applications of basic building materials.
5. **Apply** the basic principles of engineering surveying, linear and Angular measurements**.**

LIST OF EXPERIMENTS

Any Ten experiments from the following list are required to be conducted

1. Calibration of Venturimeter.
2. Performance Test on PeltonWheel.
3. Performance Test on FrancisTurbine.
4. Performance Test on Single Stage CentrifugalPump.
5. Performance Test on ReciprocatingPump.
6. Determination of Calorific Value of a fuel using Bomb Calorimeter
7. Performance Test on 4-Stroke Petrol Engine
8. Measurement the distance between two points using Chain and tape.
9. Measurement of angles between two points using Prismatic Compass.
10. Compression test on mild steel, Brick, Wood.
11. Impact test on Mild steel (Charpy)
12. Impact test on Mild Steel (Izod)
13. Hardness tests on Ferrous metals – Brinell's, Rockwell
14. Hardness tests on ferrous metals – Vicker's.

VIRTUAL LAB

1. Verification of Bernoulli's theorem
2. Closed Traverse by using Compass Surveying

I B. Tech. – II SEMESTER

S. No.	Subject Code	Subject	Cat. Code	L	T	P	Internal Marks	External Marks	Total Marks	Credits
1	R20CC1201	Differential Equations and Vector Calculus	BS	2	1	0	30	70	100	3
2	R20CC1205	Applied Physics	BS	3	0	0	30	70	100	3
3	R20EE1209	Electronics Devices and Circuits	ES	3	0	0	30	70	100	3
4	R20EE1213	Electrical Circuit Analysis-I	PC	2	1	0	30	70	100	3
5	R20CC1210	Data Structures	ESC	3	0	0	30	70	100	3
6	R20EE12L9	Electronics Devices and Circuits Lab	ES	0	0	3	15	35	50	1.5
7	R20CC12L10	Applied Physics Lab	BS	0	0	3	15	35	50	1.5
8	R20CC12L11	Data Structures Lab	ES	0	0	3	15	35	50	1.5
9	R20CC12MC2	Constitution of India (Zero Credit Course)	MC	2	0	0	-	-	-	-
		Total		**15**	**2**	**9**	**195**	**455**	**650**	**19.5**

I B.TECH II-SEMESTER	L	T	P	INTERNAL MARKS	EXTERNAL MARKS	TOTAL MARKS	CREDITS
	2	1	0	30	70	100	3
R20CC1201	DIFFERENTIAL EQUATIONS AND VECTOR CALCULUS (Common to Civil, EEE, ME and ECE)						

COURSE OBJECTIVES

1. To formulate and solve first order ordinary differential equations.
2. To solve second order differential equations of various kinds.
3. To find the solution of first order linear and non-linear partial differential equations.
4. The skills derived from the course will help the student from a necessary base to develop analytic and design concepts.

COURSE OUTCOMES

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

CO 1: Apply first order ordinary differential equations to real life situations
CO 2: Identify and apply suitable methods in solving the higher order differential equations.CO 3: Solve the partial differentiation equations.
CO 4: Interpret the physical meaning of different operators as gradient, curl and divergence.CO 5: Estimate the work done against a field, circulation and flux using vector calculus.

UNIT I: DIFFERENTIAL EQUATIONS OF FIRST ORDER AND FIRST DEGREE

Linear-Bernoulli's-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-II: LINEAR DIFFERENTIAL EQUATIONS OF HIGHER ORDER

Finding the complementary functions, Inverse operator, Rules for finding the particular integrals, Method of variation of parameters. Cauchy's and Legendre's linear equations, simultaneous linear equations with constant coefficients.
Application: L-C-R Circuit problems.

UNIT – III: FIRST ORDER PARTIAL DIFFERENTIAL EQUATIONS

Formation of partial differential equation by elimination of arbitrary constants and arbitrary functions, solutions of first order linear (Lagrange's) equations.

UNIT- IV: VECTOR DIFFERENTIATION

Scalar and vector point functions, vector operator del, del applies to scalar point functions- Gradient, del applied to vector point functions-Divergence and Curl, vector identities.

UNIT- V: VECTOR INTEGRATION

Line integral-circulation-work done, surface integral-flux, Green's theorem in the plane (without proof), Stoke's theorem (without proof), volume integral, Divergence theorem (without proof).

TEXT BOOKS

1 Dr. B.S. Grewal, "*Higher Engineering Mathematics*", 43rd Edition, Khanna Publishers, 2012.
2 B.V.Ramana, "Higher Engineering Mathematics", 32nd Edition, McGraw Hill Education, 2018.
3 Bhavanari Satyanarayana, Pradeep Kumar T.V. and Srinivasulu D, "Linear Algebra and Vector Calculus", Studera Press, New Delhi, 2017.

REFERENCES

1 Kreyszig E, "*Advanced Engineering Mathematics*", 8th Edition, John Wiley, Singapore,2001.
2 Greenberg M D, "*Advanced Engineering Mathematics*", 2nd Edition, Pearson Education, Singapore, Indian Print, 2003.
3 Peter V. O'Neil, *"Advanced Engineering Mathematics"*, 7th Edition, Cengage Learning,2011.
4 N.P. Bali, Bhavanari Satyanarayana, Indrani Promod Kelkar, "*Engineering Mathematics*", University Science Press, (An Imprint of Lakshmi Publications Pvt., Ltd) New Delhi, 2012.

I B.TECH II-SEMESTER	L	T	P	INTERNAL MARKS	EXTERNAL MARKS	TOTAL MARKS	CREDITS
	3	0	0	30	70	100	3
R20CC1205	APPLIED PHYSICS (COMMON TO ECE,EEE,CSE,ITandCAI)						

COURSE OBJECTIVES

1. To impart knowledge in basic concepts of wave optics, fiber optics, properties of solid crystal materials and magnetic materials, acoustics, superconductors.
2. To familiarize the applications of materials relevant to engineering field.

COURSE OUTCOMES

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

CO 1: Interpret the experimental evidence of wave nature of light and interference in thinFilms, Diffraction grating and Polaraisation in various fields.

CO 2: Analyse and understand various types of lasers and optical fibers.CO 3: Identify the crystal structures and XRD techniques.

CO 4: Apply the magnetic materials in engineering field.

CO 5: Identify the various applications of semiconductors in engineering field.

UNIT– I: INTERFERENCE and DIFFRACTION

Introduction -Interference in thin films by reflection – Newton's rings, introduction to diffraction – difference between Fresnel's and Fraunhofer diffraction - Fraunhofer diffraction at single slit (qualitative) - Diffraction grating.

Polarization: Introduction – Types of Polarization – Double refraction – Nicol's prism-Quarter wave plate and Half Wave plate - Applications

UNIT–II: LASERS

Introduction – Characteristics of lasers – Spontaneous and Stimulated emission of radiation – Population inversion – Ruby laser – Helium Neon laser-Applications.

Fiber Optics: Introduction- Basic Structure and Principle of optical fiber - Acceptance angle – Acceptance cone - Numerical Aperture-Applications.

UNIT–III: CRYSTALLOGRAPHY

Introduction – Space lattice – Basis – Unit Cell – Lattice parameters – Bravais lattices – Crystal systems – Structures and packing fractions of SC,BCC and FCC.

X-Ray Diffraction: Directions and planes in crystals – Miller indices – Separation between successive (h k l) planes – Bragg's law..

UNIT-IV: ELECTROMAGNETIC FIELDS

Gauss divergence theorem - Stokes theorem (Quantitative) – Fundamental laws of electromagnetism

– Maxwell's Electromagnetic Equations.

Magnetic materials: Magnetic Susceptibility- Magnetic permeability –Classification of Magnetic materials – Dia, Para, and Ferro – Hysteresis Loop- Soft and Hard magnetic materials – Applications- Superconductivity- Properties, Meissner effect - Type-I and Type-II super conductors.

UNIT-V: QUANTUM MECHANICS

Introduction –de-Broglie's concept of Matter waves – Physical significance of wave function -Schrodinger Time Independent wave equations – Particle in a one dimensional potential box.

Semiconductor Physics: Origin of energy band formation in solids- classification of materials intoconductors, semiconductors and insulators, Intrinsic and Extrinsic semiconductor- Hall Effect.

TEXT BOOKS

1. A.J. Dekker, "Solid state Physics", ISBN 10: 0333918339 / ISBN 13: 9780333918333, Mc Millan India Ltd, First edition, 2000.
2. M.N. Avadhanulu and P.G. Kshirasagar, "A text book of Engineering Physics", ISBN 81-219-0817-5, S. Chand publications, First Edition, 2011.
3. P. K. Palanisamy, "Engineering Physics", ISBN: 9788183714464, Scitech Publishers, 4th Edition, 2014
4. M.R. Srinivasan, "Engineering Physics", ISBN978-81-224-3636-5, New Age international publishers, 2nd Edition,2014

REFERENCE BOOKS

1. Charles Kittle, "Introduction to solid state physics" ISBN: 9788126578436, Willey India Pvt.Ltd, 5TH edition, 2012.
2. M.Arumugam, "Applied Physics", ISBN: 81-89638-01-7, Anuradha Agencies, 4th edition, 2013.
3. D.K.Bhattacharya, "Engineering Physics", ISBN: 0198065426, 9780198065425, Oxford University press, 2nd edition, 2010.
4. Sanjay D Jain and Girish G Sahasrabudhe "Engineering Physics", University PressISBN: 8173716781,1st edition, 2010.
5. B.K.Pandey and S. Chaturvedi "Engineering Physics" ISBN: 8131517616, CengageLearning, 1st edition, 2012.

WEB REFERENCES

1. http://link.springer.com/physics
2. http://www.thphys.physics.ox.ac.uk
3. http://www.sciencedirect.com/science
4. http://www.e-booksdirectory.com

E-BOOKS

1. http://www.peaceone.net/basic/Feynman
2. http://physicsdatabase.com/free-physics-books
3. http://www.damtp.cam.ac.uk/user/tong/statphys/sp.pdf
4. http://www.freebookcentre.net/Physics/Solid-State-Physics-Books.h

I B.TECH II-SEMESTER	L	T	P	INTERNAL MARKS	EXTERNAL MARKS	TOTAL MARKS	CREDITS
	3	0	0	30	70	100	3
R20EE1209	ELECTRONICS DEVICES AND CIRCUITS						

COURSE OBJECTIVES

1. Understand the operation and principles of P-N diode.
2. Understand various types of Special diodes, rectifiers and filters.
3. Know the working of BJT.
4. Know the need for transistor biasing and stabilization.
5. Know the working of FET and other Transistors.

COURSE OUTCOMES

After completion of the course, students will be able to

CO1: Use P-N diodes in electronic circuits.

CO2: Use special diodes and rectifiers in electronic circuits.CO3: Explore the operation of BJT and its applications.

CO4: Analyse the thermal stability of BJT.

CO5: Explore the operation of FET, other transistors and their applications.

UNIT- I: PN JUNCTION DIODE CHARACTERISTICS

Insulators, Semiconductors and Metals–Classification using Energy gap, Intrinsic and Extrinsic Semiconductors. P-N Junction Diode - Formation of P-N Junction, Open Circuited P-N Junction, Biased P-N Junction - Forward Bias, Reverse Bias, Current Components in PN Junction Diode, Law of Junction, Diode Current Equation - Quantitative Analysis, V-I Characteristics of Diode - Forward Bias, Reverse Bias, Breakdown in P-N Junction Diode, Temperature Dependence on V-I Characteristics, Diode Resistance-Static Resistance, Dynamic Resistance, Reverse Resistance, DiodeCapacitance - Transition Capacitance, Diffusion Capacitance, Energy Band Diagram of PN Junction Diode.

UNIT- II: SPECIAL DIODES AND RECTIFIERS

SPECIAL DIODES: Zener Diode - V-I Characteristics, Applications, Breakdown Mechanisms - Zener Breakdown and Avalanche Breakdown, Construction, Operation, Characteristics and applications of LED, LCD, Photodiode, Varactor Diode and Tunnel diode.

RECTIFIERS: Basic Rectifier setup, Half Wave Rectifier, Full Wave Rectifier, Bridge Rectifier, Inductive and Capacitive Filters, L– Section and π- Section, Derive and compare rectifier parameters with and without filter.

UNIT- III: BIPOLAR JUNCTION TRANSISTOR (BJT)

Bipolar Junction Transistor – Types, Symbols and Operation, Transistor Current Components, Transistor Equation - Relation among I_C, I_B, I_{CBO}, Transistor Configurations - CB, CE and CC, Transistor as a switch, Transistor switching times, Transistor as an Amplifier, Characteristics of Transistor in Common Base Configuration, Common Emitter and Common Collector Configurations

Input and output characteristics, Early effect, Transistor parameters, Current amplification factor, Relation among α, β, and γ, Comparison of CB, CE and CC Configurations, Punch Through/ Reach through, Typical transistor junction voltage values.

UNIT- IV: BJT BIASING AND THERMAL STABILITY

Need For Biasing, Operating Point, Load Line Analysis - D.C. Load Line, A.C. Load Line, and Biasing - Methods, Basic Stability, Fixed Bias, Collector-to-base Bias and Self Bias.

UNIT- V: FET and OTHER TRANSISTORS

FET Types and Symbols - JFET and MOSFET/IGFET, JFET: N- Channel and P-Channel Construction, Operation, Characteristics - Drain and Transfer, Parameters - Drain Resistance, Amplification factor, Transconductance, Pinch-off voltage, MOSFET - Types - Depletion MOSFET

- N Channel and P Channel, Enhancement MOSFET - N-Channel and P-Channel, Construction, Operation, Characteristics - Transfer and Drain Characteristics for Depletion and Enhancement Modes , Comparison between JFET and MOSFET.

SCR- Symbol, Two-Transistor version, DIAC, TRIAC UJT - Negative Resistance Property and Applications.

TEXT BOOKS

1. J. Millman, C. Halkias, “Electronic Devices and Circuits”, Tata McGraw-Hill, Third edition, 2010.
2. Allen Mottershed, “Electronic Devices and Circuits”, PHI, 2011.
3. Salivahanan, N. Suresh Kumar, A. Vallavaraj, “Electronic Devices and Circuits” Tata McGraw-Hill, Second Edition, 2008.

REFERENCE BOOKS

1. Jacob Millman, C. Halkies, C.D. Parikh, Satyabrata Jit, “Integrated Electronics”, Tata McGraw-Hill, Second Edition, 2011.
2. R.L. Boylestad and Louis Nashelsky, “Electronic Devices and Circuit Theory”, Pearson Publications, Eleventh Edition, 2013.

I B.TECH II-SEMESTER	L	T	P	INTERNAL MARKS	EXTERNAL MARKS	TOTAL MARKS	CREDITS
	2	1	0	30	70	100	3
R20EE1213	ELECTRICAL CIRCUIT ANALYSIS-I						

COURSE OBJECTIVES

1. To introduce fundamental laws, basic electrical elements, sources and their characteristics.
2. To learn the concept of phase and phase relationship of basic electrical elements.
3. To impart the basic knowledge about the Resonance and coupled circuits
4. To compute electrical parameters like current, voltage and power using network theorems for AC and DC circuits.

COURSE OUTCOMES

After successful completion of this course, the students will be able to:
CO 1: Analyze basic electrical circuits using mesh and nodal analysis.
CO 2: Illustrate phase and phase relationship of basic electrical elements and circuits.CO 3: Design of tank circuit for given frequency and analyse the coupled circuits.
CO 4: Analyze the electrical circuits using network theorems for D.C. excitation.CO 5: Analyze the electrical circuits using network theorems for A.C. excitation.

UNIT-I: INTRODUCTION TO ELECTRICAL CIRCUITS

Passive components and their V-I relations. Sources (dependent and independent), Ohm's Law-Kirchhoff's laws, Network reduction techniques (series, parallel, series - parallel, star- to-delta and delta-to-star transformation). Source transformation technique, nodal analysis, mesh analysis, super node and super mesh analysis for D.C. excitations.

UNIT-II: SINGLE PHASE A.C. CIRCUITS

Periodic waveforms (determination of rms, average value and form factor). Concept of phase and phase difference. Complex and polar forms of representations, steady state analysis of R, L and C circuits with sinusoidal excitation, Power Factor and its significance, Real, Reactive power and apparent Power.

UNIT-III RESONANCE AND COUPLED CIRCUITS

Series and parallel resonance - Q factor and bandwidth - Resonant frequency of a tank circuit - Coupled circuits - Self and mutual inductances - Coefficient of Coupling - Analysis of coupled circuits - Dot rule for coupled circuits - Equivalent circuit of coupled circuits - Coupled circuits in Series and Parallel.

UNIT-IV: NETWORK THEOREMS (DC EXCITATION)

Superposition theorem, Thevenin's theorem, Norton's theorem, Maximum Power Transfer theorem, Reciprocity theorem, Millman's theorem, Tellegen's theorem and compensation theorem.

UNIT-V: NETWORK THEOREMS (AC EXCITATION)

Superposition theorem, Thevenin's theorem, Norton's theorem, Maximum Power Transfer theorem, Reciprocity theorem, Millman's theorem, Tellegen's theorem and compensation theorem.

TEXT BOOKS

1. William H. Hayt, Jack E. Kemmerly and Steven M. Durbin, "Engineering Circuit Analysis", TMH, 8th Edition, 2012

2. Chakrabarti A, "Circuits Theory (Analysis and synthesis), Dhanpath Rai and Sons, New Delhi, 1999.

REFERENCE BOOKS

1. M.E. Vanvalkenburg, "Network Analysis", PHI, 3rd Edition, 2006.
2. A Sudhakar and Shyam Mohan SP, "Circuits and Networks: Analysis and Synthesis", TMH, 5th Edition, 2015.
3. N.C.Jagan and C. Lakshminarayana, "Network Theory", B.S Publications

WEB REFERENCES

1. https://www.youtube.com/watch?v=7Nh7ISeqn6Eandlist=PLbRMhDVUMngfNnABo5mre45ZbHqJE2sUnandindex=1-82
2. https://www.youtube.com/watch?v=zkWvL1pPkMYandlist=PLFW6lRTa1g81LohrWnYo_hsVB-RIzJDRmandindex=1-60
3. https://www.youtube.com/watch?v=GZmi4mBidpwandlist=PLa4KQhDlGd7QCTX3gTz0LyoL93jVjtaMeandinde=1-148
4. https://www.youtube.com/watch?v=BqmztRuKpYIandlist=PLfDaOYdi9aZwlZNAU0gl0rZ-SctZJcLe7andindex=1-31

E-BOOKS

1. http://elearning.vtu.ac.in/P9/notes/06ES34/Unit1-KCV.pdf

I B.TECH II-SEMESTER	L	T	P	INTERNAL MARKS	EXTERNAL MARKS	TOTAL MARKS	CREDITS
	3	0	0	30	70	100	3
R20CC1210	DATA STRUCTURES (Common to EEE and ECE)						

COURSE OBJECTIVES

1. Comprehensive knowledge of data structures and exposure to recursive algorithms, searching andsorting techniques
2. Apply stack and queue data structures for logical operations
3. Understand Linked-list representation models in various types of applications
4. Implementation of trees in various forms, orientation on graphs, representation of graphs,graph traversals

COURSE OUTCOMES

After completion of this course the student should be able to

CO1: Illustrate sorting and searching algorithms.

CO2: Summarize elementary data structures such as stacks, queues and linked lists.CO3: Compare and contrast various forms of trees.

CO4: Outline graph data structures and various graph traversal techniques.

UNIT – I: INTRODUCTION TO DATA STRUCTURES AND ALGORITHMS

Basic Terminology, Elementary Data Structure Organization, Classification of Data structures, Operations on Data structures, Abstract Data Type.

Recursion: Pseudocode, Recursive examples, Factorial, GCD implementation, Fibonacci numbers, Tower of Hanoi.

UNIT – II: SEARCHING AND SORTING

Introduction to Searching, Linear Search, Binary Search, Introduction to Sorting, Bubble sort, Insertion sort, Selection sort, Merge sort, Quick sort and Heap Sort.

UNIT – III: STACKS

Introduction to stacks, Array Representation of stacks, Operations on stack, Linked representation of stacks, Applications of stacks, evaluation of a postfix expression, conversion of infix expression into a postfix expression.

Queues: Introduction, Array Representation of Queues, Linked representation of Queues, Circular Queues, Applications of queues.

UNIT – IV: LINKED LISTS

Introduction, Basic terminologies, Linked lists versus Arrays, Memory allocation and De-allocation for a linked list, single linked list, Circular linked, Doubly linked list. (Searching, inserting, Deleting and displaying operations for all Linked Lists)

UNIT – V: TREES

Introduction, Basic Terminology, Types of Trees, Expression Trees, Traversing a Binary Tree, Pre-order Traversal, In-order Traversal, Post-order traversal, Level order traversal**,** constructing a Binary Tree from Traversals**,** Binary Search Trees, operations on Binary Search Trees, AVL Trees.

Graphs: Introduction, Graph Terminology, Directed Graphs, Representations of Graphs, Graph Traversal algorithms, Breadth- First Search Algorithm, Depth-First-Search Algorithm.

TEXT BOOKS

1. Data Structures using C,Reema Thareja, Oxford, Second Edition, 2014(UNITS: I, II, III, IV, V and VI).
2. Data Structures, 2/e, Richard F, Gilberg , Forouzan, Cengage (UNIT: I).

REFERENCE BOOKS

1. Data Structures and Algorithms, 2008,G.A.V.Pai, TMH.
2. Data Structure with C, Seymour Lipschutz, TMH.
3. Data structures and algorithm analysis in C, 2/e, Mark Allen Weiss.

WEB RESOURCES

1. nptel.ac.in/courses/106102064/1
2. nptel.ac.in/courses/106103069

I B.TECH II-SEMESTER	L	T	P	INTERNAL MARKS	EXTERNAL MARKS	TOTAL MARKS	CREDITS
	0	0	3	15	35	50	1.5
R20EE12L9	ELECTRONICS DEVICES AND CIRCUITS LAB						

Course Objectives:

1. Understand the operation of PN diode and Zener diode.
2. Identify and verify the efficiency of Half wave and Full wave Rectifiers.
3. Know the working of BJT.
4. Know the characteristics of transistor.
5. Know the UJT characteristics.

Course Outcomes:

After the completion of this course the student will able to

CO1: Understand and analyze the behaviour of PN junction diode, Zener diode.
CO2: Understand the operational difference between Half wave and Full wave Rectifiers.
CO3: Identify the switching characteristics of transistor.
CO4: Analyze the characteristics of transistor.
CO5: Identify and analyze the UJT characteristics and its applications

LIST OF EXPERIMENTS

1. P- N Junction diode characteristics
   Part A: Germanium Diode (Forward bias & Reverse bias)
   Part B: Silicon Diode (Forward bias & Reverse bias)
2. Zener diode characteristics
   Part A: V-I characteristics.
   Part B: Zener diode as voltage regulator.
3. Rectifiers (with and without 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 (CS configuration)
   Part A: Drain characteristics
   Part B: Transfer characteristics
6. SCR Characteristics.
7. UJT characteristics
8. CRO Operation and its Measurements
9. BJT-CE Amplifier
10. FET-CS Amplifier

I B.TECH II-SEMESTER	L	T	P	INTERNAL MARKS	EXTERNAL MARKS	TOTAL MARKS	CREDITS
	0	0	3	15	35	50	1.5
R20CC12L10	APPLIED PHYSICS LAB (Common to ECE,EEE,CSE,ITandCAI)						

COURSE OBJECTIVES

1. To impart physical measurement skills and make the students understand coherence between theoretical and practical knowledge.

COURSE OUTCOMES

After successful completion of this course, the students will be able to
CO1: Apply the principle of physics in engineering field
CO2: Utilize the modern engineering physics techniques and tools in real time applicationsCO3: Analyse characteristics, usage and the behaviour of materials

LIST OF EXPERIMENTS

Any Ten experiments from the following list are required to be conducted

1. Rigidity modulus of material by wire-dynamic method (torsional pendulum)
2. Determination of wavelength of a source-Diffraction Grating-Normal incidence
3. Newton's rings –Radius of Curvature of Plano Convex Lens.
4. Determination of thickness of thin wire- Air wedge method
5. Determination of wavelength of Laser Source-single slit diffraction.
6. Determine the Numerical aperture of an optical fiber.
7. Melde's experiment – Transverse and Longitudinal modes.
8. Magnetic field along the axis of a current carrying coil – Stewart and Gee's apparatus.
9. Verification of laws of stretched string by using Sonometer.
10. Calculate the energy loss in a given ferromagnetic material by plotting B-H Curve.
11. Energy Band gap of a Semiconductor p - n junction
12. Characteristics of Thermistor – temperature coefficient

TEXT BOOKS

1. Engineering Physics Lab Manual by Dr.Y. Aparna and Dr.K.Venkateswarao (V.G.S.Book links).
2. Physics Practical Manual, Lorven Publications
3. S. Balasubramanian , M.N. Srinivasan " A Text book of Practical Physics"- S ChandPublishers, 2017.

WEB REFERENCES

1. https://www.youtube.com/watch?v=NDsSPtL9dyQ
2. https://www.youtube.com/watch?v=9agoJRCnu4w
3. https://www.youtube.com/watch?v=bv-lLJreyCU

I B.TECH II-SEMESTER	L	T	P	INTERNAL MARKS	EXTERNAL MARKS	TOTAL MARKS	CREDITS
	0	0	3	15	35	50	1.5
R20CC12L11	DATA STRUCTURES LAB (Common to EEE and ECE)						

COURSE OBJECTIVES

1. The purpose of this course is to develop skills to design simple linear and nonlinear data structures.
2. It strengthen the ability to the students to identify and apply the suitable data structure for the given real world problem.
3. It enables them to gain knowledge in practical applications of data structures.

COURSE OUTCOMES

After the completion of this course the student should be able to

CO1: Develop various algorithms using recursive and non-recursive functions.CO2: Experiment with linear data structures.

CO3: Apply Tree traversal techniques in various applications.

EXERCISE 1

1. Write a recursive C program which computes the n^{th} Fibonacci number, for appropriate values of n.
2. Write recursive C programs for the following

i) Factorial of a given number

ii) GCD Computation

iii) Towers of Hanoi

EXERCISE 2

1. Write a C program that use both recursive and non-recursive functions to perform linear search.
2. Write a C program that use both recursive and non-recursive functions to perform binary search.

EXERCISE 3

1. Write a C program to implement Bubble sort.
2. Write a C program to implement Insertion sort.
3. Write a C program to implement Selection sort.

EXERCISE 4

1. Write a C program to implement Quick sort.
2. Write a C program to implement Merge sort.
3. Write a C program to implement heap sort.

EXERCISE 5

1. Write a C program to implement Stack operations using arrays.
2. Write a C program to implement Queue operation using arrays.
3. Write a C program to convert infix expression into postfix expression using stack.

EXERCISE 6

1. Write a C program to implement Stack operation using Linked list.
2. Write a C program to implement Queue operations using Linked lists.

EXERCISE 7

1. Write a C program to implement the following operations on a singly Linked using functions

i) Insertion
ii) Deletion
iii) Displaying
iv) Reversing

EXERCISE 8

1. Write a C program to implement following Operations on a Binary Tree

i) Create
ii) In-order traversal
iii) Pre-order traversal
iv) Post-order traversal

2. Write a C program to implement following Operations a Binary Search Tree

i) Create
ii) Insert
iii) Delete

I B.TECH II-SEMESTER	L	T	P	INTERNAL MARKS	EXTERNAL MARKS	TOTAL MARKS	CREDITS
	2	0	0	-	-	-	-
R20CC12MC2	CONSTITUTION OF INDIA (MC)						

COURSE OBJECTIVES

1. To train students in understanding the basic structure of Indian Constitution
2. To aware the students about the role of constitution in a democratic society
3. To prepare students to live better and happily with other fellow beings through the application of Fundamental Rights in their lives.
4. To know about the powers of Union Government and State Government

COURSE OUTCOMES

After the completion of this course the student should be able to

CO 1: Examine salient features of Indian Constitution and live accordingly in societyand interpret the meaning of Fundamental Rights of State Policy
CO 2: Discover various aspects of Union Government legislation and live up to theExpectations of the rules.
CO 3: Critically examine State Government legislation and improve your living standards by following the rules strictly
CO 4: Examine powers and functions of local bodies such as Municipalities and Panchayats and, take advantage of available resources for better living
CO 5: Analyze the powers and functions of Election Commission and The Union PublicService Commission and decide upon it for safe and secured life.

UNIT-I: INTRODUCTION TO INDIAN CONSTITUTION and FUNDAMENTAL RIGHTS

Meaning of the term Indian Constitution –Preamble- Constituent Assembly- Salient Features of Indian Constitution. Fundamental Rights - Fundamental Duties -The Directive Principles of State Policy.

UNIT-II: UNION GOVERNMENT

Union Government -Union Legislature (Parliament) -Lok Sabha and Rajya Sabha (with Powers and Functions) -Union Executive -President of India (with Powers and Functions) -Prime Minister of India (with Powers and Functions) -Union Judiciary (Supreme Court) -Jurisdiction of the Supreme Court

UNIT-III: STATE GOVERNMENT

State Government -State Legislature (Legislative Assembly / Vidhan Sabha, Legislative Council / Vidhan Parishad) -Powers and Functions of the State Legislature -State Executive-Governor of the State (with Powers and Functions) -The Chief Minister of the State (with Powers and Functions) -State Judiciary (High Courts)

UNIT-IV: LOCAL SELF GOVERNANCE

Powers and functions of Municipalities, Panchyats, ZP's and Co – Operative Societies

UNIT-V: SOVEREIGN BODIES

Election Commission of India (with Powers and Functions) -The Union Public Service Commission(with Powers and Functions)

TEXT BOOKS

1. Introduction to constitution of India, Durga Das Basu, Lexis Nexis Publications
2. Constitution of India by PRFESSIONAL BOOK PUBLISHERS
3. The Constitution of India by Arun K Tiru vengadam, Blooms bury publishers.
4. The constitution of India by PM Bakshi, Universal law publishing co
5. The Constitution of India by S.R. Bhansali, Universal law publishing co

II B. Tech. - I SEMESTER

S. No.	Subject Code	Subject	Cat. Code	L	T	P	Internal Marks	External Marks	Total Marks	Credits
1	R20CC2101	Numerical Methods and Transformations	BS	2	1	0	30	70	100	3
2	R20EE2102	Electrical Circuit Analysis-II	PC	2	1	0	30	70	100	3
3	R20EE2103	Electrical Machines-I	PC	2	1	0	30	70	100	3
4	R20EE2104	Electromagnetic Fields	PC	2	1	0	30	70	100	3
5	R20EE2105	Analog Electronics	PC	3	0	0	30	70	100	3
6	R20EE21L1	Electrical Circuit Analysis Lab	PC	0	0	3	15	35	50	1.5
7	R20EE21L2	Electrical Machines-I Lab	PC	0	0	3	15	35	50	1.5
8	R20EE21L3	Analog Electronics Lab	PC	0	0	3	15	35	50	1.5
9	R20EE21SC1	PLC Automation Lab	SC	0	0	4	-	50	50	2
10	R20CC21MC1	Environmental Studies (Non-Credit Course)	MC	2	0	0	-	-	-	-
		Total		**13**	**4**	**13**	**195**	**505**	**700**	**21.5**

II B.TECH I-SEMESTER	L	T	P	INTERNAL MARKS	EXTERNAL MARKS	TOTAL MARKS	CREDITS
	3	0	0	30	70	100	3
R20CC2101	Numerical Methods and Transformations						

COURSE OBJECTIVES:

1. To elucidate the different numerical methods to solve nonlinear algebraic equations.
2. To propagate the use of different numerical techniques for carrying out numerical integration.
3. Explore the use of Laplace transform method to solve with initial value problems of ODE.
4. To acquire fundamental Knowledge of Fourier series and Fourier Transform and able to give Fourier expansions of a given function.

COURSE OUTCOMES:

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

1. Evaluate approximating roots of polynomials and transcendental equations by different algorithms. [**Evaluating – K5**]
2. Apply Newton's forward backward and Lagrange's interpolation for equal and unequal intervals. [**Apply – K3**]
3. Apply different algorithms for approximating solutions of ordinary differential equation to its analytical computations. [**Apply – K3**]
4. Select appropriate technique of Laplace transforms in solving differential equations [**Apply – K3**]
5. Relate Fourier series, integral, transforms techniques in their core. [**Understanding – K2**]

UNIT –I: SOLUTIONS TO ALGEBRAIC EQUATIONS AND INTERPOLATION: (10 hours)

Solution of polynomial and transcendental equations: bisection method, Regula-Falsi method and Newton-Raphson method. Finite differences, relation between operators, interpolation using Newton's, Gauss's forward and backward difference formulae. Interpolation with unequal intervals: Lagrange's formulae.

UNIT –II: NUMERICAL SOLUTIONS OF ODE AND INTEGRATION: (8 hours)

Numerical Differentiation, Ordinary differential equations-Taylor's series, Euler and modified Euler's methods. Runge-Kutta method of fourth order for solving first and second order equations. Numerical integration- trapezoidal rule and Simpson's 1/3rd and $3/8^{th}$ rules.

UNIT-III: LAPLACE TRANSFORMATIONS: (12 hours)

Laplace transform and its properties, Transform of derivatives and integrals, Multiplication by t^n, division by t, Unit step function and unit impulse function. Transform of periodic functions, Evolutions of integrals by Laplace Transforms. Finding inverse transforms by the method of partial fractions, other methods of finding inverse Laplace Transforms, Convolution theorem (without proof), Solutions of Initial and Boundary Value Problems.

UNIT – IV: FOURIER SERIES: (10 hours)

Introduction, Euler's formulae, Periodic functions, Dirichlet's conditions, conditions for a Fourier expansion, functions of any period, functions having points of discontinuity, odd and even functions - half range series.

UNIT – V: FOURIER TRANSFORMS: (8 hours)

Fourier integral theorem (without proof), Fourier cosine and sine integrals, Fourier transform, Fourier sine and cosine transforms, properties of Fourier Transforms, convolution theorem (without proof).

TEXT BOOK:

1. B.S.Grewal, Higher Engineering Mathematics, 43rd Edition, Khanna Publisher.
2. B.V.Ramana, "Higher Engineering Mathematics", 32nd Edition, McGraw Hill Education, 2018.

REFERENCES:

1. N.P. Bali, Bhavanari Satyanarayana, Indrani Promod Kelkar, "Engineering Mathematics", University Science Press, (An Imprint of Lakshmi Publications Pvt., Ltd) New Delhi, 2012.
2. Erwin Kreyszig, Advanced Engineering Mathematics, 9thEditiwiley-India.
3. Peter V. O'Neil, "Advanced Engineering Mathematics", 7th Edition, Cengage Learning, 2011.

II B.TECH I-SEMESTER	L	T	P	INTERNAL MARKS	EXTERNAL MARKS	TOTAL MARKS	CREDITS
	2	1	0	30	70	100	3
R20EE2102	ELECTRICAL CIRCUIT ANALYSIS-II						

COURSE OBJECTIVES

1. To apply circuit analysis to AC Poly phase circuits
2. To analyse R, L, C components for transient response.
3. To study the basic concepts of different types of filters

COURSE OUTCOMES

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

CO 1: Analyse the balanced three phase supply connected to balanced systems.
CO 2: Analyse the balanced three phase supply connected to unbalanced systems.
CO 3: Ability to analyse steady state and transient response of various electrical networks.
CO 4: Estimate the different types of two port network parameters.
CO 5: Acquire knowledge on Filters.

UNIT–I BALANCED THREE PHASE CIRCUITS

Advantages of a three phase system - Generation of three phase voltages- Phase sequence - star and delta connection - Relation between line and phase voltages and currents in balanced systems - Analysis of balanced three phase circuits - Three phase four wire supply connected to balanced star connected load - Three phase three wire supply connected to balanced star connected load - Three phase three wire supply connected to balanced delta connected load - Measurement of active and reactive power in balanced three phase systems.

UNIT-II UNBALANCED THREE PHASE CIRCUITS

Analysis of Unbalanced three phase circuits - Three phase four wire supply connected to unbalanced star connected load -Three phase three wire supply connected to unbalanced delta connected load- Three phase three wire supply connected to unbalanced star connected load: Loop method - Star-Delta transformation technique - Three wattmeter method and Two wattmeter methods for measurement of three phase power - Power factor by Two wattmeter method.

UNIT–III TRANSIENT RESPONSE ANALYSIS

Initial Conditions-Steady state and transient response of RL, RC and RLC Circuits for DC input and A.C. sinusoidal input. Solutions using differential equations and Laplace transforms.

UNIT-IV TWO – PORT NETWORK

Two Port network - Z parameters - Y parameters - Transmission line parameters - h- parameters - Inverse h parameters - Inverse Transmission line parameters - Relationship between parameter sets - T and π representation-Series connection of two port networks - Parallel connection of two port networks - Cascading of two port networks - Lattice Network.

UNIT - V: NETWORK SYNTHESIS

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.

TEXT BOOKS

1. William H. Hayt, Jack E. Kemmerly and Steven M. Durbin, “Engineering Circuit Analysis”, TMH, 8th Edition, 2012
2. Chakrabarti A, “Circuits Theory (Analysis and synthesis), Dhanpath Rai and Sons, New Delhi, 1999.

REFERENCE BOOKS

1. M.E. Vanvalkenburg, “Network Analysis”, PHI, 3rd Edition, 2006.
2. A Sudhakar and Shyam Mohan SP, “Circuits and Networks: Analysis and Synthesis”,
3. N.C.Jagan and C. Lakshminarayana, “Network Theory”, B.S Publications.

WEB REFERENCES

1. https://www.youtube.com/watch?v=7Nh7ISeqn6Eandlist=PLbRMhDVUMngfNnABo5mre45Z b HqJE2sUnandindex=1-82
2. https://www.youtube.com/watch?v=zkWvL1pPkMYandlist=PLFW6lRTa1g81LohrWnYo_hsV B-RIzJDRmandindex=1-60
3. https://www.youtube.com/watch?v=GZmi4mBidpwandlist=PLa4KQhDlGd7QCTX3gTz0LyoL 93jVjtaMeandinde=1-148
4. https://www.youtube.com/watch?v=BqmztRuKpYIandlist=PLfDaOYdi9aZwlZNAU0gl0rZ-SctZJcLe7andindex=1-31

II B.TECH I-SEMESTER	L	T	P	INTERNAL MARKS	EXTERNAL MARKS	TOTAL MARKS	CREDITS
	2	1	0	30	70	100	3
R20EE2103	ELECTRICAL MACHINES-I						

COURSE OBJECTIVES

1. To familiarize with the constructional details and working principles of D.C. machines
2. To introduce the methods of starting, speed control and testing of D.C. Machines.
3. To impart knowledge on constructional details, working principles, and performance characteristics of transformers.

COURSE OUTCOMES

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

CO 1: Determine the performance of D.C generator for various operating conditions.

CO 2: Analyze the performance characteristics of various types of D.C motors.

CO 3: Select suitable speed control and testing methods of D.C motor for various applications.

CO 4: Analyze the performance specifications of a single-phase transformer for various loading conditions.

CO 5: Interpret the operation of three-phase transformers for various connections and achieve three-phase to two-phase transformation.

UNIT - I: DC GENERATOR

Electromechanical energy conversion-Principle-DC Generators-Principle of operation - Constructional Features-EMF Equation-Armature windings-Armature reaction- Commutation Process-Types of DC generators-Losses and efficiency of generator-No load and load characteristics of all types of DC generators and their applications.

UNIT - II: DC MOTOR

Principle of DC Motor-Concept of back EMF-Torque equation-Power stages of DC Motor-Characteristics of DC motors (series, shunt and compound)-Applications-Losses- efficiency of DC motor.

UNIT - III: SPEED CONTROL AND TESTING OF D.C. MOTORS

Speed control – by varying armature resistance, field flux and armature terminal voltage. Necessity of starter in a D.C motor-Three-point starter-Four-point starter -Testing Methods-Direct method-Swinburne's Method and Regenerative method-Losses and efficiency.

UNIT - IV: SINGLE PHASE TRANSFORMERS

Principle of operation-Constructional features of transformers - EMF equation - no load and load phasor diagrams - equivalent circuit of single-phase transformers-Regulation - losses - efficiency and all-day efficiency-Testing of transformers - OC and SC tests - Sumpner's test -Auto transformers.

UNIT - V: THREE PHASE TRANSFORMERS

Poly Phase Connections - Y/Y- Y/Δ- Δ/Y- Δ/Δ and open delta connection - Scott Connection-Tap changing transformers- parallel operation-Methods of cooling.

TEXT BOOKS

1. Electrical machines – P.S. Bhimbra, Khanna Publishers.
2. Performance and Design of Alternating Current Machines – Clayton and Hancock
3. Electrical Machines - J.B.Gupta, S.K.Katariaand Sons
4. Performance and Design of Alternating Current Machines – M.G. Say, John Wiley and Sons Publications, 3rd Edition, 1983.

REFERENCE BOOKS

1. Problems in Electrical Engineering – Parker Smith, CBS Publishers, 9th edition, 1984.
2. Electrical machines – S.K. Bhattacharya
3. Electrical machines –D P. Kothari and I. J. Nagarth, TMH, 4th Edition, 2010
4. Theory of Alternating Current Machinery- Langsdorf, TMH Electrical Machines - A.Chakrabarti and S. Debnath – Mc Graw - Hill Education, 1st Edition, 2015.

WEB REFERENCES

1. www.electrical4u.com/electrical-transformer/three-phase-transformer.php % reference for single phase and three transformers
2. www.hammondpowersolutions.com/products/locate_by_product/Autotransformers /index.php% reference for autotransformers.
3. www.electrotechnik.net/2006/08/in-autotransformer-primary-and.html % for autotransformers.
4. www.allaboutcircuits.com/vol_2/chpt_13/7.html % poly phase induction

II B.TECH I-SEMESTER	L	T	P	INTERNAL MARKS	EXTERNAL MARKS	TOTAL MARKS	CREDITS
	2	1	0	30	70	100	3
R20EE2104	ELECTRO MAGNETIC FIELDS						

COURSE OBJECTIVES

1. To acquire the knowledge in electrostatic fields, electrical potential, energy density and their applications.
2. To gain the knowledge in magnetic fields produced by currents in various configurations, application of Ampere's and Biot-Savart's Law.
3. To study the magnetic force and torque through Lorentz's force equation in magnetic field environment.
4. To develop a solid grasp about Maxwell's equations and their usage in solving time varying field problems.

COURSE OUTCOMES

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

CO 1: Apply the principles of electrostatics to the solutions of problems relating to electric field and electric potential, and electric energy density

CO 2: Describe static electric their behaviour in different media, associated laws, and boundary conditions.

CO 3: Gain the knowledge in laws of Magneto statics and apply them in static magnetic field.

CO 4: Compute the force experienced by charged bodies in magnetic field and identifies magnetic potential and its properties.

CO 5: Identify the time varying field and understand Faraday's Laws of Electromagnetic Induction.

UNIT-I: ELECTROSTATICS – I

Coordinate systems: Cartesian - cylindrical-spherical co-ordinates- coulombs law-Electric field intensity-Field due to a point charge - line charge - sheet of charge. Definition of potential and potential difference - the potential field of a point charge - a line charge - sheet of charge - potential gradient - the dipole - dipole moment Capacitance - Capacitance of parallel plates - Spherical and Coaxial Cables with composite dielectrics Energy stored and Energy density in electrostatic field.

UNIT-II: ELECTROSTATICS – II

Electric flux density - Gauss's law - Applications of Gauss law - Maxwell's First equation (Electrostatics) div(D) = ρ_v - Current and current density - continuity of current - conductor properties and boundary conditions - Boundary conditions for perfect dielectric materials- Derivations of Poisson's and Laplace's equations.

UNIT-III: MAGNETOSTATICS

Biot-Savart's Law - Ampere's Circuital Law - Magnetic Flux and Magnetic Flux Density (B) - Magnetic Field Intensity (MFI) due to straight current carrying filament - Infinite sheet of current - circular loop - rectangular and square loop - Maxwell's Second equation div(B)=0 and Third Equation Curl H = J.

UNIT-IV: MAGNETIC FORCES

Force on a moving charge- Lorentz force equation - Force on a differential current element - Force between differential current elements - Force and torque on current loop placed in magnetic fields - Inductors and inductances: Inductor - Self Inductance - mutual inductance - energy stored and energy density in a magnetic field.

UNIT-V: TIME VARYING FIELDS

Magnetic Circuits - Faraday's law of electromagnetic fields– static and motional EMF – Displacement current – Point form of Maxwell's equations and Integral form of Maxwell's equations. The Uniform Plane Wave: Wave propagation in free space-dielectrics and good conductors-skin effect-Pointing theorem and wave power.

TEXT BOOKS

1. W H Hayt, J A Buck 'Engineering Electromagnetics', 8th Edition TMH, 2012.
2. Mathew NO Sadiku, 'Elements of Electromagnetics', 6th Edition Oxford University Press, 2014.

REFERENCE BOOKS

1. Joseph A Edminister, 'Theory and Problems of Electromagnetics', 4th Edition, Schaum's Outline Series, Mc-Graw Hill International, 2014
2. EC Jordan and KG Balmain, 'Electromagnetic Waves and Radiating Systems', 2nd Edition PHI 2003.

WEB REFERENCES

1. http://nptel.ac.in/courses/108106073/
2. http://ocw.mit.edu/resources/res-6-001-electromagnetic-fields-and-energy-spring-2008/
3. http://freevideolectures.com/Course/2340/Electromagnetic-Fields#
4. https://www.brainkart.com/article/Electrostatics_12824/
5. https://www.brainkart.com/article/Magnetostatics_12825/

II B.TECH I-SEMESTER	L	T	P	INTERNAL MARKS	EXTERNAL MARKS	TOTAL MARKS	CREDITS
	3	0	0	30	70	100	3
R20EE2105	ANALOG ELECTRONICS						

COURSE OBJECTIVES:

- Design and understand the operation of analog electronics circuits such as feedback amplifiers
- Discuss the operation of Linear, Non-Linear wave shaping circuits and its applications
- Analyze the different basic op-amp circuits and its applications.
- Compare the working of multivibrators using op-amp, IC 555 and the operation of different oscillators.
- Discuss the operation of the most commonly used D/A and A/D converters.

COURSE OUTCOMES:

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

CO1: Design the operation of feedback amplifiers.
CO2: Explain different wave shaping circuits
CO3: Design different basic op-amp circuits.
CO4: Design different multivibrators using op-amp and 555 timers, different oscillators.
CO5: Analyze about different D/A and A/D converters.

UNIT -I: Feedback Amplifiers

Feedback principle and concept, Types of feedback, Classification of amplifiers-Voltage amplifier, Current amplifier, Trans conductance amplifier, Trans resistance amplifier, Feedback topologies, Characteristics of negative feedback amplifiers, General analysis of feedback amplifiers-input resistance and output resistance, Performance comparison of feedback amplifiers, introduction to Power Amplifiers and Oscillators.

UNIT -II: Linear and Non-Linear Wave Shaping

Linear Wave Shaping: The high pass and low pass RC circuits: Sinusoidal input, Step input, Pulse input, Square and Ramp input, RC network as a differentiator and an integrator.
Non-Linear Wave Shaping: Diode and its characteristics, Diode series clippers, Diode parallel clippers, Two level clipping circuits and Emitter coupled clipper, Clamping operation

UNIT -III: Operational Amplifier and its Applications

Different stages of Operational Amplifier: Differential Amplifier, Ideal and practical Op- Amp. Characteristics of OP-Amps, DC and AC characteristics, Inverting and Non-inverting amplifier, Integrator and differentiator, Instrumentation amplifier, V to I and I to V converters, Log and Anti log amplifiers.

UNIT -IV: Multivibrators and Timers

Multivibrators: Monostable, Bistable and Astable multivibrators using Op-amp.
Timers: Introduction to 555 timer, Functional diagram, Monostable and Astable operation using 555 Timer

UNIT -V: Active Filters, D/A and A/D Converters

Active Filters Introduction–Merits and demerits of active filters over passive filters–1st order, LPF, HPF filters, Band pass, Band reject.

D/A and A/D Converters: Introduction, Basic DAC techniques, Weighted resistor DAC, R-2R ladder DAC, Inverted R-2R DAC, Different types of ADCs -Parallel comparator type ADC, Counter type ADC, Successive approximation ADC and Dual slope ADC.

TEXT BOOKS:

1. Integrated Electronics-Jacob Millman, C. Halkies, C.D. Parikh, Satyabrata Jit, Tata McGraw-Hill, Second Edition, 2011.
2. Linear Integrated Circuits -D. Roy Chowdhury, New Age International Pvt Ltd, Second Edition, 2003.
3. Pulse, Digital and Switching Waveforms –J. Millman, H. Taub and Mothiki S. Prakash Rao, Tata McGraw-Hill, Second Edition, 2008.

REFERENCE BOOKS:

1. Op-Amps & Linear ICs -Ramakanth A. Gayakwad, Pearson Education, Fourth Edition, 2015.
2. Electronic Devices and Circuit Theory–R.L. Boylestad and Louis Nashelsky, Pearson Publications, Eleventh Edition, 2013.
3. Operational Amplifiers with Linear Integrated Circuits–William D. Stanley, Pearson Education India, Fourth Edition, 2002.

II B.TECH I-SEMESTER	L	T	P	INTERNAL MARKS	EXTERNAL MARKS	TOTAL MARKS	CREDITS
	0	0	3	15	35	50	1.5
R20EE21L1	ELECTRICAL CIRCUIT ANALYSIS LAB						

COURSE OBJECTIVES

1. To learn the methods used for verification of circuit theorems.
2. To study the concepts of resonance in series and parallel circuits.
3. To understand the measurement of active and reactive power in a three-phase system
4. To conduct experiment to calculate network parameters
5. To learn the measurement of inductance of a mutually coupled coil.

COURSE OUTCOMES

After completion of this course, Students will be able to

CO 1: Become familiar with the basic circuit components and know how to connect them to make a real electrical circuit.

CO 2: Verify the basic network theorems and understand the relationships and differences between theory and practice.

CO 3: Estimate the different types of two port network parameters

CO 4: Analyse the balanced three phase supply connected to balanced and unbalanced Systems.

LIST OF EXPERIMENTS

Any Ten experiments from the following list are required to be conducted.

1. Verification of Thevenin's and Norton's Theorems.
2. Verification of Superposition theorem.
3. Verification of Maximum Power Transfer Theorem.
4. Verification of Reciprocity Theorem.
5. Verification of Millman's Theorem.
6. Series and Parallel Resonance of a RLC circuit.
7. Determination of Self, Mutual Inductances and Coefficient of coupling.
8. Z and Y Parameters of a Two-Port Network.
9. Transmission and hybrid parameters of a Two-Port Network.
10. Measurement of Active Power for Star and Delta connected balanced loads.
11. Measurement of Reactive Power for Star and Delta connected balanced loads.
12. Measurement of 3-phase Power by two wattmeter method for unbalanced loads.

VIRTUAL LAB:

1. Thevenin's, Norton's and Theorems
2. Series and Parallel Resonance of a RLC circuit

II B.TECH I-SEMESTER	L	T	P	INTERNAL MARKS	EXTERNAL MARKS	TOTAL MARKS	CREDITS
	0	0	3	15	35	50	1.5
R20EE21L2	ELECTRICAL MACHINES-I LAB						

COURSE OBJECTIVES

1. To familiarize various testing methods and speed control of DC Machines.
2. To disseminate knowledge on various tests and parallel operation of single-phase transformers.

COURSE OUTCOMES

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

CO 1: Select the appropriate apparatus for determining the performance of DC machines and transformers based on the capacity experimentally.

CO 2: Determine the equivalent circuit parameters of transformers experimentally.

CO 3: Compute the performance characteristics of transformers and DC machines through suitable tests.

LIST OF EXPERIMENTS

Any 10 of the following experiments are to be conducted

1. Open circuit characteristics of separately excited / self-excited DC shunt generator
2. Load test on DC Shunt Generator
3. Load test on DC series generator
4. Swinburne's Test DC shunt machine
5. Speed control of DC shunt motor
6. Brake test on DC Shunt Motor
7. Brake test on DC compounds Motor
8. Hopkinson's test on DC Machines
9. OC and SC tests on single - phase transformer
10. Load test on single - phase transformer
11. Scott Connection of Transformers
12. Parallel Operation of Two Single - Phase Transformers.

VIRTUAL LAB:

1. Speed control of DC shunt motor by Field and armature Control
2. Determination of Transformer equivalent circuit from Open Circuit and Short Circuit Test

II B.TECH I-SEMESTER	L	T	P	INTERNAL MARKS	EXTERNAL MARKS	TOTAL MARKS	CREDITS
	0	0	3	15	35	50	1.5
R20EE21L3	ANALOG ELECTRONICS LAB						

COURSE OBJECTIVES:

- Realization of Adder, Subtractor, Comparator, Differentiator, Integrator and Schmitt trigger circuit using op-amp.
- Realization of LPF, HPF, and RC Phase shift oscillator (first order) using Op-amp.
- Analyzing linear wave shaping and nonlinear wave shaping
- Explain multivibrators using 555 IC timers

COURSE OUTCOMES:

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

CO1: Designing Adder, Subtractor, Comparator, Differentiator and Integrator using Op-amp.
CO2: Designing LPF, HPF, and RC Phase shift oscillator (first order) using Op-amp.
CO3: Design and analyze clippers, Clampers and also implement the applications using op-amps.
CO4: Design of multivibrators using 555 IC timers and Schmitt trigger circuit using op-amp.

LIST OF EXPERIMENTS:

1. Design of half adder, full adder and half subtractor.
2. Linear wave shaping-low pass and high pass circuits.
3. Nonlinear wave shaping-clippers and clampers circuits.
4. Realization of adder, subtractor, and comparator circuits using Op-amp.
5. Designing LPF (first order) using Op-amp.
6. Designing HPF (first order) using Op-amp.
7. Designing Differentiator and Integrator using Op-amp.
8. Designing Monostable and Astable operation circuits using Op-amp.
9. Designing Monostable and Astable operation circuits using IC 555 timer.
10. Designing RC Phase shift oscillator using Op-amp
11. Design of Schmitt trigger using Op-amp
12. Design of Weighted resistor DAC using Op-amp.
13. Design of Analog to Digital Converter using Op-amp.

EXPERIMENTS BEYOND SYLLABUS:

1. Designing Wein bridge oscillator using operational amplifier
2. Design of function generator using operational amplifier (sine, triangular & square wave)

VIRTUAL LAB:

A. Design of voltage to current converter
B. Designing Astable and Monostable Multivibrator

II B.TECH I-SEMESTER	L	T	P	INTERNAL MARKS	EXTERNAL MARKS	TOTAL MARKS	CREDITS
	0	0	4	-	50	50	2
R20EE21SC1	PLC AUTOMATION						

COURSE OBJECTIVES

1. To make the students understand the fundamentals of automation and various automation systems used in industry.
2. Students should be able to determine hardware and software requirements of Automation.
3. They should further understand how to design any application based on the requirement.

COURSE OUTCOMES

After completion of this course, Students will be able to

CO 1: Describe the working of various blocks of basic industrial automation system.

CO 2: Connect the peripherals with the PLC.

CO 3**:** Use various PLC functions and develop small PLC programs.

LIST OF EXPERIMENTS

Any Ten experiments from the following list are required to be conducted

Study hardware and software used in PLC

1. Implementation Logic Gates
2. Implementation of DOL Starter
3. Implementation of On-Delay Timer
4. Implementation of Off-Delay Timer
5. Implementation of Up-Down Counter
6. Implementation of PLC Arithmetic Instructions
7. Implementation of PID Controller

WEB REFERENCE

1. https://plc-coep.vlabs.ac.in/List%20of%20experiments.html?domain=Electrical%20Engineering.

II B.TECH I-SEMESTER	L	T	P	INTERNAL MARKS	EXTERNAL MARKS	TOTAL MARKS	CREDITS
	2	-	-	-	-	-	-
R20CC21MC1	ENVIRONMENTAL STUDIES (Common to all Branches)						

COURSE OBJECTIVES:

1. To make the students aware about the environment and it's inter–disciplinary, to familiarize the concept of ecosystem and their importance, basic understanding of the ecosystem and its diversity.
2. Overall understanding of the natural resources.
3. To bring the awareness among students about the importance of biodiversity and the need for its conservation.
4. To make the students understand the adverse effects of environmental pollution, its causesand measures to control it.
5. Acquaintance on various environmental challenges induced due to unplanned anthropogenic activities. Awareness on the social issues, environmental legislation and global treaties understanding the environmental policies and regulations.

COURSE OUTCOMES:

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

CO-1 Explain the concepts of the ecosystem and its function in the environment. The need for protecting the producers and consumers in various ecosystems and their role in the food web.

CO-2 Analyze the natural resources and their importance for the sustenance of the life and recognize the need to conserve the natural resources.

CO-3 Explain the biodiversity of India and the threats to biodiversity, and conservation practicesto protect the biodiversity.

CO-4 Distinguish various attributes of the pollution, their impacts and measures to reduce or control the pollution along with waste management practices.

CO-5 Define Environmental policy, legislation, environmental assessment and the stagesinvolved in EIA Environmental audit.

UNIT – I

Multidisciplinary nature of Environmental Studies: Definition, Scope and Importance – Need for Public Awareness. Institutions and people in Environment.

Ecosystems:

Definitions and concepts – Characteristics of ecosystem – Structural and functional features – Producers, consumers and decomposers and food webs – Types of ecosystems – Forests, grassland, desert, crop land, pond, lake, river and marine ecosystems – Energy flow in the ecosystem – Ecological pyramids – Ecological successions.

UNIT – II

Natural Resources: Water resources–Use and over utilization of surface and natural resourced ground water–Floods, drought, conflicts over water, dams–benefits and problems on tribal population & Environment.

Forest resources: Use and over–exploitation, deforestation.

Mineral resources: Use and exploitation, tribal & environmental effects of extracting and using mineral resources.

Food resources: World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer–pesticide problems, water logging, salinity–concept ofsustainable agricultural methods.

Energy Resources: Renewable (wind energy, tidal energy) and non-renewable energy resources (Fossil fuels, coal).

UNIT – III

Biodiversity: Definition: genetic, species and ecosystem diversity- classification - Value of biodiversity: consumptive use, productive use, social-Biodiversity at national and local levels. India as a mega-diversity nation - Hot-spots of biodiversity

Conservation of biodiversity: Threats to biodiversity: habitat loss, man wildlife conflicts - Endangered and endemic species of India – Conservation of biodiversity: In-Situ conservation and Ex- situ conservation.

UNIT – IV

Environmental Pollution and Control Technologies: Definition, Cause, effects and control measures of Air pollution, Water pollution, Soil pollution, Noise pollution, and nuclear hazards. Role of an individual in prevention of pollution. - Pollution case studies, Good Agricultural Practices – Drip irrigation, soil erosion and desertification.

Solid Waste Management: Sources, Classification, effects and control measures of urban and industrial solid wastes. Consumerism and waste products, Biomedical, Hazardous and e – waste management.Covid-19- and environmental Health –Impact of the Coronavirus-Precautions and infection control.

UNIT – V

Environmental Policy, Legislation and Environmental Management: Environmental ethics: Issues and possible solutions. Environmental Protection Act, Legal aspects -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.

Impact Assessment and its significance - various stages of EIA, preparation of EMP and EIS, Environmental audit, Ecotourism.

Visit to some local Polluted Site: Study of an industrially Polluted area.

TEXT BOOKS:

1. AnubhaKaushik& C. P. Kaushik, Environmental Studies, NewAge International (P) Ltd., New Delhi.Fourth edition,2014.

2. P. N. Palanisamy, P. Manikandan, A. Geetha, and K. Manjula Rani, Environmental Studies, PearsonEducation, Chennai.ISBN 978-93-325-2052-3,Secondedition-2014.

REFERENCE BOOKS:

1. Deekshita Dave & P. UdayaBhaskar, Text Book of Environmental Studies CengageLearning.
2. Shaashi Chawla, a Textbook of Environmental Studies, TMH, NewDelhi.
3. Benny Joseph Environmental Studies, Tata McGraw Hill Co, NewDelhi.
4. Dr.K.V.S.G. Murali Krishna, Environmental Studies VGS Publishers, Vijayawada, First Edition2016.
5. Bharucha, E. Text book of Environmental Studies, First edition, Universities Press (India) Pvt., Ltd.,Hyderabad,2005.

Web References:

1. URL:https://www.youtube.com/watch?v=7G3eXI_DPn8
2. URL: https://www.eolss.net/sample-chapters/C09/E6-70-05-01.pdf

3. URL: https://www.youtube.com/watch?v=QuRL6NbyvEQ
4. URL: https://google/ Introduction to Environmental Studies5JM1G2
5. URL:http://www.teacherspayteachers.com/Product/Food-Chains-Trophic-Levels-and-Ecological-Pyramids-PowerPoint Click the above
6. URL:http://iadc-dredging.com/en/371/environment/ecosystem-services/ this webinar will focus on the concept of eco system services
7. URL: http://mocomi.com/ presents: What is Air Pollution? Air pollution is the introduction of foreignproducts into the atmosphere.
8. URL: https://en.wikipedia.org/wiki/green_impact_assessment

E-books:

1. .https://faculty.psau.edu.sa/.../doc-5-pdf-d78456fce3bebc84d9320fa2f9cf9e2a-original
2. https://www.researchgate.net/.../273775623_Introduction_to_Environmental_Sciences

II B. Tech. - II SEMESTER

S. No.	Subject Code	Subject	Cat. Code	L	T	P	Internal Marks	External Marks	Total Marks	Credits
1	R20CC2201	Technical and Communicative English – II	HSMC	3	0	0	30	70	100	3
2	R20CC2202	Complex Variables , Probability and Statistics	BSC	2	1	0	30	70	100	3
3	R20EE2203	Control Systems	PCC	2	1	0	30	70	100	3
4	R20EE2204	Electrical Machines-II	PCC	2	1	0	30	70	100	3
5	R20EE2205	Digital Electronics	PCC	3	0	0	30	70	100	3
6	R20EE22L1	Control System Lab	PCC	0	0	3	15	35	50	1.5
7	R20EE22L2	Electrical Machines Lab-II	PCC	0	0	3	15	35	50	1.5
8	R20EE22L3	Digital Electronics Laboratory	PCC	0	0	3	15	35	50	1.5
9	R20EE22SC1	Numerical Techniques using MATLAB	SC	0	0	4	-	50	50	2
		Total		**12**	**3**	**13**	**195**	**505**	**700**	**21.5**

II B.TECH II-SEMESTER	L	T	P	INTERNAL MARKS	EXTERNAL MARKS	TOTAL MARKS	CREDITS
	4	0	0	30	70	100	3
R20CC2201	Technical and Communicative English - II						

COURSE OBJECTIVES:

1. To equip the students with appropriate oral and written communication skills.
2. To inculcate the skills of listening, reading and critical thinking.
3. To enhance the students' proficiency in reading skills enabling them meet the academic needs of their course.
4. To enable the engineering students develop their basic communication skills in English for academic and social purposes.

COURSE OUTCOMES:

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

CO1: Infer explicit and implicit meaning of a text, recognize key passages; raise questions and summarize it **(Apply-3)**

CO2: Compose paragraphs, essays, emails, letters, reports, resume and transfer information into tables, Pie and bar diagrams. **(Creating-5)**

CO3: Build grammatically correct sentences using a variety of sentence structures **(Apply3)**

CO4: Enhance word power and usage of lexicons **(Apply3)**

UNIT– I

1. A Proposal to Gridle the Earth, Nellie Bly

a) **Placement Papers**.

b) **Reading**: Skimming for main idea, scanning for specific piece of information.

c) **Writing**: Note – making flowed by paragraph writing, effective opening sentences, introducing the topic, key words, main idea, summarize the main idea.

d) **Grammar and Vocabulary**: Content words and function words, verbs, nouns, adjectives and adverbs. Basic sentence structure and simple question form, framing jargon, technical vocabulary (15 words)

UNIT–II

2. The District School As It Was by One who Went to It, Warren Burton

a) **Placement Papers.**

b) **Reading**: Identifying the sequence of ideas and recognizing verbal techniques to link the ideas in a paragraph.

c) **Writing**: Paragraph writing, using key words/phrases and organizing points in a coherent manner.

d) **Grammar and Vocabulary**: Linkers, articles and prepositions.

UNIT–III

3. The future of Work- Jacob Morgan

a) **Placement Papers**.

b) **Reading**: Sequencing of ideas and recognizing verbal techniques to link the ideas in a paragraph.

c) **Writing**: Paragraph writing, using key words/phrases and organizing points in a coherent manner.

d) **Grammar and Vocabulary**: Cohesive devices, articles and prepositions.

UNIT-IV

4. H.G.Wells and the Uncertainties of Progress, Peter J. Bowler

a) **Placement Papers**.
b) **Reading**: Understand and interpret graphic elements used in texts.
c) **Writing**: Information transfer.
d) **Grammar and Vocabulary**: Adjectives, adverbs and antonyms.

UNIT-V

5. Leaves from the Mental Portfolio of a Eurasian, Sui Sin Far

a) **Placement Papers**.
b) **Reading:** Reading for comprehension.
c) **Writing**: Essay writing
d) **Grammar and Vocabulary**: Articles, prepositions, tenses, subject verb agreement and technical jargon (15 words)

TEXT BOOKS:

1. English All Round -I (Communication skills for Under Graduate Learners)– Orient Black Swan Pvt.Ltd.Publisher, 1st edition,2019

REFERENCE BOOKS:

4. Raymond Murphy, *Murphy's English Grammar,* Cambridge University Press 2004
5. Meenakshi Raman, Sangeeta Sharma, *Technical Communication: English Skills for Engineers*, Oxford University Press, 2009
6. Michael Swan, *Practical English Usage,* Oxford University Press, 1996

Web References:

1. https://www.grammarly.com/blog
2. https://www.englishclub.com/
3. www.nonstopenglish.com/
4. https://www.fluentu.com/blog/english/
5. https://beta.freerice.com/
6. https://prepinsta.com/cognizant/
7. https://www.geeksforgeeks.org/tcs-placement-paper-mcq-1/
8. https://www.firstnaukri.com/career-guidance/infosys-placement-papers-with-solutions-2019-firstnaukri-prep
9. https://in.usembassy.gov/education-culture/american-spaces/dostihouse-mumbai/library-services/
10. https://www.youtube.com/user/bbclearningenglish
11. https://www.cambridgeenglish.org/learning-english/free-resources/write-and-improve/
12. https://englishlive.ef.com/blog/language-lab/5-simple-ways-improve-written-english/

II B.TECH II-SEMESTER	L	T	P	INTERNAL MARKS	EXTERNAL MARKS	TOTAL MARKS	CREDITS
	3	0	0	30	70	100	3
R20CC2202	COMPLEX VARIABLES, PROBABILITY AND STATISTICS (EEE & ME)						

COURSE OBJECTIVES:

1. To analyze the function of complex variable and its analytic property with a review of elementary complex function.
2. To understand the Taylor and Laurent expansion with their use in finding out the residue and improper integral.
3. To revise the elementary concepts of probability
4. To introduce techniques for carrying out probability calculations and identifying probability distributions.

COURSE OUTCOMES:

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

1. Apply the probability concepts in their respective engineering data. [**Apply–K3**]
2. Apply discrete and continuous probability distributions to solve various engineering problems. [**Apply–K3**]
3. Analyze the multivariate problems in engineering. [**Analyzing–K4**]
4. Apply the method of least squares to estimate the parameters of a regression model. [**Apply–K3**]
5. Determine the confidence interval for a population parameter for single sample and two sample cases. [**Evaluating–K5**]

UNIT I: FUNCTIONS OF COMPLEX VARIABLES: (10 hours)

Limit and Continuity of f(z), Derivative of f(z), Cauchy-Riemann equations, analytic functions, harmonic functions, Orthogonal system. Application: Flow problems.

UNIT II: COMPLEX INTEGRATION: (10 hours)

Integration of Complex functions, Cauchy theorem (without proof), Cauchy integral formula (without proof), Series of complex terms, Taylor's series, Laurent's series, zeros and singularities of analytic functions, residues and residue theorem(without proof), Calculation of residues.
Applications: Evaluation of real definite integrals (Integration around the semi-circle and Unit Circle)

UNIT III: PROBABILITY AND RANDOM VARIABLES: (8 hours)

Probability axioms, addition law and multiplicative law of probability, conditional probability, Baye's theorem, random variables (discrete and continuous)**,** Binomial - Poisson approximation to the binomial distribution and normal distribution-their properties.

UNIT IV: SAMPLING DISTRIBUTION: (10 hours)

Estimation: Point Estimation, Interval Estimation, Bayesian Estimation.

UNIT V: TESTING OF HYPOTHESIS: (10 hours)

Formulation of null hypothesis, critical regions, level of significance.
Large sample tests: test for single mean test for single proportion.
Small Sample tests: Student t-distribution (single mean, two means and paired t-test), Testing of equality of variances (F-test), $\chi 2$ - test for goodness of fit, $\chi 2$ - test for independence of attributes.

Text Books:

1. **B.S. Grewal,** Higher Engineering Mathematics, 44th Edition, Khanna Publishers.
2. **Miller and Freund's,** Probability and Statistics for Engineers, 7/e, Pearson, 2008.

Reference Books:

1. **T. K. V. Iyenger**, Probability and Statistics, S. Chand & Company Ltd, 2015.
2. **Jay I. Devore,** Probability and Statistics for Engineering and the Sciences, 8th Edition, Cengage.
3. **S. C. Gupta and V. K. Kapoor,** Fundamentals of Mathematical Statistics, 11/e (Reprint) 2019, Sultan Chand & Sons Publications.

II B.TECH II-SEMESTER	L	T	P	INTERNAL MARKS	EXTERNAL MARKS	TOTAL MARKS	CREDITS
	2	1	0	30	70	100	3
R20EE2203	CONTROL SYSTEMS						

COURSE OBJECTIVES

1. To provide sufficient theoretical and analytical background to understand the concepts of continuous time linear control systems
2. To make the student to learn the mathematical applications related to control systems
3. To develop skills for applying them in future on various engineering applications
4. To analyse and design of feedback control systems
5. To give an idea on state space analysis, modelling and analysis of linear control systems using state space representation.

COURSE OUTCOMES

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

CO1: Develop a mathematical model of electrical and physical system.

CO2: Analyse the concepts of continuous time linear control systems.

CO3: Assess the stability of feedback control system with classical approach.

CO4: Design simple control systems and modify the parameters to meet specific Requirements.

CO5: Modelling and analysis of linear control systems using state space approach.

UNIT - I INTRODUCTION

Basic concept of simple control system - open loop - closed loop control systems - Effect of feedback on overall gain - stability sensitivity and external noise - Types of feedback control systems - Liner time invariant, time variant systems and non-linear control systems.

Mathematical Models and Transfer Functions of Physical Systems:

Transfer function - Translational and rotational mechanical systems - Block diagram representation of control systems - block diagram algebra - signal flow graph - Mason's gain formula.

UNIT - II: TIME RESPONSE ANALYSIS

Standard test signals - characteristic polynomial and characteristic equations of feedback systems - transient response of first order and second order systems to standard test signals - Time domain specifications - steady state response - steady state error and error constants.

UNIT – III: CONCEPTS OF STABILITY

The concept of stability - Routh's stability criterion - limitations of Routh's stability - Special cases in R-H criteria - The root locus concept - construction of root loci - Effect of Addition of poles and Zeros on Root locus.

UNIT – IV: STABILITY IN FREQUENCY DOMAIN

Introduction - frequency domain specifications - Bode plots - phase margin, Gain margin - Phase crossover frequency and Gain crossover frequency - polar plots - Nyquist stability criterion - Nyquist plots - Assessment of relative stability using Nyquist criterion.

UNIT – V: STATE VARIABLE ANALYSIS

Concepts of state, state variables and state models – diagonalisation - solution of state equations - state models for LTI systems - State Transition Matrix and its Properties - Concepts of Controllability and Observability.

TEXT BOOKS

1. I. J. Nagrath and M Gopal, Control Systems Engineering, New Age International 5th edition, 2009.
2. B.C. Kuo and Farid Golnaraghi, Automatic control systems, Wiley India, 8 th edition.

REFERENCE BOOKS

1. Schaum Series, Feedback and Control Systems, TMH, 3rd edition.
2. A.K. Jairath, Problems and Solutions of Control Systems, CBS Problems andSolutions Series, 6th Edition.
3. A. Anand Kumar, Control Systems, PHI, 2nd edition
4. K. Ogata, Modern Control Engineering, PHI, 5th edition, 2010
5. S. Hasan saeed, Automatic Control Systems, 6th Revised Edition, Katson Educational Series.

WEB REFERENCES

1. Users.ece.utexas.edu/~buckman/Svars1.pdf % Reference for state space analysis
2. http://techteach.no/publications/control_system_toolbox/ % Reference for MATLAB Control system tool
3. http://csd.newcastle.edu.au/simulations/roll_sim.html % Reference for design problem
4. www.dprg.org/tutorials/2003-10a/motorcontrol.pdf % Control system design for robo Application

II B.TECH II-SEMESTER	L	T	P	INTERNAL MARKS	EXTERNAL MARKS	TOTAL MARKS	CREDITS
	2	1	0	30	70	100	3
R20EE2204	ELECTRICAL MACHINES-II						

COURSE OBJECTIVES

- To familiarize with Construction, principle of operation and performance of induction machines.
- To introduce the methods Starting and speed control of three-phase induction motors.
- To impart basic knowledge on construction, principle of operation and performance of single phase induction motors
- To understand common performance of salient and non – salient type synchronous generators.
- To learn the basic principle of operation and performance of synchronous motor.

COURSE OUTCOMES

After completion of this course, Students will be able to

CO 1: Explain the working of poly phase induction motor and its testing and to draw Equivalent circuit.

CO 2: Use suitable starting and speed control methods to enhance the performance of three phase induction motors.

CO 3: Acquire the knowledge of 1-ph induction motors and their characteristics and their applications.

CO 4: Gain the knowledge on the construction and performance of Salient and Non-Salient Synchronous Generator

CO 5: Recall the knowledge on the construction and performance of Salient and Non- Salient type Synchronous Motor.

UNIT – I: THREE PHASE INDUCTION MOTOR

Constructional details - Types of rotors- Principle of operation - Slip –cogging and crawling- Equivalent circuit – Torque-Slip characteristics - Condition for maximum torque –Losses and efficiency – Load test - No load and blocked rotor tests - Circle diagram –Separation of losses – Double cage induction motors –Induction generators.

UNIT – II: STARTING AND SPEED CONTROL OF THREE PHASE INDUCTION MOTOR

Need for starting – Types of starters – DOL, Rotor resistance, Autotransformer and Star delta starters – Speed control – Voltage control, Frequency control and pole changing –Cascaded connection-V/f control – Slip power recovery scheme-Braking of three phase induction motor: Plugging, dynamic braking and regenerative braking.

UNIT - III: SINGLE PHASE INDUCTION MOTORS

Constructional details of single phase induction motor – Double field revolving theory and operation – Equivalent circuit -No load and blocked rotor test – Performance analysis – Starting methods of single-phase induction motors – Capacitor-start capacitor run Induction motor- Shaded pole induction motor - Linear induction motor – Repulsion motor - Hysteresis motor.

UNIT – IV: SYNCHRONOUS GENERATOR

Constructional details – Types of rotors –winding factors- emf equation – Synchronous reactance – Armature reaction – Phasor diagrams - synchronous generator connected to infinite bus-Synchronizing and parallel operation-Voltage regulation-EMF-MMF-ZPF and ASA methods–slip test

UNIT – V: SYNCHRONOUS MOTOR

Principle of operation – Torque equation – Operation on infinite bus bars - V and Inverted V curves – Power input and power developed equations – Starting methods – constant power input-constant excitation and constant power developed-Hunting — damper windings- synchronous condenser.

TEXT BOOKS

1. D.P. Kothari and I.J. Nagrath, 'Electric Machines', McGraw Hill Publishing Company Ltd, 2002.
2. P.S. Bhimbhra, 'Electrical Machinery', Khanna Publishers, 2003.

REFERENCE BOOKS

1. Vincent Del Toro, 'Basic Electric Machines' Pearson India Education, 2016
2. M.N. Bandyopadhyay, Electrical Machines Theory and Practice, PHI Learning PVT LTD., New Delhi, 2009.
3. B.R.Gupta,'Fundamental of Electric Machines' New age International Publishers, 3rd Edition, and Reprint 2015.
4. Murugesh Kumar, 'Electric Machines', Vikas Publishing House Pvt. Ltd, 2002

WEB REFERENCES

1. www.allaboutcircuits.com/vol_2/chpt_13/7.html % poly phase induction.

II B.TECH II SEMESTER	L	T	P	INTERNAL MARKS	EXTERNAL MARKS	TOTAL MARKS	CREDITS
	3	0	0	30	70	100	3
R20EE2205	DIGITAL ELECTRONICS						

COURSE OBJECTIVES:

1. To learn basic techniques for the design of digital circuits and fundamental concepts used in the design of digital systems.
2. To Discuss common forms of number representation in digital electronic circuits and to be able to convert between different representations.
3. To implement simple logical operations & to familiarize with the concepts of Boolean algebra.
4. To design combinational & sequential logic circuits for Various Applications.
5. To implement the logic circuits on Programmable Logic Devices such as PROM, PLA, PAL.

COURSE OUTCOMES:

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

CO1: Manipulate numeric information in different forms, e.g. different bases, signed integers, various codes such as ASCII, Gray, and BCD.

CO2: Deploy simple Boolean expressions using the theorems and postulates of Boolean algebra and to minimize combinational functions.

CO3: Design and analyze combinational circuits for various Applications.

CO4: Design and analyze sequential circuits for various Applications.

CO5: Implement the logic circuits on PLD's such as PROM, PAL, PLA, CPLD and FPGAs.

UNIT- I: NUMBER SYSTEMS & CODES

Number systems: Representation of numbers of different radix, Conversation from one radix to another radix, r-1's compliments and r's compliments of signed numbers, Problem solving. Arithmetic operations (addition & subtraction): Binary, Octal, Decimal & Hexadecimal. Binary Codes: Classifications, BCD, Execess-3, Gray and their Properties.

UNIT- II: LOGIC OPERATIONS AND MINIMIZATION TECHNIQUES

Logic Operations: Basic logic operations- AND, OR, NOT, Universal building blocks, EX-OR, EX-NOR gates, Boolean theorems, Principle of complementation & Duality, De-Morgan theorems, Standard SOP& POS forms and their conversions, Two level NAND – NAND and NOR- NOR realizations.

Minimization Techniques: Minimization of logic functions using Boolean theorems, minimization of switching functions using K-Map up to 4 variables, Tabular (Quine-McCluskey) minimization, Problem solving.

UNIT- III: COMBINATIONAL LOGIC CIRCUIT DESIGN

Introduction, Design of Half adder, Full adder, half subtractor, Full subtractor. Applications: 4-bit binary parallel adder, Binary parallel subtractor, Adder-Subtractor circuits & Look ahead carry adder. BCD adder circuit, Excess 3adder circuit. Encoders & Decoder: Design of decoder, Encoder, priority encoder, Realization of Boolean functions using decoders. Multiplexers & Demultiplxer: Design, Higher order, Realization of Boolean functions using multiplexers & demultiplxer. Comparators: Design of 2, 3 & 4-bit digital comparator.

UNIT- IV: SEQUENTIAL LOGIC CIRCUIT DESIGN

Introduction, Distinctions between Combinational and Sequential circuits.

Latches and Flip Flops: SR, JK, D and T type Flip Flops, Race around Condition in JK, JK Master Slave flip flop, Excitation table of all Flip Flops. Conversion from one flip-flop to another flip-flop.

Registers and Counters: Shift Registers, Data Transmission in Shift Registers, Operation of Shift Registers, Bidirectional Shift Registers, and Universal Shift register. Design of synchronous and Asynchronous Counters, Design and Operation of Ring and Twisted Ring Counter.

UNIT- V: INTRODUCTION TO PLDs

Introduction to PLDs, Realization of switching functions using PROM, PLA and PAL, Basics structures, Programming tables of PLDs, Merits & demerits of PROM, PAL and PLA comparison, Implementation of code converters. Introduction to FPGAs.

TEXT BOOKS:

1. Digital Design – M. Morris Mano, PHI, Fourth Edition, 2008.
2. Switching and Finite Automata Theory – ZviKohavi, Cambridge University Press, ThirdEdition, 2009.
3. Switching Theory and Logic Design – A. Anand Kumar, Prentice-Hall of India Pvt.Ltd,Second Edition, 2014.

REFERENCE BOOKS:

1. Modern Digital Electronics – R. P. Jain, TMH, Fourth Edition, 2010.
2. Fundamentals of Logic Design – Charles H. Roth, Jr, Jaico Publishing House, Fourth Edition,2006.
3. Microelectronics – Jacob Millman, Arvin Grabel, TMH, Second Edition, 2009.
4. Introduction to Switching Theory & Logical Design – Frederick J. Hill & Gerald R. Peterson,John Wiley & Sons Inc, Second Edition, 2012.

II B.TECH II-SEMESTER	L	T	P	INTERNAL MARKS	EXTERNAL MARKS	TOTAL MARKS	CREDITS
	0	0	3	15	35	50	1.5
R20EE22L1	CONTROL SYSTEM LAB						

COURSE OBJECTIVES

1. To impart hands on experience to understand the performance of basic control system components such as magnetic amplifiers, D.C. servo motors, A.C. Servo motors, stepper motor and potentiometer.
2. To understand time and frequency responses of control system with and without controllers and compensators.

COURSE OUTCOMES

After the completion of the course the student should be able to

CO1: Analyze the performance and working Magnetic amplifier, DC and AC servo motors and synchros.

CO2: Design P, PI and PID controllers and lag, lead and lag–lead compensators

CO3: Control the temperature using PID controller

CO4: Determine the transfer function of DC Generator and DC Motor

LIST OF EXPERIMENTS

Any 10 of the following experiments are to be conducted

1. Time response of Second order system
2. Characteristics of Synchros
3. Temperature controller using PID
4. Characteristics of magnetic amplifier
5. Characteristics of AC servo motor
6. Characteristics of DC servo motor
7. Effect of feedback on DC servo motor
8. Lag and lead compensation – Magnitude and phase plot
9. Transfer function of DC Generator
10. Transfer function of DC Generator

VIRTUAL LAB:

1. Programmable logic controller
2. Effect of P, PD, PI, PID Controller on a second order systems

II B.TECH II-SEMESTER	L	T	P	INTERNAL MARKS	EXTERNAL MARKS	TOTAL MARKS	CREDITS
	0	0	3	15	35	50	1.5
R20EE22L2	ELECTRICAL MACHINES LAB-II						

COURSE OBJECTIVES

1. To empower the students to determine the regulation of three–phase alternator by various methods.
2. To find Xd/Xq ratio of alternator and asses the performance of three–phase synchronous motor.
3. Assessing the Induction motor by performing various test

COURSE OUTCOMES

After completion of this course, Students will be able to

CO 1: Formulate and then analyse the working and operation of any electrical machine under loaded and unloaded conditions

CO 2: Identify different speed controlling techniques of Induction motor for the given application

CO 3: Conduct testing and experimental procedures on different types of electrical machines.

CO 4: Troubleshoot the operation of an electrical machine

LIST OF EXPERIMENTS

Any 10 of the following experiments are to be conducted

1. Brake test on three-phase Slip Ring induction motor.
2. No-load and blocked rotor tests on three- phase induction motor and circle diagram.
3. Determination of equivalent circuit parameters of a single phase induction motor.
4. Regulation of a three-phase alternator by synchronous impedance, M.M.F. Methods.
5. Determination of X_d and Xq of a salient pole synchronous generator.
6. Measurement of Negative and Zero sequence impedance of a three-phase alternator
7. Load Test on Single Phase Induction Motor.
8. Separation of Core loss for an Single Phase Transformer.
9. Regulation of Alternator by ZPF Method.
10. Determination of sub-Transient Reactance of Salient pole Synchronous Machine.
11. Brake Test on Squirrel Cage Induction Motor.

VIRTUAL LAB:

1. Simulation of Speed control of 3-phase Induction Motor
2. Load Test on Three Phase Alternator

WEB REFERENCES

1. http://emcoep.vlabs.ac.in/Exp7/Theory.html?domain=Electrical%20Engineeringandlab=Welcome%20to%20Electrical%20Machines

II B.TECH II SEMESTER	L	T	P	INTERNAL MARKS	EXTERNAL MARKS	TOTAL MARKS	CREDITS
	0	0	3	15	35	50	1.5
R20EE22L3	DIGITAL ELECTRONICS LAB						

COURSE OBJECTIVES:

1. Discuss the realization of logic gates, realize the logic gates with universal gates.
2. The realization of the combinational circuits like adders, subtractor, Muxs and Demux and comparators.
3. The realization of basic flip-flops like SR, D, T and JK. .
4. The realization of the sequential circuits like counters, registers and shift registers

COURSE OUTCOMES:

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

CO1: Realization of logic gates using universal gates and realization of Flip-Flops.
CO2: Design the complex combinational circuit for various applications.
CO3: Design the complex sequential circuits for various applications.
CO4: Design and analyze the read and write operations for memory applications.

LIST OF EXPERIMENTS:

1. Realization of logic gates.
2. Representation of logic gates with universal gates.
3. Verification of SR and JK Flip-Flops operation.
4. Design of half adder, full adder and half Subtractor.
5. Verify the truth tables for RS, D, T, and JK Flip-flops.
6. Verify the function of counter (IC's like 7490, 7493).
7. Verify the function of shift Register (IC7495).
8. Verify the truth table of digital comparator using IC 7485.
9. Verify the working of Multiplexer and Demultiplxer (using IC 74153).
10. Design the MOD 6 counter using D- flip-flops.

BEYOND THE SYLLABUS:

1. Verify the Write and read operations of RAM.
2. Construct and verify 4-bit Ring counter and Johnson counter with T-flip-flops.

VIRTUAL LABS:

1. Analysis and Synthesis of Arithmetic Expressions using Adders / Subtractors
2. Analysis of Functions of BCD-TO-7-segment Decoder / Driver and Operation of 7-segment LED Display

II B.TECH II-SEMESTER	L	T	P	INTERNAL MARKS	EXTERNAL MARKS	TOTAL MARKS	CREDITS
	0	0	4	-	50	50	2
R20EE22SC1	NUMERICAL TECHNIQUES USING MATLAB						

COURSE OBJECTIVES

1. To introduce the various numerical techniques using MATLAB
2. To be aware of different methods to solve first order differential equations.
3. To find time response of RLC circuit

COURSE OUTCOMES

After successful completion of the course, Students will be able to

CO 1: Demonstrate various commands in MATLAB programming.
CO 2: Solve linear equations and differential equations.
CO 3: Construct an interpolating polynomial for the given data using MATAB.
CO 4: Determine time response of RLC circuit.

LIST OF EXPERIMENTS

Any 10 of the following experiments are to be conducted

1. Study of Introduction to MATLAB
2. Study of basic matrix operations
3. To solve linear equation
4. Solution of Linear equations for Underdetermined and over determined cases
5. Determination of Eigen values and Eigen vectors of a Square matrix.
6. Solution of Difference Equations.
7. Solution of Difference Equations using Euler Method.
8. Solution of differential equation using 4th order Runge- Kutta method.
9. Determination of roots of a polynomial.
10. Determination of polynomial using method of Least Square Curve Fitting.
11. Determination of polynomial fit, analysing residuals, exponential fit and
12. Error bounds from the given data.
13. Determination of time response of an R-L-C circuit

III B. Tech. - I SEMESTER

S. No.	Subject Code	Subject	Cat. Code	L	T	P	Internal Marks	External Marks	Total Marks	Credits
1	R20EE3101	Problem Solving with Python	PC	3	0	0	30	70	100	3
2	R20EE3102	Power Electronics	PC	3	0	0	30	70	100	3
3	R20EE3103	Power Generation and Transmission	PC	3	0	0	30	70	100	3
4	R20CC1OE03	**Open Elective-I** a. Micro Electro Mechanical System	OE	3	0	0	30	70	100	3
	R20CC1OE04	b. Fundamentals of Electrical Engineering								
5	R20EE3106	**Professional Elective-I** a. Digital Control System	PE	3	0	0	30	70	100	3
	R20EE3107	b. Signals and Systems								
	R20EE3108	c. Special Electrical Machines								
	R20EE3109	d. Energy Conservation and Auditing								
6	R20EE31L1	Problem Solving with Python Programming Lab	PC	0	0	3	15	35	50	1.5

7	R20EE31L2	Power Electronics Lab	PC	0	0	3	15	35	50	1.5
8	R20EE31SC3	Internet of Things	SC	1	0	2	-	50	50	2
9	R20CC31MC01	Professional Ethics and Human Values (MC)	MC	2	0	0	-	-	-	-
10	R20CC31IN	Summer Internship / Community Service Project	PROJ	0	0	0	0	50	50	1.5
Total				**18**	**-**	**8**	**180**	**520**	**700**	**21.5**
		Honors/Minor courses (The hours distribution can be 3-0-2 or 3-1-0 also)								**4**

III B.TECH I-SEMESTER	L	T	P	INTERNAL MARKS	EXTERNAL MARKS	TOTAL MARKS	CREDITS
	3	0	0	30	70	100	3
Code: R20EE3101	PROBLEM SOLVING WITH PYTHON (OTHER THAN CSE)						

COURSE OBJECTIVES:

- To teach problem solving through flow charting tool-Raptor.
- To elucidate problem solving through python programming language.
- To introduce function oriented programming paradigm through python.
- To train in development of solutions using modular concepts.

COURSE OUTCOMES:

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

CO 1: Outline the computer system concepts.
CO 2: **S**ummarize the fundamental concepts of python programming.
CO 3: Apply the suitable data structures to solve the real time situational problems.
CO 4: Interpret object oriented concepts in python.

UNIT-I: Introduction to computers

Algorithms; modern computer systems: hardware architecture, data representation in computers, software and operating system.

UNIT-II: Introduction to python

Numbers, strings, variables, operators, expressions, statements, string Operations& Methods, math function calls, Input/output statements, conditional if, while and for loops.

UNIT-III: Functions

User defined functions, parameters to functions, recursive functions, and lambda function.

UNIT-IV: Data structures

List- list methods & functions, Tuple-tuple methods & functions, Dictionaries- dictionary methods & functions, traversing dictionaries. Sets-methods & functions, Files.

UNIT-V: OOP:

Class, object, methods, constructors, inheritance, inheritance types polymorphism, operator overloading, abstract classes, exception handling.

TEXT BOOKS:

1. Fundamentals of Python: First Programs ,Kenneth Lambert
2. Allen B. Downey, "think python: how to think like a computer scientist",2nd edition, O'reilly, 2016 .

REFERENCE BOOKS:

1. Python programming: A modern approach, vamsi kurama,pearson.
2. Learning python, Mark Lutz, Orielly.
3. Core python programming, W.Chun, pearson.
4. Introduction to python, Kenneth A. Lambert, Cengage.

WEB RESOURCES:

1. https://raptor.martincarlisle.com/
2. http://www.ict.ru.ac.za/Resources/cspw/thinkcspy3/thinkcspy3.pdf
3. https://zhanxw.com/blog/wp-content/uploads/2013/03/BeautifulCode_2.pdf
4. http://www.ict.ru.ac.za/Resources/cspw/thinkcspy3/thinkcspy3.pdf
5. https://www.cse.msu.edu/~stockman/ITEC/Scratch/BGC2011Scratch-Rev1.pdf
6. https://nostarch.com/scratchplayground
7. http://fusecontent.education.vic.gov.au/9f79537a-66fc-4070-a5ce-e3aa315888a1/scratchreferenceguide14.pdf

III B.TECH I-SEMESTER	L	T	P	INTERNAL MARKS	EXTERNAL MARKS	TOTAL MARKS	CREDITS
	3	0	0	30	70	100	3
Code: R20EE3102	POWER ELECTRONICS						

COURSE OBJECTIVES:

The objectives of this course is to acquire knowledge on

1. Characteristics of various power semiconductor devices and analyze the operation of silicon-controlled rectifier.
2. Operation of half-wave and full-wave phase-controlled rectifiers and analyze harmonics in the input current.
3. Operation of three phase full-wave converter and dual converter.
4. Operation of ac voltage controller, single phase cyclo converters.
5. Working of inverters and application of pwm techniques for voltage control

COURSE OUTCOMES:

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

CO1: **Draw** the characteristics of various power semiconductor devices and **analyze** the operation of silicon-controlled rectifier. **[K4]**

CO2: **Analyze** the operation of half-wave and full-wave phase-controlled rectifiers and harmonics in the input current. **[K4]**

CO3: **Examine** the operation of three phase full converter and dual converter. **[K3]**

CO4: **Examine** the operation of AC voltage controller and single phase cyclo converter. **[K3]**

CO5: **Examine** dc-dc converters and **apply** PWM technique for voltage control. **[K4]**

UNIT-I: Power Semi-Conductor Devices

Basic Theory of Operation - Static Characteristics-Two Transistors analogy -Turn on and Turn off Methods - Methods of SCR Triggering - Dynamic & Gate Characteristics of SCR - Series and Parallel Operation - Snubber circuit - Characteristics of Power MOSFET and IGBT.

UNIT–II: Single Phase Converters

Phase control technique - Natural Commutation- Single-phase Half-Controlled Converter– R,RL & RLE load - Half wave Controlled Converters: R and RL loads (Principle of operation only) - Fully Controlled Converters: Midpoint converter with R-Load (Principle of operation only) - Bridge connections with RL, RLE load without and with Freewheeling Diode – Derivation of average load voltage and current.

UNIT–III: Three Phase Converters

Three phase converters – Three pulse and six pulse converters – average load voltage with R and RL loads. Effect of source inductance (for single phase and three phase converters–Dual converters (both single phase and three phase).

UNIT - IV: AC Voltage Controllers & Cyclo-Converters

Single Phase AC Voltage Controllers –Two SCRs in anti-parallel – With R and RL loads - Derivation of RMS load voltage, current and power factor – Numerical problems -Cyclo-Converters: Single phase Bridge configuration with Resistive and inductive load (Principle of operation only) - Introduction to bidirectional converters.

UNIT - V: DC-DC Converters and DC-AC Converters

Choppers: Introduction - Operation of Buck Converter - Boost Converter, Buck-Boost Converter – Derivation of Output Voltage – Current -Duty ratio & Numerical Problems -Inverters: Single phase bridge inverter–Unipolar voltage switching and Bipolar voltage switching -Phase displacement control- three Phase -120^0 and 180^0 modes of operation.-SPWM control

TEXT BOOKS:

1. Power Electronics – by P.S.Bhimbra, Khanna Publishers.
2. Power Electronics: Circuits, Devices and Applications – by M. H. Rashid, Prentice Hall of India, 2nd edition, 1998.
3. Power Electronics-by M.D. Singh, Tata McGraw-Hill Education, 2008.

REFERENCE BOOKS:

1. Power Electronics-by P.C.Sen,TataMcGraw-Hill Publishing.
2. Erickson, Robert W., and DraganMaksimovic. Fundamentals of Power Electronics. Springer Science & Business Media, 2007.

WEB REFERENCE:

1. https://www.vssut.ac.in/lecture_notes/lecture1424354515.pdf
2. https://mrcet.com/downloads/digital_notes/EEE/31082020/Power%20Electronics.pdf
3. https://nptel.ac.in/courses/108105066

III B. TECH I-SEMESTER	L	T	P	INTERNAL MARKS	EXTERNAL MARKS	TOTAL MARKS	CREDITS
	3	0	0	30	70	100	3
Code: R20EE3103	POWER GENERATION AND TRANSMISSION						

COURSE OBJECTIVES:

- To introduce the operation of Hydel, Thermal and Nuclear power plants. To introduce the working of Solar, Wind, Tidal & Geothermal power plants.
- To introduce the transmission line parameters and methods for calculation of line parameters for the single phase and three phase circuits.
- To obtain the equivalent circuits for the transmission lines based on distance and to determine voltage regulation and efficiency.
- To understand the mechanical design of transmission lines and grading of cables.

COURSE OUTCOMES:

After completion of this course, Students will be able to

CO 1: **Apply** the knowledge of Power Generation from conventional sources. [**K3**]
CO 2: **Apply** the knowledge of Power Generation from Non - conventional sources. [**K3**]
CO 3: **Derive** the inductance and capacitance for various conductor configurations. [**K3**]
CO 4: **Analyse** the performance of transmission lines based on distance. [**K4**]
CO 5: **Apply** the knowledge on design of transmission lines, insulated Cables and effect of corona. [**K3**]

UNIT-I: Conventional Sources

Hydro Power: Selection of site-block diagram approach of hydroelectric power **Thermal Power:** Selection of site-general layout of a thermal power plant showing paths of coal-steam-water-air-ash and flue gasses-ash handling system **Nuclear Power:** Basics of Nuclear Engineering-Layout and subsystems of Nuclear Power Plants-Working of Nuclear Reactors, Safety measures for Nuclear Power plants.

UNIT-II: Non - Conventional Sources

Solar Power: Basics of solar energy - Solar Radiation at the Earth's surface - solar radiation on titled surfaces - Photovoltaic energy conversion **Wind Energy**: Principles of wind power - types of wind turbines - wind turbine operation **Tidal energy:** Principle of Tidal power- Components of Tidal power **Geo thermal Energy**: Nature of Geothermal fields- Geothermal Sources - Potential of Geothermal resources in India.

UNIT–III: Transmission Line Parameters

Expressions for inductance and capacitance of single phase and 3- phase lines of symmetrical and transposed configurations. Concept of self GMD (GMR) and mutual GMD - bundled conductors - effect of ground on capacitance – Numerical Problems.

UNIT - IV: Performance of Transmission Lines

Representation of lines – Short line: Model, Generalized circuit constants, Voltage regulation and efficiency – Medium length line: Model: Nominal–τ and Nominal–π, generalized circuit constants, Voltage regulation and Efficiency – Long transmission line –Equivalent–π circuit–Equivalent–τ circuit – Numerical Problems.

UNIT - V: Mechanical Design of Transmission Lines and Overhead Line Insulators & Cables
Introduction – calculation of sag and tension – Effects of wind and ice loading – Supports at different levels – String chart and sag template – Numerical Problems – Types of insulators – Potential distribution over a string of suspension insulators – String Efficiency – Methods for equalizing the potential – Numerical problems.
Insulating materials – Low voltage and extra high voltage Cables – Electrostatic stress in a single – core cables – Grading of cables – Capacitance of insulated cables – Corona – Critical voltage – Factors affecting corona – Advantages and disadvantages of corona – Radio interference.

TEXT BOOKS:
1. M.L.Soni,P.V.Gupta, U.S.Bhatnagarand A. Chakrabarti -A Text Book on Power System Engineering, Dhanpat Rai& Co. Pvt. Ltd.
2. Electrical Power Systems by C.L. Wadhwa, New Academic Science Ltd, 2009.
3. Electric Power Transmission and Distribution by S.Sivanagaraju & S.Satyanarayana, Pearson Education, New Delhi.

REFERENCE BOOKS:
1. Modern Power System Analysis by D.P.Kothari, I.J. Nagarath ', Tata McGraw-Hill, New Delhi, Fourth Edition, 2013.
2. The Transmission and Distribution of Electrical Energy by Harry Cotton, H. Barbe, English Universities Press, 1970.

WEB REFERENCES:
1. URL:https://www.youtube.com/watch?v=uy9lZCdkQIM&list=PLD4ED2FAF3C155625& index=1
2. URL:https://www.engineeringbookspdf.com/principles-of-power-systems-v-k-mehta.

Open Elective-I III B. TECH I-SEMESTER	L	T	P	INTERNAL MARKS	EXTERNAL MARKS	TOTAL MARKS	CREDITS
	3	0	0	30	70	100	3
Code: R20CC1OE03	Micro Electro Mechanical System						

Course Objectives:
- To impart the basics of Micro Electro Mechanical Systems (MEMS).
- To know the principle and various devices of MOEMS
- To learn about various sensors and actuators used in MEMS.
- To understand the principle and various devices of Micro Fluidic systems.
- To acquire the knowledge on concepts of bio and chemical systems and devices.

Course Outcomes:
After completion of this course, Students will be able to
CO1: Understand the basics of MEMS sensors and actuators. (K2)
CO2: Know the working principle of MOEMS. (K2)
CO3: Use various Magnetic Sensors and Actuators. (K3)
CO4: Explain the principle of Micro Fluidic systems. (K2)
CO5: Illustrate the Chemical and Bio Medical Micro Systems. (K4)

UNIT-I: Introduction & Thermal Sensors and Actuators
Definition of MEMS, MEMS history and development, micro machining, Principles of sensing and actuation: piezo electric, strain, pressure, flow, MEMS gyroscopes, Thermal energy basics and heat transfer processes, thermo devices, thermal flow sensors, micro hot plate gas sensors, micro spring thermal actuator, data storage cantilever.

UNIT-II: Micro-Opto-Electro Mechanical Systems
Principle of MOEMS technology, properties of light, light modulators, beam splitter, micro lens, micro mirrors, digital micro mirror device (DMD), light detectors, grating light valve (GLV), optical switch, wave guide and tuning, shear stress measurement.

UNIT-III Magnetic Sensors and Actuators
Magnetic materials for MEMS and properties, magnetic sensing and detection, magneto resistive sensor, more on Hall Effect, MEMS magnetic sensor, pressure sensor utilizing MOKE, mag MEMS actuators, bidirectional micro actuator, and feedback circuit integrated magnetic actuator.

UNIT-IV: Micro Fluidic Systems
Applications, considerations on micro scale fluid, fluid actuation methods, electro wetting, electro thermal flow. Radio Frequency MEMS: RF - based communication systems, RF MEMS, MEMS inductors, varactors, tuner/filter, resonator, MEMS switches, phase shifter.

UNIT-V: Chemical and Bio Medical Micro Systems
Sensing mechanism & principle, membrane-transducer materials, chem.-lab-on-a-chip (CLOC) chemo resistors, chemo capacitors, chemo transistors, electronic nose(E-nose), mass sensitive chemo sensors, fluorescence detection, calorimetric.

Text Books:

1. 1. MEMS, Nitaigour Premchand Mahalik, TMH Publishing co.

Reference Books:

1. Foundation of MEMS, Chang Liu, Prentice Hall Ltd.
2. MEMS and NEMS, Sergey Edwrd Lyshevski, CRC Press, Indian Edition.
3. MEMS and Micro Systems: Design and Manufacture, Tai-Ran Hsu, TMH Publishers.
4. Introductory MEMS, Thomas M Adams, Richard A Layton, Springer International Publishers.

Web Resources:

1. https://nptel.ac.in/courses/117105082
2. https://nptel.ac.in/courses/108108113

Open Elective-I III B. TECH I-SEMESTER	L	T	P	INTERNAL MARKS	EXTERNAL MARKS	TOTAL MARKS	CREDITS
	3	0	0	30	70	100	3
Code: R20CC1OE04	Fundamentals of Electrical Engineering						

Course Objectives:
- To understand operation of various basic electrical components.
- To analyse circuits by using basic network theorems and reduction techniques.
- To familiarize Magnetic circuits.
- To familiarizes about D.C Machines operation,
- To identify the importance of transformers and induction motor.

Course Outcomes:
Upon successful completion of the course, the students will be able to
CO1: Describe the history and classify elements of electrical engineering**(K3)**
CO2: Apply various laws to the electrical circuits**. (K3)**
CO3: Describe the concept of self, Mutual Impedances**. (K3)**
CO4: Measure the performance quantities such as losses, efficiency of DC machines**(k3)**
CO5: Create the construct of transformer and Induction motor**(k3)**

UNIT I
Introduction to Electrical Engineering-History of Electrical Engineering -Network elements classification, Circuit concepts –Resistor(R) - Inductor(L) - Capacitor(C) - Ohm's law - Kirchhoff's laws Voltage and Current Sources (Ideal and Non-Ideal)- Independent and Dependent Sources-Voltage - Current relationship for passive elements.

UNIT II
Network Equations and Reduction Techniques– Source transformation - Network reduction techniques series, parallel, series parallel, star-to-delta or delta-to-star transformation, Nodal analysis, mesh analysis for D.C excitations.

UNIT III
Magnetic Circuits:
Concept of self, mutual inductance, coefficient of coupling, dot convention rules and analysis of simple circuits – simple problems.

UNIT-IV DC Machines:
Principle Operation-Constructional features-induced EMF-Types of DC generators-Working of DC motor-Torque expression-3point starter-Speed controls-Losses and Efficiency by direct loading..

UNIT V Transformers:
Constructional details-working principle-EMF equation-losses and efficiency-open/short circuit tests.
Induction Motors: 3-Phase Induction motor Construction-working principle-Types-slip-Performance characteristics-applications

Text Books:

1. D.P.Kothari, I.J.Nagrath, Basic Electrical and Electronics Engineering, 1stedition, McGraw Hill Education (India) Private Limited, 2017.
2. B.L. Theraja, Fundamentals of Electrical Engineering and Electronics, 1stedition, S. Chand Publishing, New Delhi, 2006.
3. Theory & Problems of Electric Circuits by Joseph A Edminister- schaum series, 6th edition

Reference Books:

1. S.K.Bhattacharya, Basic Electrical and Electronics Engineering, Pearson Education, 2011.
2. Dharma Raj Cheruku, B T Krishna, Electronic Devices and Circuits, 2/e, Pearson Education, 2008
3. Fundamentals of Electric Circuits by Alexander & Sadiku, 2nd edition.

III B.TECH I-SEMESTER	L	T	P	INTERNAL MARKS	EXTERNAL MARKS	TOTAL MARKS	CREDITS
	3	-	-	30	70	100	3
Code: R20EE3106	DIGITAL CONTROL SYSTEMS (Professional Elective-I)						

COURSE OBJECTIVES:

- To explain basic and digital control system for the real time analysis and design of control systems.
- Analyze and solve linear control systems models, variation of constants formula z-transform method
- To explain the concept of stability analysis of discrete time systems.
- To apply the knowledge state variable analysis of discrete systems.
- To the design of state feedback control by "the pole placement method."

COURSE OUTCOMES:

After completion of this course students will be able to

CO1: Identify the basic principles and techniques of A/D and D/A conversions and basics of transform**. (K2)**

CO2: Apply Z-Transformation to Linear differential Equations. **(K3)**

CO3: Analyze the concept of stability analysis of discrete time systems. **(K3)**

CO4: Calculate the performance of a given pulse transfer function in time domain and frequency domain. **(K3)**

CO5: Design the state feedback control by "the pole placement method." **(K3)**

UNIT-1: Sampling and Reconstruction

Introduction - Examples of Data control systems – Digital to Analogue conversion and analogue to Digital conversion - sample and hold operations.

UNIT-II: The Z – Transforms

Introduction - Linear difference equations - Pulse response - Z – transforms - Theorems of Z – Transforms - the inverse Z – Transforms - Modified Z- Transforms Z-Transform method for solving difference equations; Pulse transforms function - Block diagram analysis of sampled – Data systems - Mapping between s-plane and z-plane.

UNIT-III: Stability Analysis

Mapping between the S-Plane and the Z-Plane – Primary strips and Complementary Strips – Constant frequency loci - Constant damping ratio loci - Stability Analysis of closed loop systems in the Z-Plane - Jurystablility test – Stability Analysis by use of the Bilinear Transformation and Routh Stability - Criterion.

UNIT-IV: Controllability and Observability

Concepts of Controllability and Observability - Tests for controllability and Observability - Duality between Controllability and Observability - Controllability and Observability conditions for Pulse Transfer Function.

UNIT-V: State Feedback Controllers and Observers

Design of state feedback controller through pole placement – Necessary and sufficient conditions, Ackerman's formula. State Observers – Full order and Reduced order observers.

TEXT BOOKS:

3. Discrete-Time Control systems – K. Ogata, Pearson Education/PHI, 2nd Edition.
4. Digital Control Systems, Kuo, Oxford University Press, 2nd Edition, 2003.
5. Digital Control and State Variable Methods by M.Gopal, TMH.

REFERENCE BOOKS:

1. 'Digital Control and State Variable Methods'M.Gopal, ', Tata McGraw Hill, 3rd Edition, 2009.
2. Digital Control Systems C.M. Houpis, G.B.Lamount, - Theory, Hardware, Software', International Student Edition, McGraw Hill Book Co., 1985.
3. Digital Control, Kannan M.Moddgalya, Wiley India, 2007.
4. "Feedback Control System, C.L.Philips and J.M.Pan, "Feedback Control System, Pearson.

III B.TECH I SEMESTER	L	T	P	INTERNAL MARKS	EXTERNAL MARKS	TOTAL MARKS	CREDITS
	3	1	0	30	70	100	3
Code: R20EE3107	SIGNALS AND SYSTEMS (Professional Elective-1)						

COURSE OBJECTIVES:

1. To get an in-depth knowledge about signals and analysis of the same using various transforms.
2. Able to know different types of signals and their frequency domain analysis.
3. Understand the principle, filter characteristics and bandwidth of a linear system.
4. Understand the concepts of auto correlation, cross correlation and power density.

COURSE OUTCOMES: After completion of this course, the students would be able to

CO1: Apply signal operations on basic Signals. **[K3]**
CO2: Develop Fourier series representation for trigonometric and exponential signals. **[K3]**
CO3: Translate signals from time-domain to frequency-domain and vice versa. **[K2]**
CO4: Build the LTI system and responses for different inputs. **[K3]**
CO5: Evaluate different properties of Sampling. **[K5]**

UNIT-I: SIGNAL ANALYSIS

Classification of Signals: Analog, Discrete, Digital, Deterministic & Random, Periodic & Aperiodic, Even & Odd, Energy & Power signals. Basic Operations on Signals: Time-Shifting, Time-Scaling, Time-Reversal, Amplitude Scaling and Signal Addition. Elementary Signals: Unit Step, Unit Ramp, Unit Parabolic, Impulse, Sinusoidal function, Exponential function, Gate function, Triangular function, Sinc function and Signum function. Signal approximation using orthogonal functions, Mean square error.

UNIT-II: FOURIER SERIES REPRESENTATION OF SIGNALS

Continuous time periodic signals, Properties of Fourier Series, Dirichlet‘s conditions, Trigonometric Fourier Series and Exponential Fourier Series, Conversion of Exponential Fourier Series from Trigonometric Fourier series & vice versa.

UNIT-III: FOURIER TRANSFORMS

Deriving Fourier Transform from Fourier series, Fourier Transform of arbitrary signal, Fourier Transform of standard signals, Fourier Transform of periodic signals, Properties of Fourier Transform, Fourier Transforms involving Impulse function and Signum function.

UNIT-IV: SIGNAL TRANSMISSION THROUGH LINEAR SYSTEMS

System and its types: Linear & Non-Linear, Time Variant & Time Invariant, Causal & Non Causal, Static & Dynamic, Stable & Unstable. Impulse response of a linear time invariant (LTI) system and linear time variant (LTV) system, Transfer function of a LTI system, Filter characteristics of linear systems, Distortion less transmission through a system, Signal bandwidth, System bandwidth, Ideal LPF, HPF and BPF and its characteristics, Relationship between bandwidth and rise time.

UNIT-V: SAMPLING

Sampling theorem, Types of Sampling: Impulse Sampling, Natural and flattop Sampling, Reconstruction of signal from its samples, Effect of under sampling – Aliasing.

TEXT BOOKS:

1. B.P. Lathi, Signals, Systems and Communications, BS Publications, 2008.
2. Simon Haykin and Van Veen, Wiley, Signals and Systems, 2nd Edition, 2003.

REFERENCE BOOKS:

1. A.V. Oppenheim, A.S. Will Sky and S.H. Nawab, Signals and Systems, 2nd Edition, PHI, 2013.
2. P. Ramesh Babu, Signals and Systems, 3rd Edition, SciTech Publications, 2011.
3. A.Anand Kumar, Signals and Systems, 3rd Edition, PHI Publications, 2013.

WEB REFERENCES:

1. https://nesoacademy.org/ee/02-signals-and-systems
2. https://onlinecourses.nptel.ac.in/noc21_ee28/preview

III B.TECH I-SEMESTER	L	T	P	INTERNAL MARKS	EXTERNAL MARKS	Total Marks	CREDITS
	3	-	-	30	70	100	3
Code: R20EE3108	SPECIAL ELECTRICAL MACHINES (Professional Elective-1)						

COURSE OBJECTIVES:

The objectives of this course is to

- Explain the performance and control of Stepper motors and their Applications
- Explain Theory of operation and control of Switched Reluctance Motor.
- Describe the power converter and sensor operation of permanent magnet brushless D.C. motors.
- Describe Construction, principle of operation and control of permanent magnet synchronous motors
- Explain the Construction, principle of operation and performance of other special Machines.

COURSE OUTCOMES:

After completion of this course, Students will be able to

CO1: Contrast the performance and control of stepper motors, and their applications**.(K3)**
CO2: Illustrate the control of switched reluctance motor**. (K3)**
CO3: Classify different types of permanent magnet motors & explain PMDC motor operation**.(K3)**
CO4: Compare the construction and operation of PMDC Motor &PM synchronous motor**.(K3)**
CO5: Select a special Machine for a particular application**.(K4)**

UNIT-I: Stepper Motors

Types - Constructional features – Principle of operation - Torque equation – Characteristics - Drive circuits - Open loop and Closed loop control – Comparison of stepper motors - Applications.

UNIT-II: Switched Reluctance Motors

Constructional features – Principle of operation - Torque Equation- Characteristics - Power Converter - Control of SRM - Rotor Position Sensors - Sensor less operation of SRM - Advantages and Disadvantages of SRM - Applications.

UNIT-III: Permanent Magnet Brushless D.C. Motors

Classifications - Construction - Commutation-principle of operation - EMF and Torque equations – types - Sensor less control of BLDC motor - Applications.

UNIT-IV: Permanent Magnet Synchronous Motors

Construction - Principle of operation- EMF and Torque equations - Phasor Diagram – Torque - Speed Characteristics - Control of PMSM - Applications.

UNIT-V: Other Special Machines

Constructional features – Principle of operation and Characteristics of Hysteresis motor - Synchronous Reluctance Motor – Linear Induction motor - Repulsion motor - Applications.

TEXT BOOKS:

1. K.Venkataratnam, 'Special Electrical Machines', Universities Press (India) Private Limited, 2008.
2. Kenjo, 'Stepping Motors and Their Microprocessor Controls', Clarendon Press London, 1984.
3. E.G. Janardanan, 'Special electrical machines', PHI learning Private Limited, Delhi, 2014.

REFERENCES BOOKS:

1. R.Krishnan, 'Switched Reluctance Motor Drives – Modeling, Simulation, Analysis, Design and Application', CRC Press, New York, 2001.
2. T. Kenjo and S. Nagamori, 'Permanent Magnet and Brushless DC Motors', Clarendon Press, London, 1988.
3. T.J.E.Miller, 'Brushless Permanent-Magnet and Reluctance Motor Drives', Oxford University Press, 1989.
4. R.Srinivasan, 'Special Electrical Machines', Lakshmi Publications, 2013.

WEB REFERENCES:

1. https://www.monolithicpower.com/en/stepper-motors-basics-types-uses
2. https://www.linquip.com/blog/switched-reluctance-motor/
3. https://robu.in/brushless-dc-motor-working-principle-construction-applications/
4. https://electricalbaba.com/permanent-magnet-synchronous-motor-pmsm-construction-working-principle/

III B.TECH I-SEMESTER	L	T	P	INTERNAL MARKS	EXTERNAL MARKS	TOTAL MARKS	CREDITS
	3	-	-	30	70	100	3
Code: R20EE3109	ENERGY CONSERVATION AND AUDITING (Professional Elective-1)						

COURSE OBJECTIVES:

- To introduce the basic concepts of Energy Auditing and Management.
- To enable the students to understand the concept of energy management and energy management opportunities.
- To illustrate the factors to increase the efficiency of electrical equipment of motors
- To understand the different methods used to Power factor improvement and various energy measuring instruments.
- To understand the different methods used for the economic analysis of energy projects.

COURSE OUTCOME:

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

CO1: **Demonstrate** skills required for energy audit and management.**(K2)**
CO2: **Identify** different areas of Energy conservation and management. **(K2)**
CO3: **Suggest** cost-effective measures towards improving energy efficient and energy **conservation. (K3)**
CO4: **Analyse** the power factor and to design a good illumination system and can find the applications of all the areas in day to day life. **(K4)**
CO5: **Determine** pay back periods for energy saving equipment. **(K3)**

UNIT-I: Basic Principles of Energy Audit

Energy audit – Definitions - Concept - Types of audit - Energy index - Cost index - Pie charts - Sankey diagrams - Load profiles - Energy conservation schemes - Energy audit of industries - Energy saving potential - Energy audit of process industry - Thermal power station - Building energy audit.

UNIT-II: Energy Management

Principles of energy management - Organizing energy management program – Initiating – Planning – Controlling – Promoting – Monitoring - Reporting - Energy manger - Qualities and functions, - Language - Questionnaire – Check list for top management.

UNIT-III: Energy Efficient Motors

Energy efficient motors - factors affecting efficiency - Loss distribution - Constructional details - Characteristics – Variable speed - Variable duty cycle systems - RMS hp - Voltage variation - Voltage unbalance - Over motoring - Motor energy audit.

UNIT-IV: Power Factor Improvement, Lighting and Energy Instruments

Power factor – Methods of improvement - Location of capacitors - Power factor with nonlinear loads - Effect of harmonics on power factor - Power factor motor controllers – Good lighting system design and practice - Lighting control - Lighting energy audit – Energy Instruments – Wattmeter - Data loggers – Thermocouples – Pyrometers - Lux meters - Tongue testers - Application of PLC's.

UNIT-V: Economic Aspects and Analysis

Economics Analysis - Depreciation Methods - Time value of money - Rate of return - Present worth method - Replacement analysis - Life cycle costing analysis - Energy efficient motors - Calculation of simple payback method , Net present worth method - Power factor correction - Lighting – Applications of life cycle costing analysis , Return on investment .

TEXT BOOKS:

1. Energy management by W.R. Murphy AND G. Mckay Butter worth, Heinemann publications.
2. Energy management by Paul o' Callaghan, Mc-graw Hill Book company-1st edition, 1998.
3. Energy efficient electric motors by John .C. Andreas, Marcel Dekker Inc Ltd 2nd edition, 1995.

REFERENCE BOOKS:

1. Energy efficient electric motors by John .C. Andreas, Marcel Dekker Inc Ltd-2nd edition, 1995.
2. Energy management hand book by W.C.Turner, John wiley and sons.
3. Energy management and good lighting practice: fuel efficiency- booklet 12-EEO.
4. Electric Energy Utilization and Conservation by S C Tripathy, Tata McGraw hill publishing company Ltd. New Delhi.

III B.TECH I-SEMESTER	L	T	P	INTERNAL MARKS	EXTERNAL MARKS	TOTAL MARKS	CREDITS
	0	0	3	15	30	50	1.5
Code:R20EE31L1	PROBLEM SOLVING WITH PYTHON PROGRAMMING LAB (OTHER THAN CSE)						

COURSE OBJECTIVES:

- To introduce programming through Visual programming tool - Scratch
- To teach problem solving through Flow charting tool - Raptor
- To elucidate problem solving through python programming language
- To introduce function-oriented programming paradigm through python
- To train in development of solutions using modular concepts
- To teach practical Pythonic solution patterns

COURSE OUTCOMES:

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

CO 1: Create interactive visual programs using Scratch.
CO 2: Develop flowcharts using raptor to solve the given problems.
CO 3: Develop Python programs for numerical and text based problems.
CO 4: Develop graphics and event based programming using Python.

LABOTORY EXPERIMENTS:

WEEK-1:

1. Design a script in Scratch to make a sprite to draw geometrical shapes such as Circle, Triangle, Square, and Pentagon.
2. Design a script in Scratch to make a sprite to ask the user to enter two different numbers and an arithmetic operator and then calculate and display the result.

WEEK-2:

3. Design a python script to print Armstrong number.
4. Design a python script to check the given no is factorial or not.

WEEK-3:

5. Design a Python script to convert a Binary number to Decimal number and verify if it is aPerfect number.
6. Design a Python script to determine if a given string is a Palindrome using recursion.

WEEK-4:

7. Design a Python script to sort numbers specified in a text file using lists.
8. Write a Python program to count the number of strings where the string length is 2 or more and the first and last character are same from a given list of strings.

WEEK-5:

9. Design a Python script to determine the difference in date for given two dates in YYYY:MM:DD format(0 <= YYYY <= 9999, 1 <= MM <= 12, 1 <= DD <= 31) following theleap year rules.
10. Design a Python Script to determine the Square Root of a given number without using inbuilt functions in Python.

WEEK-6:

11. Design a Python Script to determine the time difference between two given times inHH:MM:SS format.(0 <= HH <= 23, 0 <= MM <= 59, 0 <= SS <= 59)
12. Design a Python Script to convert a given number to words.

WEEK-7

13. Design a Python Script to convert a given number to roman number.
14. Design a Python Script to generate the frequency count of words in a text file.

WEEK-8:

15. Design a Python Script to print a spiral pattern for a 2 dimensional matrix.
16. Design a Python script to generate statistical reports (Minimum, Maximum, Count, Average, Sum etc) on public datasets.

WEEK-9:

17. Design a Python script using the Turtle graphics library to construct a turtle bar chart representing the grades obtained by N students read from a file categorizing them into distinction,first class, second class, third class and failed.
18. Write a Python program to convert a given tuple of positive integers into an integer.

WEEK-10:

19. Write a Python program to remove the intersection of a 2nd set from the 1st set.
20. Design a Python script on oop's concepts: Class variables and instance variable
    i) Robot ii) ATM Machine

TEXT BOOKS:

1. Kenneth Lambert, "Fundamentals of Python: First Programs".
2. Allen B. Downey, "think python: how to think like a computer scientist",2nd edition, O'reilly,2016.

REFERENCE BOOKS:

1. Python programming: A modern approach, vamsi kurama,pearson.
2. Learning python, Mark Lutz, Orielly.
3. Core python programming, W.Chun, pearson.
4. Introduction to python, Kenneth A. Lambert, Cengag

WEB RESOURS:

1. https://raptor.martincarlisle.com/
2. http://www.ict.ru.ac.za/Resources/cspw/thinkcspy3/thinkcspy3.pdf
3. https://zhanxw.com/blog/wp-content/uploads/2013/03/BeautifulCode_2.pdf
4. http://www.ict.ru.ac.za/Resources/cspw/thinkcspy3/thinkcspy3.pdf
5. https://www.cse.msu.edu/~stockman/ITEC/Scratch/BGC2011Scratch-Rev1.pdf
6. https://nostarch.com/scratchplayground

III B.TECH I-SEMESTER	L	T	P	INTERNAL MARKS	EXTERNAL MARKS	TOTAL MARKS	CREDITS
	0	0	3	15	35	50	1.5
Code: R20EE31L2	POWER ELECTRONICS LAB						

COURSE OBJECTIVES:

- To study the characteristics of various power electronic devices and analyse firing circuits and commutation circuits of SCR.
- To analyse the performance of single–phase and three–phase full wave bridge converters, single–phase dual converter with both resistive and inductive loads.
- To understand the operation of AC voltage controller and cyclo converter with resistive and inductive loads.
- To analyse the performance and working of single–phase bridge inverter and PWM inverter.

COURSE OUTCOMES:

After completion of this course student will be able to

CO1: Study the characteristics of various power electronic devices and analyse firing circuits and commutation circuits of SCR.

CO2: Analyse the performance of single–phase and half wave and Full wave bridge converters, single–phase dual converter with both resistive and inductive loads.

CO3: Understand the operation of AC voltage controller and cyclo converter with resistive and inductive loads.

CO4: Understand the working of single–phase bridge inverter and PWM inverter.

List of Experiments

Any 10 of the following experiments are to be conducted:

1. Study of Characteristics of SCR, MOSFET &IGBT
2. Study of Gate firing circuits for SCR‟s
3. Forced commutation circuits (Class A, Class B, Class C, Class D)
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 Controller with R and RL Loads
7. Single -Phase Cyclo–converter with R and RL loads
8. Single -Phase Bridge Inverter with R and RL Loads
9. Single -Phase dual converter with R and RL Loads
10. Single -Phase parallel inverter with R and RL Loads
11. Three -Phase half controlled bridge converter with R load.
12. Three- Phase full converter with RL–load.
13. Single -phase PWM inverter.

VIRTUAL LAB:

1. Single Phase Half Wave Uncontrolled Rectifier for R and L load.
2. Characteristics of MOSFET.
3. Design and Simulation of Buck Converter.

COURSE OBJECTIVES:

Students will be explored to

III B.TECH I-SEMESTER	L	T	P	INTERNAL MARKS	EXTERNAL MARKS	TOTAL MARKS	CREDITS
	1	0	2	0	50	50	2
Code: R20EE31SC3	INTERNET OF THINGS						

- Classify the latest microcontrollers with application development
- Plan about the product design and prototyping.
- Build interconnection and integration of the physical world and the cyber space.
- Construct the IOT Devices.
- Apply to develop the IOT Devices.

COURSE OUTCOMES:

After completion of this course, the student will able to

CO1: Explain the application areas of IOT ·

CO2: Influence the revolution of Internet in Mobile Devices,

CO3: Discuss about the importance of Cloud in IOT.

CO4: Justify about the importance of Sensor Networks.

CO5: Explain building blocks of Internet of Things and characteristics.

LIST OF EXPERIEMENTS

1. Familiarization with Arduino/Raspberry Pi and perform necessary software installation.
2. To interface LED/Buzzer with Arduino/Raspberry Pi and write a program to turn ON LED for 1 sec after every 2 seconds.
3. To interface Push button/Digital sensor (IR/LDR) with Arduino/Raspberry Pi and write a program to turn ON LED when push button is pressed or at sensor detection.
4. To interface DHT11 sensor with Arduino/Raspberry Pi and write a program to print temperature and humidity readings.
5. To interface motor using relay with Arduino/Raspberry Pi and write a program to turn ON motor when push button is pressed.
6. To interface OLED with Arduino/Raspberry Pi and write a program to print temperature and humidity readings on it.
7. To interface Bluetooth with Arduino/Raspberry Pi and write a program to send sensor data to smartphone using Bluetooth.
8. To interface Bluetooth with Arduino/Raspberry Pi and write a program to turn LED ON/OFF when '1'/'0' is received from smartphone using Bluetooth.
9. Write a program on Arduino/Raspberry Pi to upload temperature and humidity data to Thing speak cloud.
10. Write a program on Arduino/Raspberry Pi to retrieve temperature and humidity data from Thing speak cloud.

EXPERIMENTS BEYOND SYLLABUS:

1. To install MySQL database on Raspberry Pi and perform basic SQL queries.
2. Write a program on Arduino/Raspberry Pi to publish temperature data to MQTT broker.
3. Write a program on Arduino/Raspberry Pi to subscribe to MQTT broker for temperature data and print it.

4. Write a program to create TCP server on Arduino/Raspberry Pi and respond with humidity data to TCP client when requested.
5. Write a program to create UDP server on Arduino/Raspberry Pi and respond with humidity data to UDP client when requested.

VIRTUAL EXPERIMENTS:

1. Auto desk Eagle & Microsoft Raspberay Pi Simulation.
2. Proteus.
3. Virtronics simulation.

III B.TECH I-SEMESTER	L	T	P	INTERNAL MARKS	EXTERNAL MARKS	TOTAL MARKS	CREDITS
	2	0	0	-	-	-	-
Code:R20CC31MC01	PROFESSIONAL ETHICS AND HUMAN VALUES						

COURSE OBJECTIVES:

- Learn about morals, values & work ethics. Learn to respect others and develop civic virtue. Develop commitment and learn how to live peacefully.
- Learn about the different professional roles to be played by Engineer.
- Provide depth knowledge on Principles of Harmony and How emotional competencies helps them to accomplish goals, meet challenges, and engage effectively in social groups and environments.
- Develop knowledge about Professional and Individual Rights. Create awareness on Collective Bargaining and Industrial Espionage.
- Create awareness about safety, risk & risk benefit analysis. Engineer's design practices for providing safety. Provide knowledge on intellectual property rights.

COURSE OUTCOMES:

Student is able to

CO1: Interpret the fundamentals of Human values. **[K2]**
CO2: Analyse the ethical issues and role of engineers in industry. **[K4]**
CO3: Develop the principles of harmony in value education. **[K3]**
CO4: List out the duties and rights of engineers. **[K4]**
CO5: Summarise the engineer's responsibilities towards safety and risk. **[K2]**

Unit-I: Human Values

Ethics, Morals, Values, Integrity, Work Ethics- Service Learning – Civic Virtue- Respect for Others- Living Peacefully- Caring- Sharing- Honesty- Courage- Value Time- Cooperation- Commitment – Empathy- Self-Confidence- Spirituality- Character.

Unit-II: Engineering Ethics

Professional Roles to Be Played By Engineer- Engineers Role As Managers, Consultants And Leaders- Ethical Theories and Its Uses.

Unit- III: Principles for Harmony

Truthfulness – Customs and Traditions -Value Education – Human Dignity – Human Rights – Fundamental Duties - Aspirations and Harmony (I, We & Nature) – Gender Bias – Emotional Intelligence – Salovey – Mayer Model – Emotional Competencies – Conscientiousness.

Unit-IV: Engineers' Duties and Rights

Concept of Duty - Professional Duties – Collegiality - Techniques for Achieving Collegiality – Senses of Loyalty - Consensus and Controversy - Professional and Individual Rights –Confidential and Proprietary Information - Conflict of Interest-Ethical egoism – Collective Bargaining – Confidentiality - Gifts and Bribes - Problem solving-Occupational Crimes-Industrial Espionage-Price Fixing-Whistle Blowing.

Unit-V: Engineers' Responsibilities towards Safety and Risk

Concept of Safety - Safety and Risk – Types of Risks – Voluntary v/s Involuntary Risk – Consequences - Risk Assessment – Accountability – Liability - Reversible Effects – Threshold Levels of Risk - Delayed v/s Immediate Risk - Safety and the Engineer – Designing for Safety – Risk-Benefit Analysis-Accidents.

TEXT BOOKS:

1. "Professional Ethics and Morals by Prof. A.R.Arasri, Dharanikota Suyodhana- Maruthi Publications.
2. Professional Ethics by R. Subramaniam – Oxford Publications, New Delhi.
3. Ethics in Engineering by Mike W. Martin and Roland Schinzinger - Tata McGraw-Hill –2003.
4.

REFERENCES:

1. Professional Ethics by R. Subramaniam – Oxford Publications, New Delhi.
2. Ethics in Engineering by Mike W. Martin and Roland Schinzinger - Tata McGraw-Hill –2003.
3. Engineering Ethics by Harris, Pritchard and Rabins, Cengage Learning, New Delhi.
4. Human Values & Professional Ethics by S. B. Gogate, Vikas Publishing House Pvt. Ltd., Noida.
5. Engineering Ethics & Human Values by M.Govindarajan, S.Natarajan and V.S.SenthilKumar-PHI Learning Pvt. Ltd – 2009.
6. Professional Ethics and Human Values by A. Alavudeen, R.Kalil Rahman and M. Jayakumaran – University Science Press.
7. Professional Ethics and Human Values by Prof.D.R.Kiran-Tata McGraw-Hill - 2013
8. Human Values and Professional Ethics by Jayshree Suresh and B. S. Raghavan, S.Chand Publications.

III B. Tech. - II SEMESTER

S. No.	Subject Code	Subject	Cat. Code	L	T	P	Internal Marks	External Marks	Total Marks	Credits
1	R20EE3201	Microprocessor & Microcontrollers	PC	3	0	0	30	70	100	3
2	R20EE3202	Power System Analysis	PC	3	0	0	30	70	100	3
3	R20EE3203	Measurements & Instrumentation	PC	3	0	0	30	70	100	3
4	R20EE3204	**Professional Elective-II** a. Renewable and Distributed Energy System	PE	3	0	0	30	70	100	3
	R20EE3205	b. Electric Drives								
	R20EE3206	c. Utilization of Electrical Energy								
	R20EE3207	d. Big Data Analytics								
5	R20CC2OE03	**Open Elective-II** a. Hybrid Electric Vehicle	OE	3	0	0	30	70	100	3
	R20CC2OE04	b. Energy Audit and Conservation								
6	R20EE32L1	Microprocessors and Microcontrollers Lab	PC	0	0	3	15	35	50	1.5
7	R20EE32L2	Measurements and Instrumentation Lab	PC	0	0	3	15	35	50	1.5
8	R20EE32L3	Power System Simulation Lab	PC	0	0	3	15	35	50	1.5

9	R20CC32SC1	English Employability Skills	SC	1	0	2	-	50	50	2
10	R20CC32MC1	Essence of Indian Traditional Knowledge (MC)	MC	2	0	0	-	-	-	-
Total				**18**	**-**	**11**	**195**	**505**	**700**	**21.5**
		Honors/Minor courses (The hours distribution can be 3-0-2 or 3-1-0 also)								**4**

III B.TECH II-SEMESTER	L	T	P	INTERNAL MARKS	EXTERNAL MARKS	TOTAL MARKS	CREDITS
	3	0	0	30	70	100	3
Code: R20EE3201	MICROPROCESSORS & MICROCONTROLLERS						

COURSE OBJECTIVES:

1. To understand the organization and architecture of Micro Processor
2. To explain the addressing modes to access memory
3. Explore how to interface microprocessor with I/O as well as other devices.
4. To familiarize 8051 micro controller architecture
5. To know the programming principles for 8086 and 8051

COURSE OUTCOMES:

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

CO1: Recall the basic concepts, elements & operations of digital computer system. **[K1]**

CO2: Demonstrate memory organization and I/O processing for microprocessor and microcontroller. **[K3]**

CO3: Make use of Instruction set to develop Assembly Language Programming for computational operations. **[K3]**

CO4: Model a microprocessor based system by interfacing different electronic devices. **[K3]**

CO5: Illustrate the instruction set present in a microcontroller for different operations. **[K2]**

SYLLABUS:

UNIT-I: INTRODUCTION TO 8086 MICROPROCESSOR

Evolution of Microprocessors, Introduction to 8085, Architecture of 8086, Register Organization of 8086, Physical memory organization of 8086, General bus operation of 8086, Introduction to 80286–80386 and 80486 and Pentium.

UNIT-II: MINIMUM AND MAXIMUM MODE OPERATIONS

Minimum and Maximum mode operations of 8086, 8086 Control signal interfacing, Timing diagrams, Instruction set, Addressing modes.

UNIT-III: ASSEMBLY LANGUAGE PROGRAMMING

Assembler Directives, Macro's, Algorithms for Implementation of FOR Loop–WHILE– REPEAT and IF-THEN-ELSE. Addressing modes and Instruction set of 8051, Assembly language programming of 8051, Development systems and tools.

UNIT-IV: 8086 INTERFACING

8255 PPI– Architecture of 8255 & Modes of operation, Interfacing I/O devices to 8086 using 8255, Interfacing A to D converters & Interfacing D to A converters, Stepper motor interfacing, Static memory interfacing with 8086, DMA controller (8257)–Architecture & Interfacing 8257 DMA controller, Programmable Interrupt Controller (8259)–Command words, operating modes & Interfacing of 8259, Keyboard/display controller (8279)–Architecture, Modes of operation, Command words & Interfacing of 8279.

UNIT-V: INTRODUCTION TO 8051 MICRO CONTROLLER

8051 Microcontroller Architecture, Register set of 8051, I/O ports and Memory Organization, Modes of timer operation, Serial port operation, Interrupt structure of 8051.

TEXT BOOKS:

1. A.K. Ray, K.M. Bhurchandi, Advanced Microprocessors and Peripherals, Tata McGraw Hill Publications, 2000.
2. Douglas V Hall, Microprocessors and Interfacing, 2nd Edition, McGraw Hill.
3. Kenneth J Ayala, The 8051 Micro Controller Architecture, Programming and Applications, 2nd Edition, Thomson Publishers.

REFERENCE BOOKS:

1. R.S. Kaler, A Text book of Microprocessors and Micro Controllers, I.K. International Publishing House Pvt. Ltd.
2. Ajay V Deshmukh, Microcontrollers, Tata McGraw Hill publications, 2012.
3. Krishna Kant, Microprocessors and Microcontrollers, PHI Publications, 2010.

WEB RESOURCES:

1. https://learning-microprocessors.sourceforge.io/
2. https://www.sanfoundry.com/best-reference-books-microprocessors/
3. https://www.sciencedirect.com/topics/engineering/microprocessor-system
4. https://www.techtarget.com/whatis/glossary/Microprocessors
5. https://www.techtarget.com/iotagenda/definition/microcontroller
6. https://www.pcmag.com/encyclopedia/term/microcontroller
   https://electronics.howstuffworks.com/microcontroller.htm

III B.TECH II-SEMESTER	L	T	P	INTERNAL MARKS	EXTERNAL MARKS	TOTAL MARKS	CREDITS
	3	0	0	30	70	100	3
Code: R20EE3202	POWER SYSTEM ANALYSIS						

COURSE OBJECTIVES:

- Analyse multi-node power systems using an admittance matrix and impedance matrix representation of the power system.
- Understand the formulation of power flow problem and have the ability to cast any given system in this framework.
- Develop the concepts of fault analysis in interconnected systems.
- To study the stability analysis of power systems.

COURSE OUTCOMES:

After completion of this course, Students will be able to

CO 1: **Construct** a single line diagram & impedance diagram of a power system. [**K3**]
CO 2: **Analyse** an impedance matrix with any addition or removal of element. [**K4**]
CO 3: **Formulate** the power flow problem and **analyse** the power system. [**K4**]
CO 4: **Design** the positive, negative, and zero sequence networks for systems consisting of machines, transmission lines and transformers. [**K4**]
CO 5: **Derive** the swing equation & power angle curve in the stability analysis of power system. [**K4**]

UNIT-I: Representation

Per UNIT quantities - Single line diagram - Impedance diagram of a power system - Graph theory definition - Formulation of Y-Bus & Z-Bus.

UNIT-II: Power flow studies

Necessity of power flow studies – Derivation of Static power flow equations – Guass - Seidel method (limited to 3 buses) - Algorithm. Newton - Raphson method in rectangular and polar coordinates form - Derivation of Jacobean matrix - Power flow solution using N- R method-(3 bus) - Decoupled and Fast decoupled method (3 bus) – Algorithms.

UNIT–III: Symmetrical Fault analysis & Symmetrical Components

Three phase short circuit currents and reactance's of synchronous machines - Short circuit MVA calculations - Synthesis of unsymmetrical phasors from their symmetrical components – Operators - symmetrical components of unsymmetrical phasors - Power in terms of symmetrical components - sequence networks – Positive - Negative and zero sequence network.

UNIT - IV: Unsymmetrical Fault analysis

Various types of unsymmetrical faults - LG, LL, LLG on unloaded alternator - Unsymmetrical faults on power systems.

UNIT - V: Power system stability analysis

Classification of stability - Description of steady state stability power limits - Transfer reactance - Synchronizing power coefficient - Power angle curve and determination of steady state stability - Derivation of swing equation - Determination of transient stability by equal area criterion - Application of equal area criterion - Methods to improve steady state and transient state stability.

TEXT BOOKS:

1. M.L.Soni,P.V.Gupta, U.S.Bhatnagarand A. Chakrabarti -A Text Book on Power System Modern Power system analysis-I.J.Nagrath and D.P.Kothari- TMH, 2nd edition.
2. Computer methods in power systems analysis-Glenn W.Stagg, Ahmed H.EI. Abia Mc.Graw- Hill International Editions.

REFERENCE BOOKS:

1. Power system analysis-Grainger and Stevenson, Tata Mc. Graw-Hill.
2. Power system analysis-A.R.Bergen,PHI.
3. Power system analysis-Hadi saadat- TMH edition.
4. Power system analysis-B.R.Gupta-Wheeler Publications.
5. Electrical Power systems –C.L.Wadhwa -New Age International.

WEB REFERENCES:

1. https://www.youtube.com/watch?v=fBm1dr_gRBk.
2. http://nptel.iitm.ac.in.
3. https://www.youtube.com/watch?v=2JCe1riOpRg.
4. https://www.youtube.com/watch?v=wzyVtDkShC8.

III B.TECH II-SEMESTER	L	T	P	INTERNAL MARKS	EXTERNAL MARKS	TOTAL MARKS	CREDITS
	3	-	-	30	70	100	3
Code: R20EE3203	MEASUREMENTS AND INSTRUMENTATION						

Course Objectives:

To impart knowledge on the following Topics:

- Basic functional elements of instrumentation
- Fundamentals of electrical and electronic instruments
- Comparison between various measurement techniques
- various storage and display devices
- various transducers and Piezoelectric, Hall Effect

Course Outcomes:

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

CO1: Understand the Basic functional elements of instrumentation**. [K2]**

CO2: Understand and **Applying** the concepts of Fundamentals of electrical and electronic instruments**. [K3]**

CO3: Analyze the compare between various measurements techniques**. [K4]**

CO4: Understand the Various storage and display devices**. [K2]**

CO5: Apply the knowledge about transducers effectively and Piezoelectric, Hall effect**. [K3]**

UNIT I: Introduction

Functional elements of an instrument – Static and dynamic characteristics – Errors in measurement – Statistical evaluation of measurement data – Standards and calibration- Principle and types of analog and digital voltmeters, ammeters.

UNIT II: Electrical And Electronic Instruments Introduction

Principle and types of multi meters – Single and three phase watt meters and energy meters – Magnetic measurements – Determination of B-H curve and measurements of iron loss – Instrument transformers – Instruments for measurement of frequency and phase.

UNIT III: Comparative Methods Of Measurements

D.C potentiometers, D.C (Wheat stone, Kelvin and Kelvin Double bridge) & A.C bridges (Maxwell, Anderson and Schering bridges), transformer ratio bridges, self-balancing bridges. Interference & screening – Multiple earth and earth loops - Electrostatic and electromagnetic Interference – Grounding techniques.

UNIT IV: Storage And Display Devices

Digital CRO, CRT display, LED, LCD & Dot matrix display Recorders, digital plotters and printers – Data Loggers. Magnetic disk and tape

UNIT V: Transducers

Classification of transducers – Selection of transducers – Resistive, capacitive & inductive Transducers – Piezoelectric, Hall effect, optical and digital transducers.

TEXT BOOKS:

1. A.K. Sawhney, 'A Course in Electrical & Electronic Measurements & Instrumentation', hanpat Rai and Co, 2010.
2. J. B. Gupta, 'A Course in Electronic and Electrical Measurements', S. K. Kataria & Sons, Delhi, 2013.
3. Doebelin E.O. and Manik D.N., Measurement Systems – Applications and Design, Special Indian Edition, McGraw Hill Education Pvt. Ltd., 2007.

REFERENCES:

1. H.S. Kalsi, 'Electronic Instrumentation', McGraw Hill, III Edition 2010.
2. D.V.S. Murthy, 'Transducers and Instrumentation', Prentice Hall of India Pvt Ltd, 2015.
3. David Bell, 'Electronic Instrumentation & Measurements', Oxford University Press, 2013.
4. Martin Reissland, 'Electrical Measurements', New Age International (P) Ltd., Delhi, 2001.
5. Alan. S. Morris, Principles of Measurements and Instrumentation, 2nd Edition, Prentice Hall of India, 2003.

WEB REFERENCES:

1. https://onlinecourses.nptel.ac.in/noc19_ee44/preview
2. https://www.vssut.ac.in/lecture_notes/lecture1423813026.pdf
3. https://mrcet.com/downloads/digital_notes/EEE/EMI%20DIGITAL%20NOTES.pdf

III B.TECH II-SEMESTER	L	T	P	INTERNAL MARKS	EXTERNAL MARKS	TOTAL MARKS	CREDITS
	3	-	-	30	70	100	3
Code: R20EE3204	RENEWABLE AND DISTRIBUTED ENERGY SYSTEMS (Professional Elective-II)						

COURSE OBJECTIVES:

- To study the solar radiation data and radiation on earth's surface and solar pond.
- To understand wind energy conversion and Bio-mass.
- To impart knowledge on basic principles and working of Geothermal, Tidal and MHD Generators.
- To study distributed generation and micro grid.

COURSE OUTCOMES:

After completion of this course, Students will be able to,

CO1: **Illustrate** the significance of renewable energy. **(K2)**
CO2: **Analyze** the principles of wind energy and Biomass. **(K4)**
CO3: **Distinguish** the principles of Geothermal, Ocean, Tidal and Wave energy. **(K4)**
CO4: **Illustrate** the principles of MHD power generation. **(K2)**
CO5: **Outline** the Distributed Generation and Micro grid. **(K2)**

UNIT – I: Principles of Solar Radiation

Introduction to Energy Sources and their availability- renewable sources-The solar constant- Solar Radiation at the Earth's surface- solar radiation Geometry- instruments for measuring solar radiation and sun shine- solar radiation data- solar radiation on titled surfaces-Solar Pond and its Applications-Photovoltaic energy conversion.

UNIT – II: Wind Energy and Bio-Mass

Principles of wind energy conversion, Components of WECS- horizontal and vertical axis windmills- performance characteristics. Bio fuels- Methods for obtaining energy from Biomass-Thermal gasification of Biomass.

UNIT – III: Geothermal Energy, Ocean Energy, Tidal and Wave Energy

Introduction of Geothermal Energy- Nature of Geothermal fields- Geothermal Sources- Potential of Geothermal resources in India- OTEC- Methods of ocean thermal electric power generation- Open cycle and closed cycle- Principle of Tidal power- Components of Tidal power plants- Advantages and Disadvantages of Wave energy- Energy and power from the Waves.

UNIT – IV: MHD Power Generation

Introduction- Principle of MHD power generation- MHD Systems- Open cycle and closed cycle Systems- Advantages of MHD Systems- International Status of MHD power generation and its future prospects.

UNIT-V: Distributed Generation

Distributed generation – Introduction - Integration of distributed generation to Grid – Concepts of Micro Grid - Typical Microgrid configurations - AC and DC micro grids - Interconnection of Microgrids - Technical and economical advantages of Microgrid -Challenges and disadvantages of Microgrid development.

TEXT BOOKS:

1. G.D. Rai, “Non-Conventional Energy Sources”, Dhanpat Rai and Sons
2. Tiwari and Ghosal, “Renewable energy resources”,Narosa.

REFERENCE BOOKS:

1. Twidell& Weir, “Renewable Energy Sources“
2. Sukhatme, “Solar Energy”, Tata McGraw-HillEducation.
3. B.S Magal Frank Kreith& J.F Kreith, “Solar Power Engineering“
4. S. Chowdhury, S.P. Chowdhury and P. Crossley, Microgrids and Active Distribution Networks, ISBN 978-1-84919-014-5, IET, 2009

WEB RESOURCES:

1. https://www.youtube.com/watch?v=2M_r1S6yT2M&list=PLbMVogVj5nJTAW6mqiozHsjDGfkKJvNxo&index=1-43.
2. https://www.youtube.com/watch?v=mh51mAUexK4
3. https://www.youtube.com/watch?v=QueCghSlXeU

III B.TECH II-SEMESTER	L	T	P	INTERNAL MARKS	EXTERNAL MARKS	TOTAL MARKS	CREDITS
	3	0	0	30	70	100	3
Code: R20EE3205	ELECTRIC DRIVES (Professional Elective-II)						

COURSE OBJECTIVES:

The objectives of this course is to acquire knowledge on

- Fundamentals of electric drive and different electric braking methods.
- Operation of single-phase controlled converter dc motors and four quadrant operation of dc motors using dual converters.
- Choppers for speed control of dc motors.
- Concept of speed control of induction motor drive with variable voltage and v/f control.
- Speed control mechanism of synchronous motors

COURSE OUTCOMES:

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

CO1: **Know** about the fundamentals of electric drive and different electric braking methods. **[K3]**

CO2: **Operation** of single-phase controlled converter fed dc motors and **Analyse** the steady state behaviour of DC motor drive.[K4]

CO3: **Apply** the knowledge of choppers for speed control of DC Motors. **[K3]**

CO4: Know the **analysis** of speed control of induction motor with variable voltage and v/f control. **[K4]**

CO5: Know the **analysis** of speed control mechanism of synchronous motors. **[K4]**

UNIT-I: Fundamentals of Electric Drives

Electric drive – Fundamental torque equation – Load torque components – Nature and classification of load torques – Steady state stability – Four quadrant operation of drive (hoist control) – Braking methods: Dynamic – Plugging – Regenerative methods, Typical load torque characteristics – Selection of motor- Numerical problems.

UNIT-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.

UNIT-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).

UNIT-IV: 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).

Static rotor resistance control – Slip power recovery schemes – Static Scherbius drive – Static Kramer drive – Performance and speed torque characteristics – Advantages –Applications.

UNIT-V: Synchronous Motor Drives

Separate control of synchronous motor – self-control of synchronous motor employing load commutated thyristor inverter – closed loop control of synchronous motor drive – PMSM (Basic operation only).

TEXT BOOKS:

1. Fundamentals of Electric Drives – by G K Dubey, Narosa 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.

WEB REFERENCE:

1. https://mrcet.com/downloads/digital_notes/EEE/31082020/Electrical%20Drives.pdf
2. https://www.studocu.com/in/document/kalinga-institute-of-industrial-technology/electric-traction-drive/electric-drive-lecture-notes/24432893
3. https://nptel.ac.in/courses/108104140

III B.TECH II-SEMESTER	L	T	P	INTERNAL MARKS	EXTERNAL MARKS	TOTAL MARKS	CREDITS
	3	-	-	30	70	100	3
Code: R20EE3206	UTILIZATION OF ELECTRICAL ENERGY (Professional Elective-II)						

COURSE OBJECTIVES:

- To impart knowledge on electric heating and welding methods for residential, commercial and industrial applications.
- To familiarize with the fundamental laws of illumination & basic principle of light control.
- To study working principles of different lamps and various types of lightning system including design.
- To understand the basic principle of electric traction including speed–time curves of different types of services.
- To impart the concepts and calculations of tractive effort and specific energy consumption.

COURSE OUTCOMES:

After completion of this course students will be able to

CO1: Differentiate the various types of heating and welding methods. **[K4]**
CO1: Demonstrate the basic principles of illumination and light control. **[K3]**
CO3: Design illumination systems for residential, commercial and industrial environments. **[K3].**
CO4: Illustrate the basic principles of electric traction including speed–time curves of different traction services. **[K3]**
CO5: Calculate Adhesive force, tractive power and specific energy consumption. **[K3]**

UNIT-I: Electric Heating & Electric Welding

Advantages and methods of electric heating - Resistance heating - Induction heating and dielectric heating - Electric Welding - Resistance and arc welding - Electric welding equipment - comparison between A.C. and D.C. Welding.

UNIT-II: Illumination

Introduction to sources of light -Terms used in illumination -Laws of illumination - Basic principles of light control-Illumination measuring instruments-Lux meter-Numerical problems.

UNIT-III: Methods of Illumination

Types of Lamps: Discharge lamps, MV and SV lamps, tungsten filament lamps and fluorescent tubes - Comparison between tungsten filament lamps and fluorescent tubes - Design of interior and exterior lighting systems-Numerical problems.

UNIT-IV: Electric Traction – I

Systems of electric traction and track electrification - Review of existing electric traction systems in India - Special features of traction motor - Mechanics of train movement - Speed-time curves for different services - Trapezoidal and quadrilateral speed time curves-Numerical problems.

UNIT-V: Electric Traction – II

Calculations of tractive effort – Power - Specific energy consumption for given run - Effect of varying acceleration and braking retardation - Adhesive weight and braking retardation adhesive weight and coefficient of adhesion-Numerical problems.

TEXT BOOKS:

1. Utilization of Electric Energy – by E. Openshaw Taylor, Orient Longman.
2. Utilization of Electrical Energy – by G.C.Garg Khanna Publications.
3. Art & Science of Utilization of electrical Energy – by Partab, DhanpatRai& Sons.

REFERENCE BOOKS:

1. Utilization of Electrical Power including Electric drives and Electric traction – by N.V. Suryanarayana, New Age International (P) Limited, Publishers, 1996.
2. Generation, Distribution and Utilization of electrical Energy – by C.L. Wadhwa, New Age International (P) Limited, Publishers, 1997.

WEB RESOURCES:

1. https://www.youtube.com/watch?v=fQrZMMWo1mA
2. https://www.youtube.com/watch?v=uy9lZCdkQIM

III B.TECH II-SEMESTER	L	T	P	INTERNAL MARKS	EXTERNAL MARKS	TOTAL MARKS	CREDITS
	3	-	-	30	70	100	3
Code: R20EE3207	Big Data Analytics (Professional Elective-II)						

COURSE OBJECTIVES:

- Introducing Java concepts required for developing map reduce programs.
- Optimize business decisions and create competitive advantage with Big Data analytics.
- Derive business benefit from unstructured data.
- Imparting the architectural concepts of Hadoop and introducing map reduce paradigm.
- To introduce programming tools PIG & HIVE in Hadoop echo system.

COURSE OUTCOMES:

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

CO 1: Interpret the architectural elements of big data and Hadoop framework. [K2]

CO 2: Analyse various big data applications using map reduce programming module. [K4]

CO 3: Analyse Spark capabilities such as distributed datasets, in-memory caching, and the interactive shell. [K4]

CO 4: Summarize Spark's powerful built-in libraries, including Spark SQL, Spark Streaming. [K2]

CO 5: Analyze Hadoop data with PIG and Hive. Interpret the applications and architecture of Mobile Computing and multiplexing techniques. [K4]

UNIT– I

Starting Hadoop: -Google File System, -The building blocks of Hadoop: Namenode, Datanode, Secondary Namenode, JobTracker, TaskTracker. -Setting up SSH for a Hadoop cluster: Define a common account, Verify SSH installation, Generate SSH key pair, Distribute public key and validate logins. - Running Hadoop: Local (standalone) mode, Pseudo-distributed mode, Fully distributed mode.

UNIT–II

MapReduce: - A Weather Dataset: Data Format, -Analyzing the Data with Hadoop: Map and Reduce, Java MapReduce: A test run, The old and the new Java MapReduce APIs. Basic programs of Hadoop MapReduce: Driver code, Mapper code, Reducer code, RecordReader, Combiner, Partitioner.

UNIT–III

Programming with RDDs: What Is Apache Spark, RDD Basics, Creating RDDs, RDD Operations, Passing Functions to Spark, Common Transformations and Actions, Persistence (Caching).

UNIT-IV

Pig: Hadoop Programming Made Easier: -Admiring the Pig Architecture, -Going with the Pig Latin Application Flow, -Working through the ABCs of Pig Latin: Uncovering Pig Latin structures, Looking at Pig data types and syntax. -Evaluating Local and Distributed Modes of Running Pig Scripts, -Checking out the Pig Script Interfaces, -Scripting with Pig Latin

UNIT-V

Applying Structure to Hadoop Data with Hive: -Saying Hello to Hive, -Seeing How the Hive is Put Together, -Getting Started with Apache Hive, -Examining the Hive Clients: The Hive CLI client,

The web browser as Hive client, SQuirreL as Hive client with the JDBC Driver. - Working with Hive Data Types, -Creating and Managing Databases and Tables: Managing Hive databases, Creating and managing tables with Hive. -Seeing How the Hive Data Manipulation Language Works: LOAD DATA examples, INSERT examples, Create Table As Select (CTAS) examples. Querying and Analyzing Data: Joining tables with Hive, Improving your Hive queries with indexes, Windowing in HiveQL, Other key HiveQL features.

TEXT BOOKS:

1. Tom White, "Hadoop: The Definitive Guide" 3rd Edition, O'Reilly Media.
2. Matei Zaharia, Holden Karau, Andi Konwinski, Patric Wendell, Learning Spark, O'Reilly Media,2015.
3. by Chuck Lam, "Hadoop in Action" MANNING Publ.
4. Dirk deRoos, Paul C.Zikopoulos, Roman B.Melnyk,Bruce Brown, Rafael Coss, "Hadoop for Dummies"

REFERENCE BOOKS:

1. Alex Holmes, "Hadoop in Practice", MANNING Publ.
2. Srinath Perera, "Hadoop MapReduce Cookbook", Thilina Gunarathne

WEB REFERENCES:

1. https://www.edx.org/learn/big-data
2. https://www.edureka.co/big-data-and-hadoop

(Open Elective -II) III B.TECH I-SEMESTER	L	T	P	INTERNAL MARKS	EXTERNAL MARKS	TOTAL MARKS	CREDITS
	3	0	0	30	70	100	3
Code:R20CC2OE03	HYBRID ELECTRIC VEHICLES						

Course Objectives:

The objectives of this course is to

1. Familiarize working of different configurations of electric vehicles.
2. Explain the properties of batteries and its types.
3. Gain the knowledge in the Engine rating, Requirements of Dc & Ac Electrical Machines.
4. Impart the knowledge about electric vehicle drive systems.
5. Familiarize hybrid electric vehicles.

Course Outcomes:

After completion of this course Students will be able to

1. **Analyse** the behaviour of an electrical vehicles. **[K4]**
2. **Measure** the performance quantities such as Capacity, and Properties of Batteries. **[K3]**
3. **Know** the different ratings of DC and AC Electrical Machines. **[K3]**
4. **Analyse** the importance of components of Electric Vehicle Drive Train. **[K4]**
5. **Analyse** the different types of HEV. **[K4]**

UNIT–I: Electric Vehicles

Introduction – Components - Vehicle mechanics – Roadway fundamentals - Vehicle kinetics, - Dynamics of vehicle motion - Propulsion System Design.

UNIT–II: Battery

Basics – Types, Parameters – Capacity - Discharge rate - State of charge - state of Discharge - Depth of Discharge - Technical characteristics - Battery pack Design - Properties of Batteries.

UNIT–III: DC & AC Electrical Machines

Motor and Engine rating – Requirements - DC machines - Three phase A/c machines - Induction machines - Permanent magnet machines - Switched reluctance machines.

UNIT IV: Electric Vehicle Drive Train

Transmission configuration-Components- Gears-Differential-Clutch-Brakes regenerative Braking - Motor sizing.

UNIT–V: Hybrid Electric Vehicles

Types – series - Parallel and series - Parallel configuration – Design – Drive train - Sizing of components. Scenario of HEV in Indian Market

Text Books:

1. James Larminie, “Electric Vehicle Technology Explained”, John Wiley & Sons, 2003.
2. Iqbal Hussain, “Electric & Hybrid Vehicles – Design Fundamentals”, Second Edition, CRC Press, 2011.

Reference Books:

1. Sandeep Dhameja, “Electric Vehicle Battery Systems”, Newnes, 2000.
2. Mehrdad Ehsani, Yimin Gao, Ali Emadi, “Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals”, CRC Press, 2010

Web References:

1. https://www.iare.ac.in/sites/default/files/IARE_HEV_LN_0.pdf
2. http://nptel.ac.in/courses/108103009/.

(Open Elective -II) III B.TECH II-SEMESTER	L	T	P	INTERNAL MARKS	EXTERNAL MARKS	TOTAL MARKS	CREDITS
	3	0	0	30	70	100	3
Code:R20CC2OE04	ENERGY AUDITAND CONSERVATION						

Course Objectives:

1. To understand energy efficiency, scope, conservation and technologies and design energy efficient lighting systems.
2. To estimate/calculate power factor of systems and propose suitable compensation techniques.
3. To understand energy conservation in HVAC systems.
4. To calculate life cycle costing analysis and return on investment on energy efficient technologies

Course Outcomes:

After completion of this course students will be able to

1. Understand energy efficiency, scope, conservation and technologies. (K2)
2. Design energy efficient lighting systems. (K4)
3. Estimate/calculate power factor of systems and propose suitable compensation techniques. (K4)
4. Calculate life cycle costing analysis and return on investment on energy efficient technologies. (K3)
5. Calculate power factor of systems and propose suitable compensation techniques. (K3)

Unit-I: Basic Principles of Energy Audit and management Energy audit

Basic Principles of Energy Audit and management 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 – Principles of energy management –Initiating, planning, controlling, promoting, monitoring, reporting – Energy manager – Qualities and functions – Language – Questionnaire – Check list for top management.

Unit-II: Lighting

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-III: Power Factor and energy instruments

Power factor – Methods of improvement – Location of capacitors – Power factor with nonlinear 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–IV: Economic Aspects and Analysis-I

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).

Unit-V: Economic Aspects and Analysis-II

Calculation of simple payback method – Net present worth method – Power factor correction – Lighting – Applications of life cycle costing analysis – Return on investment.

Text Books:

1. Energy management by W.R. Murphy & G. Mckay Butter worth, Elsevier publications, 2012.
2. Energy efficient electric motors by John .C. Andreas, Marcel Dekker Inc Ltd–2nd edition, 1995.

Reference Books:

1. Electric Energy Utilization and Conservation by S C Tripathy, Tata McGraw hill publishing company Ltd. New Delhi.
2. Energy management by Paul o' Callaghan, Mc–Graw Hill Book company–1st edition, 1998.
3. Energy management hand book by W.C.Turner, John wiley and sons.
4. Energy management and conservation –k v Sharma and pvenkata seshaiah-I KInternational Publishing House pvt.ltd, 2011

III B.TECH II-SEMESTER	L	T	P	INTERNAL MARKS	EXTERNAL MARKS	TOTAL MARKS	CREDITS
	0	0	3	15	35	50	1.5
Code:R20EE32L1	MICROPROCESSORS AND MICROCONTROLLERS LAB						

COURSE OBJECTIVES:

- To study programming based on 8086 microprocessor and 8051 microcontroller.
- To learn 8086 microprocessor based ALP using arithmetic, logical and shift operations.
- To understand modular and Dos/Bios programming using 8086 microprocessor.
- To Familiarize to interface of 8086 with I/O and other devices.
- To understand reading and writing concepts and communication mechanisms.

COURSE OUTCOMES:

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

CO1: Apply the assembly language programs on arithmetic, logical and string operations. **[K3]**
CO2: Construct an 8086 system by interfacing I/O and other devices. **[K6]**
CO3: Make Use of Instruction set of 8086 for modular programming and DOS/BIOS Programming. **[K3]**
CO4: Model the 8051 based embedded systems for various applications. **[K3]**
CO5: Design the stepper motor control circuit with proper interfacing. **[K6]**

SYLLABUS:

I. Microprocessor 8086:

Any 8 of the following experiments are to be conducted:

1. Introduction to MASM/TASM.
2. Arithmetic operation – Multi byte addition and subtraction, multiplication and division – Signed and unsigned arithmetic operation, ASCII – Arithmetic operation.
3. Logic operations – Shift and rotate – Converting packed BCD to unpacked BCD, BCD to ASCII conversion.
4. By using string operation and Instruction prefix: Move block, Reverse string, sorting, Inserting, Deleting, Length of the string, String comparison.
5. Modular Program: Procedure, Near and Far implementation, Recursion.
6. Dos/BIOS programming: Reading keyboard (Buffered with and without echo) – Display characters, Strings.
7. Interfacing 8255–PPI
8. Programs using special instructions like swap, bit/byte, set/reset etc.
9. Programs based on short, page, absolute addressing.
10. Interfacing 8259 – Interrupt Controller.
11. Interfacing 8279 – Keyboard Display.
12. Stepper motor control using 8253/8255.

II. Microcontroller 8051

Any 2 of the following experiments are to be conducted:

13. Reading and Writing on a parallel port.
14. Timer in different modes.
15. Serial communication implementation.
16. Understanding three memory areas of 00 – FF (Programs using above areas) using external Interrupts.

III. Virtual lab Experiments:

1. Write a Program to Find LCM Of Two Numbers Using 8085 & Verify.
2. Write a program to arrange number in ascending order using 8085 & verify.
3. Write a program using 8085 for finding square-root of a number & verify.

WEB REFERENCES:

1. http://vlabs.iitb.ac.in/vlabs-dev/labs_local/microprocessor/labs/exp4/index.php
2. http://vlabs.iitb.ac.in/vlabs-dev/labs_local/microprocessor/labs/exp9/index.php
3. http://vlabs.iitb.ac.in/vlabs-dev/labs_local/microprocessor/labs/exp6/index.php

EQUIPMENT REQUIRED FOR LABORATORY

1. MASM/TASM Software.
2. 8086 Microprocessor.

Kits

1. 8051 Micro Controller kits.
2. Interfaces/peripheral subsystems.
    a) 8259 PIC
    b) 8279-KB/Display
    c) 8255 PPI
    d) 8251 USART
3. A/D and D/AC Interface

III B.TECH II-SEMESTER	L	T	P	INTERNAL MARKS	EXTERNAL MARKS	TOTAL MARKS	CREDITS
	-	-	3	15	35	50	1.5
Code: R20EE32L2	MEASUREMENTS AND INSTRUMENTATION LAB						

COURSE OBJECTIVES:

- To understand the correct function of electrical parameters and calibration of voltage, Current, single phase and three phase power and energy, and measurement of electrical Characteristics of resistance, inductance and capacitance of a circuits through appropriate Methods.
- To understand the calibration of DC and AC Potentiometers.
- To understand the testing of CT and PT.
- To Understand and the characteristics of Thermo couples, LVDT, Capacitive transducer, piezoelectric transducer.

COURSE OUTCOMES:

After the completion of the course the student should be able to:

CO1: Measure the electrical parameters voltage, current, power, energy and
CO2: Electrical Characteristics of resistance, inductance and capacitance.
CO3: Known the characteristics of transducers.

Any 10 of the following experiments are to be conducted

1. Calibration and Testing of single phase energy Meter
2. Calibration of dynamometer wattmeter using phantom loading
3. Calibration of PMMC ammeter and voltmeter using Crompton D.C. Potentiometer
4. Measurement of resistance and Determination of Tolerance using Kelvin's double Bridge.
5. Inductance Measurement using Anderson Bridge.
6. Calibration of LPF Wattmeter – by direct loading.
7. Dielectric oil testing using H.T test Kit.
8. Thermocouple – characteristics
9. LVDT – characteristics.
10. Capacitive transducers characteristics.
11. Piezoelectric transducer characteristics.
12. Measurement of strain using strain gauge

VIRTUAL LAB EXPERIMENTS:

1. Measurement of Self Inductance of High Quality Factor Coil by Hay's Bridge
   http://vlabs.iitkgp.ernet.in/asnm/exp9/index.html
2. To measure the dielectric Strength of transformer oil.
   https://vp-dei.vlabs.ac.in/Dreamweaver/exp4.html

III B.TECH II-SEMESTER	L	T	P	INTERNAL MARKS	EXTERNAL MARKS	TOTAL MARKS	CREDITS
	-	-	3	15	35	50	1.5
Code: R20EE32L3	POWER SYSTEM SIMULATION LAB						

COURSE OBJECTIVES:

- To allow students to practically verify several concepts and procedures learned in power system modeling and analysis.
- To develop hands-on experience of how certain procedures of power system operation are carried out.
- To carry out system studies using state of the art power systems analysis software to assess system operation in steady state and under faulted conditions.
- To promote teamwork among students and effective communication skills.

COURSE OUTCOMES:

After completion of this course students will be able to

CO1: Understand how to measure electrical parameters characteristics of a 3-phase transmission line.
CO2: Ability to simulate Rectifier, Chopper, Inverter and AC Voltage Controller.
CO3: Calculate the Load flow solution of power system by iterative methods
CO4: Analyse single area load frequency control.

LIST OF EXPERIMENTS

Any 10 of the following experiments are to be conducted

1. Calibration of Tong Tester.
2. Determination of Transmission Line Parameters.
3. Sequence of Impedance of 3-Φ Transformer.
4. Negative & Zero sequence Impedance of a 3-Φ Alternator.
5. Measurement of Dielectric strength of a Transformer oil.
6. Simulation of single - Phase full converter using RLE loads.
7. Simulation of single phase AC voltage controller using RLE loads.
8. Simulation of Buck chopper.
9. Simulation of Op-Amp based Integrator & Differentiator circuits.
10. Single Area Load frequency Control without and with PI Controller.
11. Load Flow solution by using Gauss-Seidel Method.
12. Solution to Swing Equation using Point-by-Point Method.

VIRTUAL LAB EXPERIMENTS

1. To study the Ferranti Effect of transmission line/cable.
   Link: http://vp-dei.vlabs.ac.in/Dreamweaver/exp9.html
2. To study the Synchronization of the alternator with infinite bus bar.
   Link: http://vp-dei.vlabs.ac.in/Dreamweaver/exp1.html

III B.TECH II-SEMESTER	L	T	P	INTERNAL MARKS	EXTERNAL MARKS	TOTAL MARKS	CREDITS
	-	-	2	0	50	50	2
Code: R20CC32SC1	ENGLISH EMPLOYABILITY SKILLS (Common to All Branches)						

COURSE OBJECTIVES:

- To train the students to use language effectively in professional situations like group discussions, public speaking, presentations and interviews.
- To make the students understand the importance of body language.
- To expose the students to SWOT Analysis.

COURSE OUTCOMES:

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

CO 1: Write effective Resume for employment..
CO 2: Make formal presentations using relevant technical style of communication and appropriate strategies for both academic and professional purpose.
CO 3: Participate in Group Discussions using analytical and problem solving skills.
CO 4: Face job interviews confidently and enhance employability.

UNIT– I:

Personal Introduction & JAM
SWOT Analysis

UNIT–II:

Resume and Video Portfolio
Non Verbal Communication
Professional Etiquette

UNIT–III:

Presentation Skills
Emotional Intelligence (How to face ambiguity, uncertainty and cobntingencies)

UNIT-IV:

Group Discussion

UNIT-V:

Interview skills- Mock Interviews

REFERENCE BOOKS:

1. Rajendra Pal, J S KorlahaHi, *Essentials of Business Communication,* Sultan Chand & Sons
2. Andrea J. Rutherford, *Basic Communication Skills for Technology,* Pearson Education Asia
3. V. Prasad, *Advanced Communication Skills,* Atma Ram Publications
4. Sanjay Kumar, Pushp Lata, *Communication Skills,* Oxford University Press
5. Meenakshi Raman, Sangeeta Sharma, *Fundamentals of Technical Communication,* Oxford University Press

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III B.TECH II-SEMESTER	L	T	P	INTERNAL MARKS	EXTERNAL MARKS	TOTAL MARKS	CREDITS
	2	0	0				
Code: R20CC32MC1	ESSENCE OF INDIAN TRADITIONAL KNOWLEDGE						

COURSE OBJECTIVES:

The objectives of this course will help the students

- To get necessary knowledge on Indian culture
- To know the Indian languages and Literature in India
- To explore the Indian arts and architecture in India
- To know the education system, science and scientists in India

COURSE OUTCOMES:

After successful completion of the course students will be abe to

CO1: Understand the philosophy of Indian Culture
CO2: Know the Indian languages, Epics Ramayana and Mahabharata
CO3: Acquire the information about Indian arts and architecture
CO4: Know the spread of cultural exchange in abroad
CO5: Know the contributions of scientists in different eras

Unit-I:Indian Culture: An Introduction

Characteristics of Indian culture, Significance of Indian culture, Geography of Indian Culture. Society in India through ages- Ancient period- varna and jati, family and marriage in India, position of women in ancient India, Contemporary period; caste system and communalism

Unit-II: Indian Languages and Literature

Evolution of script and languages in India: Harappan Script and Brahmi Script. Short History of the Sanskrit literature: The Vedas, The Brahmanas and Upanishads & Sutras, Epics: Ramayana and Mahabharata.

Unit-III: Indian Arts and Architecture

Indian Art & Architecture: Hindu Temple Architecture, Buddhist Architecture, Medieval Architecture. Rise of modern theatre and Indian cinema.

Unit-IV: Spread of Indian Culture Abroad

Causes, Significance and Modes of Cultural Exchange - Through Traders, Teachers, Emissaries, Missionaries and Gypsies. Indian Culture in South East Asia. India, Central Asia and Western World through ages.

Unit-V: Education System in India

Education in ancient, medieval and modern India, aims of education, Science and scientists of ancient India, Science and Scientists of Modern India.

SUGGESTED READINGS:

1. Kapil Kapoor, “Text and Interpretation: The indian tradition” ISBN: 81246033375, 2005
2. “ Science in Samskrit”, Samskrita Bharti Publisher , ISBN 13 : 978- 8187276333,2007
3. NCERT , “Position Paper On Arts ,Music, Dance Theatre”, ISBN 81-7450 494-X,200

IV B. Tech. - I SEMESTER

S. No.	Subject Code	Subject	Cat. Code	L	T	P	Internal Marks	External Marks	Total Marks	Credits
1	R20EE4102	**Professional Elective-III** a. High Voltage Engineering	PE	3	0	0	30	70	100	3
	R20EE4103	b. Power System Stability								
	R20EE4104	c. Flexible AC Transmission Systems								
	R20EE4105	d. Smart Grid Technology								
2	R20EE4106	**Professional Elective-IV** a. Power Quality	PE	3	0	0	30	70	100	3
	R20EE4107	b. Electrical and Hybrid Vehicles								
	R20EE4108	c. Introduction to Embedded Systems								
	R20EE4109	d. Power System Operation and Control								
3	R20EE4110	**Professional Elective-V** a. HVDC Transmission	PE	3	0	0	30	70	100	3
	R20EE4111	b. Switchgear and Protection								
	R20EE4112	c. Electrical Machine Design								
	R20EE4113	d. AI Techniques to power System								
4	R20CC3OE03	**Open Elective-III** a. Concept of Smart Grid Technology	OE	3	0	0	30	70	100	3
	R20CC3OE04	b. Industrial Automation								
5	R20CC4OE03	**Open Elective-IV** a. Non-Conventional	OE	3	0	0	30	70	100	3

		Energy Resources								
	R20CC4OE04	b. Electrical Safety								
6	R20CC4101	**Humanities and Social Science Elective** a. Business Management Concepts for Engineers	HSE	3	0	0	30	70	100	3
	R20CC4117	b. Entrepreneurship & Innovation								
7	R20EE41SC1	**Machine Learning with Python**	SC	1	0	2	-	50	50	2
8	R20CC41IN	Internship / Community Service Project	PROJ	0	0	0	0	50	50	1.5
9	R20CC41MC	MOOCs Course	PC	-	-	-	-	-	-	1.5
Total				**19**	**-**	**2**	**180**	**520**	**700**	**23**
		Honors/Minor courses (The hours distribution can be 3-0-2 or 3-1-0 also)								**4**

IV B.TECH I-SEMESTER	L	T	P	INTERNAL MARKS	EXTERNAL MARKS	TOTAL MARKS	CREDITS
	3	0	0	30	70	100	3
Code: R20EE4102	HIGH VOLTAGE ENGINEERING (Professional Elective-III)						

COURSE OBJECTIVES:

- To learn Electric field distribution and computation in different configuration of electrode systems.
- To gain knowledge on HV breakdown phenomena in gases, liquids and solids dielectrics.
- To know Generating and measuring principle of operation and Design of HVDC, AC and Impulse voltages and currents.
- To understand Insulating characteristics of dielectric materials.
- To use various testing techniques of HV equipment's.

COURSE OUTCOMES:

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

CO1: **Analyze** the performance of high voltages with regard to different configurations of electrode systems. **(K4)**

CO2: **Compare** the breakdown and withstand phenomena of all types of dielectric materials. **(K2)**

CO3: **Apply** knowledge for measurement of high voltage and high current AC, DC and Impulse. **(K3)**

CO4: **Measure** DC resistivity, dielectric constant and loss factor, partial discharge. **(K3)**

CO5: **Apply** the techniques of testing various equipment's used in HV engineering. **(K3)**

UNIT–I: Introduction to High Voltage Technology

Electric Field Stresses – Uniform and non–uniform field configuration of electrodes – Estimation and control of electric Stress – Numerical methods for electric field computation.

UNIT–II: Break down phenomenon in gaseous, liquid and solid insulation

Gases as insulating media – Collision process – 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.

UNIT–III: Generation and Measurement of High voltages and High currents

Generation of high DC voltages – Generation of high alternating voltages – Generation of impulse voltages and currents – Tripping and control of impulse generators.

Measurement of high voltages and High currents

Measurement of high AC, DC and Impulse voltages – Voltages and measurement of high currents – Direct, alternating and Impulse.

UNIT–IV: Non–destructive testing of material and electrical apparatus

Measurement of DC resistivity – Measurement of dielectric constant and loss factor – Partial discharge measurements.

UNIT–V: High voltage testing of electrical apparatus

Testing of insulators and bushings – Testing of isolators and circuit breakers – Testing of cables – Testing of transformers – Testing of surge arresters – Radio interference measurements.

TEXT BOOKS:

1. High Voltage Engineering: Fundamentals by E.Kuffel, W.S.Zaengl, J.Kuffel by Elsevier, 2nd Edition.
2. High Voltage Engineering and Technology by Ryan, IET Publishers.

REFERENCES:

1. High Voltage Engineering by M.S.Naidu and V. Kamaraju – TMH Publications, 3rd Edition
2. High Voltage Engineering by C.L.Wadhwa, New Age Internationals (P) Limited, 1997.
3. High Voltage Insulation Engineering by RavindraArora, Wolfgang Mosch, New Age International (P)Limited,1995

.

WEB REFERENCES:

1. URL: https://nptel.ac.in/courses/108104048
2. URL : https://bharatsrajpurohit.weebly.com/high-voltage-engineering-course.html

E-BOOKS:

https://books.google.co.in/books?id=4rQu1M0sjRAC&printsec=frontcover&source=gbs_ge_summary_r&cad=0#v=onepage&q&f=false

IV B.TECH I-SEMESTER	L	T	P	INTERNAL MARKS	EXTERNAL MARKS	TOTAL MARKS	CREDITS
	3	-	-	30	70	100	3
Code: R20EE4103	POWER SYSTEM STABILITY (Professional Elective-III)						

COURSE OBJECTIVES:

- To distinguish between the different types of power system stability studies
- To impart knowledge on modelling of a synchronous machine for stability analysis
- To understand the concept of small signal stability
- To study the various solution methodologies for transient stability analysis
- To study the voltage stability assessment methods

COURSE OUTCOMES:

After completion of this course Students will be able to,

CO1: Analyze the different types of stability in power systems. **(K4)**

CO2: Develop the modelling of synchronous machine. **(K3)**

CO3: Analyze the significance of small signal stability analysis. **(K4)**

CO4: Compare the various methods to enhance transient stability & the significance of voltage stability analysis. **(K4)**

UNIT-1: Introduction to Power System Stability

Basic concepts and definitions - Classification of stability - Rotor angle stability - Voltage stability and Voltage collapse - Distinction between mid-term and long-term stability - Nature of system response during severe upsets - Blackouts around the world – Ill effects of instability.

UNIT-II: Synchronous Machine Representation in Stability Studies

Need for reduced order models – stability of interconnected systems - Simplifications essential for large scale studies – Simplified model with amortisseurs neglected – Constant flux linkage model – Reactive capability limits.

UNIT-III: Small Signal Stability

State space representation – Eigen values - Modal matrices - Small signal stability of single machine infinite bus system – Effect of field circuit dynamics - Effect of excitation system - Small signal stability of multi machine system - Small signal stability enhancement methods.

UNIT-IV: Transient Stability Analysis

Distinction between transient and dynamic stability - An elementary view of the transient stability problem - Factors influencing transient stability - Review of numerical integration methods - Modified Euler's method and 4th order Runge-Kutta method - Transient stability enhancement methods – High speed fault clearing – Steam turbine fast valving - High speed excitation systems.

UNIT-V: Voltage Stability Analysis

Difficulties with reactive power transmission – Steady state stability analysis of two bus system using PV and QV curves – Voltage stability assessment using indices – Determination 30 of weakest bus or weakest bus ordering vector – Large disturbance analysis – Phase balancing and power factor correction of unsymmetrical loads.

TEXT BOOKS:

1. KundurP, “Power System Stability and Control”, McGraw Hill Education, 2006.
2. Taylor C W, “Power System Voltage Stability”, McGraw Hill, Inc., 1994.
3. Miller T.J.E, “Reactive power control in electric systems”, Wiley India, 2010.

REFERENCE BOOKS:

1. Anderson P.N, Fouad, A.A, “Power system control and stability”, Wiley India, 2008.
2. Sauer P W and Pai M A, “Power System Dynamics and Stability”, Pearson, 2003.

WEB RESOURCES:

1. https://www.youtube.com/watch?v=70gLa0-1Rho&list=PLC3FFC85203B1EC18&index=1-40.
2. https://www.youtube.com/watch?v=DzyX_GnSnL0&list=PLuv3GM6-gsE2WXbxLSnqKHf5gcnedXCZH&index=1-45.
3. https://www.youtube.com/watch?v=WkUJXxtVQII

IV B.TECH I-SEMESTER	L	T	P	INTERNAL MARKS	EXTERNAL MARKS	TOTAL MARKS	CREDITS
	3	-	-	30	70	100	3
Code: R20EE4104	FLEXIBLE AC TRANSMISSION SYSTEMS (Professional Elective-III)						

COURSE OBJECTIVES:

- To learn the basics of power flow control in transmission lines using FACTS controllers
- To explain operation and control of voltage source converter.
- To understand compensation methods to improve stability and reduce power oscillations of a power system.
- To learn the method of shunt compensation using static VAR compensators.
- To learn the methods of compensation using series compensators and Unified Power Flow Controller (UPFC).

COURSE OUTCOMES:

After completion of this course student will be able to

CO1: Analyze the power flow control in transmission lines using facts controllers**. [K2]**
CO2: Explain the operation and control of voltage and current source converter**. [K2]**
CO3: Analyze method of shunt compensation using static VAR compensators**. [K4]**
CO4: Evaluate different methods of compensations using series compensators**. [K5]**
CO5: Apply unified power flow controller (UPFC) on transmission systems**. [K3]**

UNIT-I: Introduction to FACTS

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 – Requirements and characteristics of high power devices – Voltage and current rating – Losses and speed of switching.

UNIT-II: Voltage source and Current 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 – Three–phase current source converter – Comparison of current source converter with voltage source converter.

UNIT-III 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.

UNIT-IV: Shunt Compensators–2

Thyristor Switched Capacitor (TSC) –Thyristor Controlled Reactor (TCR) – TSC–TCR. Static VAR compensator (SVC) and Static Compensator (STATCOM)**:** The regulation and slope transfer function and dynamic performance – Transient stability enhancement and power oscillation damping – Operating point control and summary of compensation control.

UNIT-V: Series Compensators & Combined Controllers

Static series compensators**:** Concept of series capacitive compensation – Improvement of transient stability – Power oscillation damping – Functional requirements – Thyristor Switched Series Capacitor (TSSC) and Thyristor Controlled Series Capacitor (TCSC) - Schematic and basic operating principles of Unified Power Flow Controller (UPFC).

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. Thyristor-based FACTS Controllers for Electrical Transmission Systems, by R.Mohan Mathur and Rajiv k.Varma, Wiley.

WEB REFERENCES:

1. https://nptel.ac.in/courses/108107114
2. https://vemu.org/uploads/lecture_notes/03_01_2020_358499686.pdf
3. https://www.iare.ac.in/sites/default/files/IARE_FACTS_LN.pdf

IV B.TECH I-SEMESTER	L	T	P	INTERNAL MARKS	EXTERNAL MARKS	TOTAL MARKS	CREDITS
	3	0	0	30	70	100	3
Code: R20EE4105	SMART GRID TECHNOLIGY (Professional Elective-III)						

COURSE OBJECTIVES:

- The objectives of this course is to acquire knowledge on
- To explain the overview of the technologies required for the smart grid.
- To impart the knowledge on switching techniques and different communication technologies for data communication.
- To inculcate security and standards in smart grid.
- To teach the importance of smart metering and demand side management in smart grid.
- To explain the energy management and energy storage technologies in smart grid.

COURSE OUTCOMES:

After completion of this course students will be able to

CO1: Illustrate the importance of smart grid initiation. **[K2]**

CO2: Apply the technologies for data communication and follow the appropriate standards**. [K3]**

CO3: Analyze the data and Communication security by adopting encryption and decryption procedures. **[K4]**

CO4: Utilize the smart metering application and demand side integration. **[K4]**

CO5: Measure the performance quantities such as Monitoring, operating, and managing the transmission and distribution tasks under smart grid environment. **[K3]**

UNIT-I: The Smart Grid

Introduction - Ageing Assets and Lack of Circuit Capacity - Thermal Constraints - Operational Constraints - Security of Supply - National Initiatives - Early Smart Grid Initiatives - Active Distribution Networks - Virtual Power Plant - Other Initiatives and Demonstrations - Overview of The Technologies Required for The Smart Grid.

UNIT-II: Communication Technologies

Data Communications: Introduction - Dedicated and Shared Communication Channels - Switching Techniques - Circuit Switching - Message Switching - Packet Switching - Communication Channels - Wired Communication - Optical Fibre - Radio Communication - Cellular Mobile Communication -

Communication Technologies: IEEE 802 Series - Mobile Communications - Multi Protocol Label Switching - Power line Communication - Standards for Information Exchange - Standards for Smart Metering - Modbus, DNP3, IEC61850.

UNIT-III: III Information Security for the Smart Grid

Introduction - Encryption and Decryption - Symmetric Key Encryption - Public Key Encryption – Authentication - Authentication Based on Shared Secret Key - Authentication Based on Key Distribution Center - Digital Signatures - Secret Key Signature - Public Key Signature - Message Digest - Cyber Security Standards - IEEE 1686: IEEE Standard for Substation Intelligent Electronic Devices(IEDs) Cyber Security Capabilities - IEC 62351: Power Systems Management And Association Information Exchange – Data and Communication Security.

UNIT-IV: Smart Metering and Demand Side Integration

Introduction - Smart metering – Evolution of electricity metering - Key components of smart metering, smart meters: an overview of the hardware used – signal acquisition - Signal conditioning - Analogue to digital conversion - Computation - Input/output - Communication.

Communication infrastructure and protocols for smart metering- Home area network, Neighbourhood Area Network - Data Concentrator - meter data management system - Protocols for communication. Demand Side Integration- Services Provided by DSI, Implementation of DSI, Hardware Support, Flexibility Delivered by Prosumers from the Demand Side - System Support from DSI.

UNIT-V: Transmission and Distribution Management Systems

Data Sources, Energy Management System - Wide Area Applications - Visualization Techniques - Data Sources and Associated External Systems - SCADA, Customer Information System - Distribution System Modelling - Topology Analysis - Load Forecasting - Applications, System Monitoring, Operation, Management - Outage Management System - Energy Storage Technologies, Batteries, Flow Battery - Fuel Cell and Hydrogen Electrolyser - Flywheels, Superconducting Magnetic Energy Storage Systems - Super capacitors.

TEXT BOOKS:

1. Smart Grid, Janaka Ekanayake, Liyanage, Wu, Akihiko Yokoyama, Jenkins, Wiley Publications, 2012, Reprint 2015.
2. Smart Grid: Fundamentals of Design and Analysis, James Momoh, Wiley, IEEE Press., 2012, Reprint 2016.

REFERENCE BOOKS:

1. The Smart Grid – Enabling Energy efficiency and demand response, Clark W. Gellings, P.E., CRC Press, Taylor & Francis group, First Indian Reprint. 2015.
2. Smart Grid – Applications, Communications, and Security Edited by Lars Torsten Berger, Krzysztof Iniewski, WILEY, 2012, Reprint 2015.
3. Practical Electrical Network Automation and Communication Systems, Cobus Strauss, ELSVIER, 2003.

WEB REFERENCE:

1. https://www.bharathuniv.ac.in/colleges1/downloads/courseware_eee/Notes/CE3/BEE019%20smart%20grid.pdf
2. https://ctijabalpur.com/Download/Study-Material/Smart%20Grid%20Notes.pdf
3. https://onlinecourses.nptel.ac.in/noc21_ee68/preview

IV B.TECH I-SEMESTER	L	T	P	INTERNAL MARKS	EXTERNAL MARKS	TOTAL MARKS	CREDITS
	3	-	-	30	70	100	3
Code: R20EE4106	POWER QUALITY (Professional Elective-IV)						

COURSE OBJECTIVES:

- To impart the knowledge on fundamentals of power quality problems.
- To identify the various causes which create the distortion in the power supply.
- To learn the various mitigation techniques and voltage regulation methods.
- To impart the knowledge on various custom power devices
- To know about power quality issues in distributed generation.

COURSE OUTCOMES:

After completion of this course students will be able to

CO1: Demonstrate the various power quality problems in power system **[K3]**

CO2: Illustrate the harmonic distortion problem due to commercial and industrial loads**[K3]**

CO3: Examine the suitable device for power quality measurements & voltage regulation methods **[K4]**

CO4: Apply skills in design of various custom power devices for power quality improvement **[K3]**

CO5: Differentiate the different power quality issues in Distributed Generation**[K4]**

UNIT-I: Fundamentals of Power Quality

Definition of Power Quality - Classification of Power Quality Issues - Power Quality Standards - Categories and Characteristics of Electromagnetic Phenomena in Power Systems: Impulsive and Oscillatory Transients – Interruption – Sag – Swell - Sustained Interruption - Under Voltage - Over Voltage and Outage - Sources and causes of different Power Quality Disturbances.

UNIT-II: Harmonics and Applied Harmonics

Harmonic Distortion - Voltage vs. Current Distortion - Harmonics Vs. Transients - Power System Qualities under Non-Sinusoidal Conditions - Harmonic Indices - Harmonic Sources from Commercial Loads, Harmonic Sources from Industrial Loads - Applied Harmonics**:** Effects of Harmonics - harmonic distortion evaluations -Principles of controlling harmonics and devices for controlling harmonic distortion.

UNIT-III: Voltage Regulation using Conventional Methods

Principles of regulating the voltage - Devices for voltage regulation: utility step voltage regulators - Ferro-resonant transformers -Magnetic synthesizers - On-line UPS systems - Motor-generator sets - Static VAR compensators - Shunt capacitors and series capacitors.

UNIT-IV: Power Quality Enhancement using Custom Power Devices

Introduction to Custom Power Devices - Network Reconfiguring Type: Solid State Current Limiter (SSCL) - Solid State Breaker (SSB) – Solid State Transfer Switch (SSTS) - Compensating Type: Dynamic Voltage Restorer - Distribution STATCOM and Unified Power Quality Conditioner – operation - Realization and control of DVR, DSTATCOM and UPQC – load compensation. Power quality monitoring – Power quality monitoring standards.

UNIT-V: Power Quality issues In Distributed Generation

DG Technologies - Perspectives on DG benefits - Interface to the Utility System - power quality issues affected by DG - Operating Conflicts: Utility fault clearing - Reclosing - Interference with relaying - Voltage regulation issues - Islanding - siting DG.

TEXT BOOKS:

1. Roger C. Dugan, Mark E. Mc. Granaghan, Surya Santosoh and H. WayneBeaty, Electrical Power Systems Quality, 2nd edition, TATA McGraw Hill,2010.
2. ArindamGhosh, Gerard Ledwich, Power Quality Enhancement Using CustomPower Devices, Springer, 2002.

REFERENCE BOOKS:

1. Math H J Bollen, "Understanding Power Quality Problems" IEEE Press, 1998.
2. C.Sankaran, Power Quality, CRC press, 2000.

WEB REFERENCES:

1. https://www.captech.com.au/what-is-power-quality/.
2. https://www.cet.edu.in/noticefiles/227_Electrical_Power_Quality-PEEL5403-8th_Sem-Electrical.pdf

IV B.TECH I-SEMESTER	L	T	P	INTERNAL MARKS	EXTERNAL MARKS	TOTAL MARKS	CREDITS
	3	0	0	30	70	100	3
Code: R20EE4107	ELECTRICAL AND HYBRID VEHICLES (Professional Elective – IV)						

COURSE OBJECTIVES:

The objectives of this course is to acquire knowledge on

- Familiarize the students with the need and advantages of electric and hybrid electric vehicles.
- Known various architectures of hybrid electric vehicles.
- Understand the power management of plug in electric vehicles.
- Study and understand different power converters used in electrical vehicles.
- Familiarize with different batteries and other storage systems.

COURSE OUTCOMES:

After completion of this course Students will be able to

CO1: Know the concept of electric vehicles and hybrid electric vehicles. **[K2]**
CO2: Examine the different configuration of hybrid electric vehicles. **[K3]**
CO3: Analyse with different configuration of hybrid electric vehicles. **[K4]**
CO4: Analyse the power converters used in hybrid electric vehicles. **[K4]**
CO5: Measure the performance quantities such as Capacity and Properties of Batteries. **[K3]**

UNIT– I: Introduction Fundamentals of vehicles

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, different Motors suitable for of Electric and Hybrid Electric Vehicles.

UNIT–II: Hybridization of Automobile

Architectures of HEVs, series and parallel HEVs, complex HEVs.Plu-in hybrid vehicle, constituents of PHEV, comparison of HEV and PHEV; Fuel Cell vehicles and its constituents.

UNIT–III: Plug-in Hybrid Electric Vehicle

PHEVs and EREVs blended PHEVs, PHEV Architectures, equivalent electric range of blended PHEVs; Fuel economy of PHEVs, power management of PHEVs, end-of-life battery for electric power grid support, vehicle to grid technology, PHEV battery charging.

UNIT–IV: Power Electronics in HEVs

Rectifiers used in HEVs, voltage ripples; Buck converter used in HEVs, non-isolated bidirectional DC-DC converter, voltage source inverter, current source inverter, isolated bidirectional DC-DC converter, PWM rectifier in HEVs, EV and PHEV battery chargers.

UNIT– V: Battery and Storage Systems

Energy Storage Parameters; Lead–Acid Batteries; Ultra capacitors; Flywheels - Superconducting Magnetic Storage System; Pumped Hydroelectric Energy Storage; Compressed Air Energy Storage - Storage Heat; Energy Storage as an Economic Resource.

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.

WEB REFERENCES:

1. https://www.iare.ac.in/sites/default/files/IARE_HEV_LN_0.pdf
2. http://nptel.ac.in/courses/108103009/.

IV B.TECH I SEMESTER	L	T	P	INTERNAL MARKS	EXTERNAL MARKS	TOTAL MARKS	CREDITS
	3	0	0	30	70	100	3
Code:R20EE4108	INTRODUCTION TO EMBEDDED SYSTEMS (Professional Elective-IV)						

COURSE OBJECTIVES:

- To gain knowledge and fundamental concepts and basic building blocks of an embedded system
- To learn characteristics, quality attributes and applications of embedded systems
- To understand the concept of real time operating systems
- To learn the RTOS basics and various Communication & Synchronization techniques
- To understand the classification and applications of embedded systems

COURSE OUTCOMES: After completion of the course, the student will be able to

CO1: Illustrate the classification and applications of embedded systems. **[K3]**
CO2: Classify the memory devices and passive components of embedded systems**. [K4]**
CO3: Summarize various Communication interface in Embedded Systems. **[K2]**
CO4: Summarize the steps involved in developing application specific embedded systems with suitable example. **[K6]**
CO5: Describe the RTOS basics and various Communication & Synchronization techniques. **[K2]**

UNIT–I: INTRODUCTION

Embedded Systems vs. general computing systems, history of embedded systems, classification of embedded systems, major application areas of embedded systems, purpose of embedded systems.

UNIT–II: CORE AND MEMORY

Core of the embedded system: general purpose and domain specific processors, ASICs, PLDs, Commercial Off-The-Shelf Components (COTS). Memory: ROM, RAM, memory according to the type of interface, memory shading, memory selection for embedded system.

UNIT–III: COMMUNICATION INTERFACE AND EMBEDDED SYSTEM COMPONENTS

Communication Interface: Onboard and external Communication Interfaces embedded firmware. Embedded system Components: reset circuit, brown-out protection circuit, oscillator unit, Real Time Clock (RTC), watchdog timer, PCB and passive components.

UNIT–IV: CHARACTERISTICS, QUALITY ATTRIBUTES AND EXAMPLES OF EMBEDDED SYSTEMS.

Characteristics of embedded systems and quality attributes of embedded systems. Embedded systems application and domain-specific: washing machine-application-specific embedded system, automotive- domain-specific embedded system.

UNIT–V: RTOS BASED EMBEDDED SYSTEM DESIGN

Operating system basics, types of operating systems, tasks, process and threads, multiprocessing and multitasking, task scheduling. Task communication, task synchronization, task communication/synchronization issues, task synchronization techniques, device drivers, How to choose an RTOS?

TEXT BOOKS:

1. Shibu K.V, Introduction to Embedded Systems, Mc Graw Hill Education, 2013.
2. Raj Kamal, Embedded Systems, TMH, 2007.
3. Tammy Noergaard, Embedded systems Architecture, Elsevier publications, 2005.

REFERENCE BOOKS:

1. Frank Vahid, Tony Givargis, Embedded System Design, John Wiley, 1999.
2. David E. Simon, An Embedded Software Primer, Pearson Education, 1999.

WEB RESOURCES:

1. http://www.embeddedtechnology.com/
2. http://www.omg.org/realtime/
3. http://www.eembc.org
4. http://www.instantweb.com/~foldoc/
5. http://www.realtime-info.be/magazine/98q4/1998q4_p014.pdf
6. http://www.eet.com/
7. http://www.zdnet.com/intweek/

IV B.TECH I-SEMESTER	L	T	P	INTERNAL MARKS	EXTERNAL MARKS	TOTAL MARKS	CREDITS
	3	-	-	30	70	100	3
Code: R20EE4109	POWER SYSTEM OPERATION AND CONTROL (Professional Elective-IV)						

COURSE OBJECTIVES:

- To make the student to understand economic load dispatch under various Operational and techniques to solve the problem.
- To impart the knowledge on optimal scheduling of hydro thermal systems.
- To study modelling of speed governing system, turbine and generator.
- To understand load frequency control of single area and two area power systems.
- To study compensations in power systems.

COURSE OUTCOMES:

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

CO1: Analyze the economic operation of power systems. **(K4)**
CO2: Solve unit commitment problems. **(K3)**
CO3: Model speed governing system, turbine and generator. **(K3)**
CO4: Develop the Block Diagram of Load frequency control of two area system. **(K3)**
CO5: Illustrate the compensation in power systems. **(K2)**

UNIT-I: Economic Operation of Power Systems

Optimal operation of Generators in Thermal power stations – Heat rate curve – Cost Curve – Incremental fuel and Production costs – Input, output characteristics – Optimum generation allocation with line losses neglected – Optimum generation allocation including the effect of transmission line losses – Loss Coefficients – General transmission line loss formula.

UNIT-II: Hydrothermal Scheduling& Unit Commitment

Optimal scheduling of Hydrothermal System: Hydroelectric power plant models – Scheduling problems – Short term hydrothermal scheduling problem. Optimal unit commitment problem – Need for unit commitment – Constraints in unit commitment – Cost function formulation – Solution methods – Priority ordering – Dynamic programming.

UNIT-III: Load Frequency Control-I

Speed governing system - Mathematical modelling of speed governing system - Modelling of steam turbine – Generator-Load Model - Necessity of keeping frequency constant – Definitions of Control area – Single area control system – Block diagram representation of an isolated power system – Steady state analysis – Dynamic response – Uncontrolled case. Proportional plus Integral control of single area and its block diagram representation – Steady state response.

UNIT-IV: Load Frequency Control-II

Block diagram development of Load Frequency Control of two area system- uncontrolled case and controlled case. Tie-line bias control. Load Frequency Control and Economic dispatch control.

UNIT-V: Compensation in Power Systems

Overview of Reactive Power control – Reactive Power compensation in transmission systems Advantages and disadvantages of different types of compensating equipment for transmission systems – Load compensation – Specifications of load compensator – Uncompensated and compensated transmission lines: Shunt and series compensation – Need for FACTS controllers.

TEXT BOOKS:

1. Electric Energy systems Theory – by O.I.Elgerd, Tata McGraw–hill Publishing Company Ltd., Second edition.
2. Modern Power System Analysis – by I.J.Nagrath & D.P.Kothari Tata McGraw Hill Publishing Company Ltd, 2nd edition.

REFERENCE BOOKS:

1. Power System Analysis and Design by J.Duncan Glover and M.S.Sarma., Thompson, 3rd Edition.
2. Power System Analysis by Grainger and Stevenson, Tata McGraw Hill.
3. Power System Analysis by Hadi Saadat – TMH Edition.
4. Power System Operation and Control by S.Sivanagaraju & G.Sreenivasan, Pearson.

WEB RESOURCES:

1. https://www.youtube.com/watch?v=zkN13OmgGOs&list=PL4BFB13CCDB954BCF&index=1-35.
2. https://www.youtube.com/watch?v=jq88tA5kePg&list=PLLm-6R2w8a1sYnjwnq7HdPlIzjHxJBdwV&index=1-8.
3. https://www.youtube.com/watch?v=eIHfSBkdejw&list=PLbRMhDVUMngeJSl9wldApgLKaxOBZguzN&index=1-55.

IV B.TECH I SEMESTER	L	T	P	INTERNAL MARKS	EXTERNAL MARKS	TOTAL MARKS	CREDITS
	3	0	0	30	70	100	3
Code: R20EE4110	HVDC TRANSMISSION (Professional Elective-V)						

COURSE OBJECTIVES:

- To analyze state of the art of HVDC technology and converter operation for two and multi-terminal DC systems
- To acquire knowledge about methods of HVDC converter control
- To impart the concept of AC-DC system interactions and protection scheme in HVDC system & MTDC systems

COURSE OUTCOMES:

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

CO1: Describe the control principles of HVDC converters. **(K3)**
CO2: Analyze the operation of power converters **(K4)**
CO3: Demonstrate the concept of harmonics in HVDC systems. **(K2)**
CO4: Assess the importance of MTDC systems. **(K4)**
CO5: Apply the Modelling of HVDC system and analysis of AC-DC system interactions. **(K3)**

UNIT- I Introduction:

HVDC Transmission: General considerations, Power Handling Capabilities of HVDC Lines, Basic Conversion principles, static converter configuration-Line commutated converters, Voltage source converters

UNIT-II Static Power Converters:

3-pulse, 6-pulse and 12-pulse converters, converter station and Terminal equipment, commutation process, Rectifier and inverter operation, equivalent circuit for converter – special features of converter transformers- Analysis of Voltage source converters

UNIT-III Harmonics and control of HVDC systems:

Harmonics in HVDC Systems, Harmonic elimination- AC and DC filters, Filter design.
Control of HVDC Converters and systems: constant current, constant extinction angle and constant Ignition angle control. Individual phase control and equidistant firing angle control, DC power flow control.

UNIT- IV MTDC systems:

Multi-terminal DC links and systems; Types of MTDC systems, Control and Protection of MTDC Systems Study of MTDC Systems, Multi in-feed DC Systems, MTDC using VSC.

UNIT- V Modelling and analysis of AC-DC system interactions:

Component models for the analysis of AC/DC systems -Introduction, System Models, General Converter Models, Model of Converter Controller, Modelling of a DC Network, Modelling of AC Network, Power flow analysis of AC/DC systems, interaction of AC/DC systems

TEXT BOOKS:

1. S.Kamakshaiah, V.Kamaraju,' HVDC Transmission', Tata McGraw-Hill Education Pvt. Ltd., 2011.
2. K. R. Padiyar, "HVDC Power Transmission Systems", Wiley Eastern Ltd., 1990.

REFERENCES:

1. E. W. Kimbark, "Direct Current Transmission", Vol. I, Wiley Inderscience, 1971.
2. Erich Uhlmann, "Power Transmission by Direct Current", B.S. Publications, 2004.
3. Arrillaga, "High Voltage Direct Transmission", Peter Peregrinus Ltd. London, 1983

.

WEB REFERENCES:

1. URL: https://nptel.ac.in/courses/108104013/
2. URL : https://nptel.ac.in/courses/108101040/22

E-BOOKS:

1. https://grieteee1317.files.wordpress.com/2016/11/hvdc-kundur-textbook.pdf

IV B.TECH I-SEMESTER	L	T	P	INTERNAL MARKS	EXTERNAL MARKS	Total Marks	CREDITS
	3	-	-	30	70	100	3
Code:R20EE4111	SWITCHGEAR AND PROTECTION (Professional Elective-V)						

COURSE OBJECTIVES:

The objectives of this course is

- To provide the basic principles of arc interruption, circuit breaking principles, operation of various types of circuit breakers.
- To study the classification, operation, construction and application of different types of electromagnetic protective relays.
- To explain various types of faults in generators and transformers and different types of protective schemes.
- To impart knowledge of various protective schemes used for feeders and bus bars.
- To study different types of Static Relays and Digital Relays.

COURSE OUTCOMES:

After completion of this course, Students will be able to

CO1: Estimate the principles of arc interruption for application to high voltage circuit breakers of air, oil, vacuum, SF6 gas type**. (k3)**

CO2: Ability to know the working principle and constructional features of different types of electromagnetic protective relays**. (k3)**

CO3: Estimate the type of faults that is observed to occur in high power generator and transformers and protective schemes used for all protections**. (K3)**

CO4: Choose the Protective Schemes to various types of feeders and bus bar protection. **(k3)**

CO5: Sketch the different types of static over current relays used in power system, (**k3)**

UNIT–I: Circuit Breakers:

Miniature Circuit Breaker (MCB)– Elementary principles of arc interruption– Restrike Voltage and Recovery voltages– Restrike phenomenon– Average and Max. RRRV– Current chopping and Resistance switching– Introduction to oil circuit breakers– Description and operation of Air Blast– Vacuum and SF6 circuit breakers– CB ratings and specifications– Auto reclosing.

UNIT–II: Electromagnetic Protection:

Principle of operation and construction of attracted armature– Balanced beam– induction disc and induction cup relays– Relays classification– Instantaneous– DMT and IDMT types– Applications of relays: Over current/under voltage relays– Directional relays– Differential relays and percentage differential relays– Universal torque equation– Distance relays: Impedance– Reactance– Mho and offset mho relays– Characteristics of distance relays and comparison.

UNIT–III: Generator Protection:

Protection of generators against stator faults– Rotor faults and abnormal conditions– restricted earth fault and inter turn fault protection– Numerical examples. Transformer Protection: Protection of transformers: Percentage differential protection– Design of CT's ratio– Buchholz relay protection–Numerical examples.

UNIT–IV: Feeder and Bus bar Protection:
Protection of lines: Over current– Carrier current and three zone distance relay using impedance relays–Translay relay Protection of bus bars– Differential protection.

UNIT–V: Static and Digital Relays:
Static relays: Static relay components– Static over current relay– Static distance relay Microprocessor based digital relays.

TEXT BOOKS:
1. "Badri Ram , D. N Viswakarma", "Power System Protection and Switchgear", TMH Publications, 2011
2. "Sunil S Rao", "Switchgear and Protection", Khanna Publishers, 2008.

REFERENCE BOOKS:
1. "Paithankar and S. R. Bhide", "Fundamentals of Power System Protection", PHI, 2003.
2. "C R Mason", Art & Science of Protective Relaying – Wiley Eastern Ltd, 1966.
3. "C. L. Wadhwa", "Electrical Power Systems", New Age international (P) Limited, Publishers, 6th Edition 2007.

WEB REFERENCES:
1. https://circuitglobe.com/circuit-breaker.html
2. https://www.machinedesign.com/automation-iiot/batteries-power-supplies/article/21832512/thermalmagnetic-circuit-breakers
3. https://www.electricaltechnology.org/2020/10/generator-protection-faults-protection-devices.html
4. https://www.electrical4u.com/busbar-protection/

IV B.TECH I-SEMESTER	L	T	P	INTERNAL MARKS	EXTERNAL MARKS	Total Marks	CREDITS
	3	-	-	30	70	100	3
Code:R20EE4112	ELECTRICAL MACHINE DESIGN (Professional Elective-V)						

COURSE OBJECTIVES:

- To get the knowledge of various materials used for design of static and rotating machines.
- To impart knowledge on the principle of design of rotating machines likeDC machines,induction machines and Synchronous machines.
- To impart knowledge on the principle of design of static machines like transformers.

COURSE OUTCOMES:

After completion of this course students will be able to

CO1: Illustrate the various materials used for design of static and rotating machines. **[K3]**

CO2: Derive the output equation of DC machine & design of main dimensions of DC machines & field circuit. **[K3]**

CO3: Derive the output equations of transformer, discuss selection of specific loadings, and estimate the number of cooling tubes, no load current and leakage reactance of core type transformer. **[K3]**

CO4: Develop the output equation of induction motor, design stator and rotor circuits of a induction motor. **[K3]**

CO5: Develop the output equation of alternator, design the field windings of Synchronous machine & short circuit ratio and its effects on performance of synchronous machines. **[K3]**

UNIT: 1 Electrical Engineering Materials:

Desirabilities of Conducting Materials, Comparison of Aluminium and Copper wires. Ferromagnetic Materials: Soft Magnetic materials – Solid Core Materials, Electrical Sheet and Strip, Cold Rolled Grain Oriented Steel. Insulating Materials: Desirable Properties, Temperature Rise and Insulating Materials, Classification of Insulating materials based on Thermal Consideration.

UNIT: 2 Design of DC Machines:

Output Equation, Choice of Specific Loadings and Choice of Number of Poles, Main Dimensions of armature, Design of Armature Slot Dimensions, Commutator and Brushes. Estimation of Ampere Turns for the Magnetic Circuit. Dimensions of Yoke, Main Pole and Air Gap. Design of Shunt and Series Field Windings.

UNIT: 3 Design of Transformers:

Output Equations of Single Phase and Three Phase Transformers, Choice of Specific Loadings, Expression for Volts/Turn, Determination of Main Dimensions of the Core, Estimation of Number of Turns and Conductor Cross Sectional area of Primary and Secondary Windings, No Load Current. Expression for the Leakage Reactance of core type transformer with concentric coils, and calculation of Voltage Regulation. Design of Tank and Cooling (Round and Rectangular) Tubes.

UNIT:4 Design of Three Phase Induction Motors:

Output Equation, Choice of Specific Loadings, Main Dimensions of Stator. Design of stator slots and Winding, Choice of Length Air Gap, Estimation of Number of Slots for Squirrel Cage Rotor. Design of Rotor Bars and End Ring. Design of Slip Ring rotor. Estimation of No Load Current and Leakage Reactance.

UNIT:5 Design of Three Phase Synchronous Machines:
Output Equation, Choice of Specific Loadings, Short Circuit Ratio, Main Dimensions of Stator. Design of stator slots and Winding. Design of Salient and non- salient Pole Rotors. Magnetic Circuit and Field Winding.

TEXT BOOK
4. A course in Electrical Machine design A.K.Sawhney, DhanpatRai 6th Edition, 2013

REFERENCE BOOKS
1. Performance and Design of Alternating Current Machines M.G. Say CBS Publisher 3rd Edition, 2002
2. Design Data Handbook A. Sanmugasundaram Et al New Age International 1st Edition, 2011

WEB RESOURCES
1. https://www.youtube.com/watch?v=AECBgmkWvo0
2. https://www.digimat.in/nptel/courses/video/108106023/L25.html

IV B.TECH I-SEMESTER	L	T	P	INTERNAL MARKS	EXTERNAL MARKS	TOTAL MARKS	CREDITS
	3	-	-	30	70	100	3
Code: R20EE4113	AI TECHNIQUES TO POWER SYSTEM (Professional Elective-V)						

Course Objectives:

The objectives of this course is

- To explain the fundamentals of soft computing techniques
- To Impart Knowledge of Mathematics and Engineering to understand the importance of ANN
- To explain importance of AI for power system applications

Course Outcomes:

After completion of this course student will be able to

CO1: apply the fundamentals of soft computing techniques.

CO2: apply knowledge of Mathematics and Engineering to understand the importance of ANN, Fuzzy and GA

CO3: apply the knowledge of AI for power system applications.

UNIT-I: INTRODUCTION

Definition of AI difference between soft computing techniques and hard computing systems, expert systems brief history of ANN, Fuzzy and GA.

UNIT-II: ARTIFICIAL NEURAL NETWORK

Introduction, History of neural network research, Basic concepts of Neural Networks, Human brain, Model of Artificial Neuron, Neural Network architectures, Single layer feed forward Network; Multi-layer feed forward network, recurrent networks, characteristics of Neural Network, Learning Methods Perceptron, ADALINE MADALINE Networks. Architecture of Back propagation Network, Non-linear activation operators, single and multilayer ANN, learning methods like Back propagation, LM etc. training and testing of ANN.

UNIT-III FUZZY LOGIC

Introduction, Comparison between Fuzzy and crisp logic, Fuzzy sets, Membership function, Basic fuzzy set operations, properties of Fuzzy set, fuzzy relations, Fuzzy interference system, Mamdani, Sugeno, Fuzzy rule based system, defuzzification methods.

UNIT-IV: GENETIC ALGORITHM

Introduction, Genetic Algorithms, Procedure of Genetic Algorithms, Genetic Representations, Initialization and Selection, Genetic Operators, Mutation, the Working of Genetic Algorithms, Evolutionary Programming, the Working of Evolutionary Programming.

UNIT-V: APPLICATION TO POWER SYSTEM

Applications of ANN, Fuzzy logic and GA for fault analysis, operation of relay and circuit breakers

Text Books:

1. Artificial Intelligence and Intelligent Systems, OXFORD University Press, New Delhi, 2005- N. P. Padhy
2. Understanding Neural Networks and Fuzzy Logic: Basic concepts and Applications, Prentice Hall India Private Limited, New Delhi, 2002- Stamations V. Kartalopoulos
3. Artificial Intelligence Techniques in Power Systems, IEE Power Engineering Series, UK, 1997- Kevin Warwick, Arthur Ekwue and Raj Aggarwal

Reference Books:

1. Intelligent Systems and Signal Processing in Power Engineering, Springer Berlin Heidelberg, New York- Abhisek Ukil
2. Neural Networks, Fuzzy logic and Genetic algorithms By S. Rajasekaran, G. A. Vijayalakshmi Pai PHI publication,
3. Optimization for Engineering Design by Kalyanmoy Deb PHI publication
4. Multi-objective Optimization using Evolutionary Algorithms By Kalyanmoy Deb Willey Publication

Open Elective-III IV B.TECH I-SEMESTER	L	T	P	INTERNAL MARKS	EXTERNAL MARKS	Total Marks	CREDITS
	3	-	-	30	70	100	3
Code:R20CC3OE03	CONCEPT OF SMART GRID TECHNOLIGES						

Course Objectives:

The objectives of this course is

1. To explain the concept of smart grid and developments on smart grid.
2. To Impart Knowledge in Smart grid technologies and application of smart grid concept in hybrid electric vehicles etc.
3. To inculcate the security in smart substations, feeder automation and application for monitoring and protection.
4. To gain the knowledge on micro grids and distributed energy systems.
5. To know power quality aspects in smart grid.

Course Outcomes:

After the completion of the course the student should be able to:

1. **Analyse** the smart grid policies and developments in smart grids. **[K4]**
2. **Develop** concepts of smart grid technologies in hybrid electrical vehicles etc**.[K4]**
3. **Illustrate** the different types of smart substations and feeder automation**.[K4]**
4. **Analyse** micro grids and distributed generation systems.**[K4]**
5. **Analyse** the effect of power quality in smart grid and to understand latest developments in ICT for smart grid.**[K4]**

Unit-I: Introduction to Smart Grid

Evolution of Electric Grid, Concept of Smart Grid, Definitions, Need of Smart Grid, Functions of Smart Grid, Opportunities & Barriers of Smart Grid, Difference between conventional & smart grid, Concept of Resilient &Self-Healing Grid, Present development & International policies on Smart Grid. Case study of Smart Grid.

Unit-II: Smart Grid Technologies: Part 1

Introduction to Smart Meters, Real Time Prizing, Smart Appliances, Automatic Meter Reading (AMR),Outage Management System(OMS), Plug in Hybrid Electric Vehicles(PHEV),Vehicle to Grid, Smart Sensors, Home & Building Automation, Phase Shifting Transformers.

Unit-III: Smart Grid Technologies: Part 2

Smart Substations, Substation Automation, Feeder Automation. Geographic Information System (GIS), Intelligent Electronic Devices (IED) & their application for monitoring & protection, Smart storage like Battery, SMES, Pumped Hydro, Compressed Air Energy Storage, Wide Area Measurement System(WAMS), Phase Measurement Unit(PMU).

Unit-IV: Micro grids and Distributed Energy Resources

Concept of micro grid, need & applications of microgrid, formation of microgrid, Issues of Inter connection, protection & control of microgrid. Plastic & Organic solar cells, thin film solar cells, Variable speed wind generators, fuel cells, micro turbines, Captive power plants, Integration of renewable energy sources.

Unit-V: Power Quality Management in Smart Grid

Power Quality & EMC in Smart Grid, Power Quality issues of Grid connected Renewable Energy Sources, Power Quality Conditioners for Smart Grid, Web based Power Quality monitoring, Power Quality Audit.

Information and Communication Technology for Smart Grid

Advanced Metering Infrastructure (AMI), Home Area Network (HAN), Neighborhood Area Network (NAN), Wide Area Network (WAN).

Text Books:

1. Ali Keyhani, Mohammad N. Marwali, Min Dai "Integration of Green and Renewable Energy in Electric Power Systems", Wiley
2. Clark W. Gellings, "The Smart Grid: Enabling Energy Efficiency and Demand Response",CRC Press

Reference Books:

1. The Smart Grid – Enabling Energy efficiency and demand response, Clark W. Gellings, P.E., CRC Press, Taylor & Francis group, First Indian Reprint. 2015.
2. Smart Grid – Applications, Communications, and Security Edited by Lars Torsten Berger, Krzysztof Iniewski, WILEY, 2012, Reprint 2015.
3. Practical Electrical Network Automation and Communication Systems, Cobus Strauss, ELSVIER, 2003.

Web Reference:

1. https://www.bharathuniv.ac.in/colleges1/downloads/courseware_eee/Notes/CE3/BEE019%20smart%20grid.pdf
2. https://ctijabalpur.com/Download/Study-Material/Smart%20Grid%20Notes.pdf
3. https://onlinecourses.nptel.ac.in/noc21_ee68/preview

Open Elective-III IV B.TECH I-SEMESTER	L	T	P	INTERNAL MARKS	EXTERNAL MARKS	Total Marks	CREDITS
	3	-	-	30	70	100	3
Code:R20CC3OE04	INDUSTRIAL AUTOMATION						

Course Objectives:

The objectives of this course is to acquire knowledge on

1. The basic concepts of programmable logic controllers and its applications.
2. Familiarize the students in programming formats and construction of PLC ladder diagrams.
3. The various PLC registers.
4. PLC functions, Data handling functions and controlling of two axes and three axes Robots with PLC.
5. Study the Analog PLC operation and different examples.

Course Outcomes:

After completion of this course, Students will be able to

1. **Illustrate** the basics of PLC & its Programming. [K2]
2. **Analyze** the Characteristics of Registers, module addressing and its importance in Ladder diagram. [K4]
3. **Develop** PLC programs using various functions of PLCs for various Industrial applications of PLC [K4]
4. **Distinguish** between various data handling functions. [K4]
5. **Differentiate** the Analog modules and systems, Analog signal processing, multi bit data processing. [K2, K4]

UNIT-I: Basics of PLC & PLC Programming

PLC system - I/O modules and interfacing – CPU processor - Programming equipment - rogramming formats - construction of PLC ladder diagrams -Devices connected to I/O modules - Input instructions – Outputs - Operational procedures - Programming examples using contacts and coils - Ladder diagrams for process control: Ladder diagrams - ladder diagram construction and flow chart for spray process system.

UNIT-II: PLC Registers

Characteristics of Registers - module addressing -Holding registers - Input registers - Output registers.

UNIT-III: PLC Functions

PLC Functions: Timer functions and Industrial applications – Counters - Counter function industrial applications - Arithmetic functions - Number comparison functions -Number conversion functions.

UNIT-IV: Data Handling Functions

Data handling functions: SKIP - Master control Relay - Jump, Move, FIFO, FAL, ONS, CLR and Sweep functions and their applications. Bit Pattern and changing a bit shift register - Sequence functions and applications - Controlling of two axes and three axis Robots with PLC - Matrix function.

UNIT-V: Analogue PLC Operation

Analog modules and systems - Analog signal processing, multi bit data processing - Analog output application examples - PID principles - Position indicator with PID control - PID modules - PID tuning - PID functions.

Text Books:

1. Programmable Logic Controllers – Principle and Applications by John W. Webb and Ronald A. Reiss, Fifth Edition, PHI.
2. Programmable Logic Controllers – Programming Method and Applications by JR. Hackworth and F.D Hackworth Jr. – Pearson, 2004.

Reference Books:

1. Programmable Logic Controllers Hardware and Programming by Max Rabiee Goodheart-Wilcox.
2. Programmable Logic Controllers by Frank D. Petuzeela McGraw-Hill.
3. Industrial Automation and Process control by Jon Stenerson Prentice-Hall.

Web Reference:

1. http://users.isr.ist.utl.pt/~jag/courses/api13/docs/API_I_C2.pdf
2. https://nptel.ac.in/courses/108105063
3. https://nptel.ac.in/courses/108105088

Open Elective-IV IV B.TECH I-SEMESTER	L	T	P	INTERNAL MARKS	EXTERNAL MARKS	Total Marks	CREDITS
	3	-	-	30	70	100	3
Code:R20CC4OE03	NON-CONVENTIONAL ENERGY RESOURCES						

Course Objectives:

- Understand the fundamentals of solar energy conversion and familiarize with solar geometry
- Learn basic principles and operational features of wind energy and Bio mass energy
- To educate Geothermal ,Ocean, tidal and wave energy principles and its operation
- To study basic principle and working of Thermal Electric Power.
- Analyze the principle and operation of direct energy conversion.

Course Outcomes:

After completion of this course, Students will be able to

CO1: Illustrate the principles of solar radiation and their applications. (K3)

CO2: Analyze the functioning of basic components of wind energy and the utilization of biomass in power generation. (K2)

CO3: Summarize the working principles of geothermal, ocean, tidal and wave energy techniques. (K3)

CO4: Interpret the functioning of Thermal Electric Power. (K3)

CO5: Analyze the MHD power generation and its future prospects.(K3)

UNIT – I: Introduction & Solar Energy

Introduction to Energy Sources and their availability- renewable sources-The solar constant- Solar Radiation at the Earth's surface-instruments for measuring solar radiation - solar radiation on titled surfaces-solar ponds-Applications of Solar ponds- solar heating-Photovoltaic energy conversion.

UNIT – II: Wind Energy and Bio-Mass

Principles of wind energy conversion, Components of WECS- horizontal and vertical axis windmills- performance characteristics. Bio fuels- Methods for obtaining energy from Biomass-Thermal gasification of Biomass.

UNIT – III: Geothermal Energy, Ocean Energy, Tidal and Wave Energy

Introduction of Geothermal Energy- Nature of Geothermal fields- Geothermal Sources- OTEC-Methods of ocean thermal electric power generation- Open cycle and closed cycle- Principle of Tidal power- Components of Tidal power plants- Advantages and Disadvantages of Wave energy- Energy and power from the Waves.

UNIT – IV: Thermal Electric Power

Introduction- Thermo electric power generation- See-beck, Peltier, Thomson effects - Thermo electric power generation- Thermo electric materials- Selection of materials.

UNIT – V: MHD Power Generation

Introduction- Principle of MHD power generation- MHD Systems- Open cycle and closed cycle Systems- Advantages of MHD Systems- International Status of MHD power generation and its future prospects.

Text Books:

1. G.D. Rai, “Non-Conventional Energy Sources”, Dhanpat Rai and Sons
2. Tiwari and Ghosal, “Renewable energy resources”, Narosa publications

Reference Books:

1. Twidell& Weir, “Renewable Energy Sources “
2. Sukhatme, “Solar Energy”, Tata McGraw-Hill Education.
3. B.S Magal Frank Kreith& J.F Kreith, “Solar Power Engineering “
4. Frank Krieth& John F Kreider, “Principles of Solar Energy”

Open Elective-IV IV B.TECH I-SEMESTER	L	T	P	INTERNAL MARKS	EXTERNAL MARKS	Total Marks	CREDITS
	3	-	-	30	70	100	3
Code:R20CC4OE04	ELECTRICAL SAFETY						

COURSE OBJECTIVES:

- To provide a comprehensive exposure to electrical hazards, various grounding techniques and safety.
- To know various safety Procedures and safety Equipment.
- To know about Safety programme structure.
- To analyse various electrical maintenance techniques.

COURSE OUTCOMES:

After completion of this course student will be able to

CO 1: Describe electrical hazards and safety equipment. [**K3**]
CO 2: Analyse and apply various grounding and bonding techniques. [**K4**]
CO 3: Select appropriate safety method for low, medium and high voltage equipment. [**K3**]
CO 4: Develop different types of safety programme structures. [**K3**]
CO 5: Analyse the maintenance of electrical equipment by using various safety & health Standards. [**K4**]

UNIT-I: Hazards of Electricity and Safety Equipment

Primary and secondary hazards- arc, blast, shocks-causes and effects-safety equipment- flash and thermal protection, head and eye protection-rubber insulating equipment, hot sticks, insulated tools, barriers and signs, safety tags, locking devices- voltage measuring instruments- proximity and contact testers-safety electrical one line diagram- electrician's safety kit.

UNIT-II: Grounding and Bonding of Electrical Systems and Equipment

General requirements for grounding and bonding- definitions- grounding of electrical equipment bonding of electrically conducting materials and other equipment-connection of grounding and bonding equipment- system grounding- purpose of system grounding- grounding electrode system grounding conductor connection to electrodes-use of grounded circuit conductor for grounding equipment- grounding of low voltage and high voltage systems.

UNIT-III: Safety Procedures and Methods

The six step safety methods- pre job briefings - hot-work decision tree-safe switching of power system- lockout-tag out- flash hazard calculation and approach distances- calculating the required level of arc protection-safety equipment , procedure for low, medium and high voltage systems- the one minute safety audit.

UNIT-IV: Safety Management and Organizational Structure

Electrical safety programme structure, development- company safety team- safety policy programme implementation- employee electrical safety teams- safety meetings- safety audit accident prevention- first aid- rescue techniques-accident investigation.

UNIT-V: Electrical Maintenance and its Relationship to Safety

Safety related case for electrical maintenance- reliability centered maintenance (RCM) - eight step maintenance programme- frequency of maintenance- maintenance requirement for specific equipment and location- regulatory bodies- national electrical safety code- standard for electrical safety in work place- occupational safety and health administration standards, Indian Electricity Acts related to Electrical Safety.

TEXT BOOKS:

1. John Cadick, Mary Capelli-Schellpfeffer, Dennis Neitzel, Al Winfield, 'Electrical Safety Handbook',McGraw-Hill Education, 4thEdition, 2012.

REFERENCE BOOKS:

1. Maxwell Adams.J, 'Electrical Safety- a guide to the causes and prevention of electric hazards', TheInstitution of Electric Engineers, IET 1994.
2. Ray A. Jones, Jane G. Jones, 'Electrical Safety in the Workplace', Jones & Bartlett Learning, 2000.

WEB REFERENCES:

1. https://www.labtrain.noaa.gov/osha600/refer/menu12a.pdf.
2.https://nptel.ac.in/courses/108107167.
3.https://onlinecourses.swayam2.ac.in/nou20_cs08/preview.

IV B.TECH I-SEMESTER	L	T	P	INTERNAL MARKS	EXTERNAL MARKS	Total Marks	CREDITS
	3	-	-	30	70	100	3
Code:R20CC4101	Business Management Concepts for Engineers						

COURSE OBJECTIVE:

1. To provide an insight into the various economic concepts which are necessary for taking decisions related to economic aspects of the organization.
2. To provide familiarity with the accounting concepts which will help in preparation of various accounting records
3. To equip the student with the basic management concepts and functions and to provide knowledge relating to recruitment, selection, training, and motivation of employees in the organization

COURSE OUTCOMES: The student is able to

CO1: Summarize fundamentals of Managerial economics for decision making (K2).
CO2: Apply concepts of Financial Accounting and BEP for business decisions (K3).
CO3: Evaluate fundamental concepts and principles of management (K5).
CO4: Discuss functional areas of management like HR, marketing and finance (K6).
CO5: Apply project management techniques for project planning and evaluation (K3).

UNIT-I: INTRODUCTION TO MANAGERIAL ECONOMICS

Definitions, - Nature And Scope- Relation With Other Subjects- Demand Definition- Determinants- Law of Demand and Its Exceptions- Concept of Elasticity of Demand- Cost Concepts- CVP Analysis (With Simple Problems), Significance- Limitations.

UNIT-II: MARKET STRUCTURES AND FINANCIAL ACCOUNTING

Introduction to Markets – Features of various markets-Perfect competition, Monopoly and Oligopoly. Definition – Importance, limitations and basic books of financial accounting, Preparation of basic books of accounting: journal, ledger and trail balance.

UNIT-III: INTRODUCTION TO MANAGEMENT

Concept, Nature, Importance- Functions of Management- Henry Fayols Principles of Management- F.W.Taylors Scientific Management- Douglas Mc Gregors Theory X and Y.

UNIT-IV: FUNCTIONAL AREAS OF MANAGEMENT

Concept of HRM, Functions of HR Manager- Marketing Management- Functions of Marketing Manager- Production Management-Functions of Production Management – Financial Management and functions of Financial Management.

UNIT-V: PROJECT MANAGEMENT: (PERT/CPM)

Development of Network – Difference between PERT and CPM- Problems on Critical Path- Problems on PERT Analysis.

TEXT BOOKS

1. Dr. N. APPARAO Dr. P. Vijay Kumar: "Managerial economics and financial analysis" Cengage publication's, New Delhi-2011.
2. Dr. A. R. Aryasri- Managerial Economics and Financial Analysis, TMH2011.
3. V. Maheswari: Managerial Economies, Sultan Chand.
4. Suma Damodaran: Managerial Economics, Oxford 2011.
5. Koontz & Weihrich: Essentials of Management" TMH 2011.

REFERENCES:

1. Managerial economics theory & applications, DM Mithani, Himalaya Publishing House, 2013. - **Unit-1, 2**
2. Accounting For Managers, G. Prasad, Jaibharath Publishers, 2016. - **Unit-3**
3. Dr. P. Vijaya Kumar & Dr. N. Appa Rao," Management Science" cengage. Delhi, 2012. -

Unit-4, 5

4. Project Planning & Control with PERT & CPM, BC Punmia & KK Khandelwal, Lakshmi Publications, New Delhi, 4th Edition – 2016. -**Unit-6**

IV B.TECH I-SEMESTER	L	T	P	INTERNAL MARKS	EXTERNAL MARKS	Total Marks	CREDITS
	3	-	-	30	70	100	3
Code:R20CC4117	ENTREPRENURSHIP & INNOVATION						

COURSE OBJECTIVE:

- Creating awareness among the students about the significance of entrepreneurship and its social relevance.
- Imparting knowledge to the students on institutional support available to start a business venture
- To understand the significance of entrepreneurial training in the development of new and existing entrepreneurs

COURSE OUTCOME: The student is able to

CO1 : Outline the concepts of Entrepreneurship. **[K2]**
CO2 : Create the awareness on creativity and innovation. **[K6]**
CO3 : Adopt the Entrepreneurship Development programs. **[K6]**
CO4 : Evaluate the project planning and feasibility studies. **[K5]**
CO5 : Analyze the concept of small and micro enterprises. **[K4]**

UNIT –I: ENTREPRENEUR AND ENTREPRENEURSHIP

Entrepreneur – Definitions, concept of entrepreneur, characteristics of entrepreneur, types of entrepreneurs, concept of entrepreneurship, characteristics of entrepreneurship, role of entrepreneurship in economic development, ethics and social responsibilities of an entrepreneur, Financial institutional support to entrepreneurs (IDBI,SISI,DIC,NIESBUD, Commercial banks etc.,

UNIT-II: CREATIVITY AND INNOVATION IN ENTREPRENEURSHIP

Meaning and concept of creativity - Nature and characteristics of creativity -Creativity Process- Factors affecting creativity - Meaning and Importance Innovation - Process -Distinguish the Creativity and Innovation.

UNIT –III: ENTREPRENEURSHIP DEVELOPMENT PROGRAMMES

Designing Appropriate Training Programme to inculcate Entrepreneurial Spirit -Training for Entrepreneurs, Entrepreneurship Development Programme (EDP) – Need and objectives of EDP's -Phases and evolution on EDP's existing and new Entrepreneurs.

UNIT –IV: PROJECT PLANNING AND FEASIBILITY STUDIES

Meaning of a project, Project identification – Sources of new Ideas, Methods of generating ideas, Project selection**,** - Project Feasibility Study -Project evaluation and Techniques (PBP, ARR, NPV, IRR & PI).

UNIT –V:
SMALL AND MICRO ENTERPRISES

Importance, definitions, MSME's Development Act 2006 – policies and their support to MSMEs - Growth of Firm and growth strategies, Factors inducing growth – sickness in small business and remedies.

TEXT BOOKS:

1. "Entrepreneurship", Arya Kumar: Pearson, Publishing House, New Delhi, 2012.
2. "Entrepreneurship', VSP Rao, Kuratko: Cengage Learning, New Delhi, 2012.
3. Shoimo Maital, DVR Seshadri, "Innovation Management", Response Books 2007.

REFERENCES:

1. "Entrepreneurship Development" B.Janakiram, M Rizwana: Excel Books, ND, 2011
2. "Entrepreneurship Development", P.C.Shejwalkar Everest Publishing House, ND, 2011
3. Vinnie Jauhari & Sudhanshu Bhushan, "Innovation Management". Oxford University Press, 2014.

IV B.TECH I-SEMESTER	L	T	P	INTERNAL MARKS	EXTERNAL MARKS	Total Marks	CREDITS
	1	0	2	0	50	50	2
Code:R20EE41SC1	Machine Learning with Python						

COURSE OBJECTIVES:

- To make the student to get a clear understanding of the core concepts of python like import data in various formats for statistical computing, data manipulation, business analytics, machine learning algorithms and data visualization etc.

COURSE OUTCOMES:

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

CO 1: Acquire the knowledge on exploratory data analysis.

CO 2: Analyze the real word datasets presented in different formats using python libraries to perform exploratory data analysis and Machine Learning algorithms.

List of Experiments

1. Perform Basic Visualizations (bar chart, scatter plot, boxplot,histogram etc) for all the columns (numerical data only) on the specified dataset and draw the inferences for the visualizations in excel.
2. Build a prediction model for simple linear regression and do the necessary transformations for input variables for getting better R^2 value for the model prepared.
3. Build a prediction model for multiple linear regression and do the necessary transformations for input variables for getting better R^2 value for the model prepared.
4. Build a prediction model to perform logistic regression.
5. Build a model to generate association rules by using apriori algorithm on the Movies data sets
   i. Try different values of support and confidence. Observe the change in number of rules for different support, confidence values
   ii. Change the minimum length in apriori algorithm. Visulize the obtained rules using different plots
6. Perform clustering using k-means clustering algorithm.
7. Perform Principle Component Analysis and then perform clustering.
8. Prepare a Classification model using decision tree Classifier.
9. Prepare a Classification model using Navie Bayes Classifier

TEXT BOOKS:

1. Aurélien Géron, “Handson machine learning with scikit learn and tensorflow”

LIST OF HONORS

POOL-1

Power Systems Engineering: (any four of the following subjects which are not chosen as professional electives are to be considered for Honors Degree)

S. No.	Subject Code	Subject	Cat. Code	L	T	P	Internal Marks	External Marks	Total Marks	Credits
1	R20EEHN01	Advanced Power System Protection	PC	3	1	0	30	70	100	4
2	R20EEHN02	Power system reliability	PC	3	1	0	30	70	100	4
3	R20EEHN03	Power Systems Dynamics and Stability	PC	3	1	0	30	70	100	4
4	R20EEHN04	Economic Operation of Power System	PC	3	1	0	30	70	100	4
5	R20EEHN05	Renewable Energy and Grid Integration	PC	3	1	0	30	70	100	4
In addition to any of the four subjects, MOOC/NPTEL Courses for 04 credits (02 courses @ 2 credits each) are compulsory in the domain of Electrical and Electronics Engineering										

POOL-2

Power Electronics and Drives: (any four of the following subjects which are not chosen as professional electives are to be considered for Honors Degree)

S. No.	Subject Code	Subject	Cat. Code	L	T	P	Internal Marks	External Marks	Total Marks	Credits
1	R20EEHN06	Analysis of Power Electronic Converters	PC	3	1	0	30	70	100	4
2	R20EEHN07	Advanced Electric Drives	PC	3	1	0	30	70	100	4
3	R20EEHN08	Analysis of Electrical Machines	PC	3	1	0	30	70	100	4
4	R20EEHN09	SMPS and UPS	PC	3	1	0	30	70	100	4
5	R20EEHN10	Power Electronics for Renewable Energy Systems	PC	3	1	0	30	70	100	4
In addition to any of the four subjects, MOOC/NPTEL Courses for 04 credits (02 courses @ 2 credits each) are compulsory in the domain of Electrical and Electronics Engineering										

POOL-3

Advanced Control Systems: (any four of the following subjects which are not chosen as professional electives are to be considered for Honors Degree)

S. No.	Subject Code	Subject	Cat. Code	L	T	P	Internal Marks	External Marks	Total Marks	Credits
1	R20EEHN11	Intelligent Controllers	PC	3	1	0	30	70	100	4
2	R20EEHN12	Non-Linear control	PC	3	1	0	30	70	100	4
3	R20EEHN13	Industrial Automation Systems	PC	3	1	0	30	70	100	4
4	R20EEHN14	Digital Instrumentation	PC	3	1	0	30	70	100	4
5	R20EEHN15	Control of Electrical Drives	PC	3	1	0	30	70	100	4
In addition to any of the four subjects, MOOC/NPTEL Courses for 04 credits (02 courses @ 2 credits each) are compulsory in the domain of Electrical and Electronics Engineering										

POOL-4

Electric Vehicle Technology: (any four of the following subjects which are not chosen as professional electives are to be considered for Honors Degree)

S. No.	Subject Code	Subject	Cat. Code	L	T	P	Internal Marks	External Marks	Total Marks	Credits
1	R20EEHN16	Electric Vehicle Mechanics and Control	PC	3	1	0	30	70	100	4
2	R20EEHN17	Electric Vehicle Dynamics	PC	3	1	0	30	70	100	4
3	R20EEHN18	Battery Technologies for Electric Vehicles	PC	3	1	0	30	70	100	4
4	R20EEHN19	Charging Infrastructure for EVs	PC	3	1	0	30	70	100	4
5	R20EEHN20	Hybrid Electric Vehicles	PC	3	1	0	30	70	100	4
In addition to any of the four subjects, MOOC/NPTEL Courses for 04 credits (02 courses @ 2 credits each) are compulsory in the domain of Electrical and Electronics Engineering										

POOL-1: POWER SYSTEMS	L	T	P	INTERNAL MARKS	EXTERNAL MARKS	Total Marks	CREDITS
	3	1	0	30	70	100	4
Code:R20EEHN01	Advanced Power System Protection						

Course Objectives:

The objectives of this course is to acquire knowledge on

- classification and operation of static relays.
- basic principles and application of comparators.
- static version of different types of relays.
- to understand about numerical protection techniques.
- microprocessor based relays and their applications

Course Outcomes:

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

CO 1: know the classifications and applications of static relays.
CO 2: analyze the application of comparators.
CO 3: know the static version of different types of relays.
CO 4: applications and numerical protection techniques.
CO 5: analyze the importance and applications of microprocessor-based relays

UNIT-I: STATIC RELAYS CLASSIFICATION AND TOOLS:

Comparison of Static with Electromagnetic Relays, Basic classification, Level detectors and Amplitude and phase Comparators – Duality – Basic Tools – Schmitt Trigger Circuit, Multivibrators, Square wave Generation – Polarity detector – Zero crossing detector – Thyristor and UJT Triggering Circuits. Phase sequence Filters – Speed and reliability of static relays.

UNIT-II: AMPLITUDE AND PHASE COMPARATORS:

Generalized equations for Amplitude and Phase comparison – Derivation of different characteristics of relays– Rectifier Bridge circulating and opposed voltage type amplitude comparators – Averaging & phase splitting type amplitude comparators – Principle of sampling comparators. Phase Comparison: Block Spike and phase Splitting Techniques – Transistor Integrating type, phase comparison, Rectifier Bridge Type Comparison – Vector product devices.

UNIT-III: STATIC OVER CURRENT (OC) RELAYS:

Instantaneous, Definite time, Inverse time OC Relays, static distance relays, static directional relays, static differential relays, measurement of sequence impedances in distance relays, multi input comparators, elliptic & hyperbolic characteristics, switched distance schemes, Impedance characteristics during Faults and Power Swings

UNIT-IV: PILOT RELAYING SCHEMES:

Wire pilot protection: circulating current scheme – balanced voltage scheme – translay scheme – half wave comparison scheme - carrier current protection: phase comparison type – carrier aided distance protection – operational comparison of transfer trip and blocking schemes – optical fibre channels.

UNIT-V: MICROPROCESSOR BASED RELAYS AND NUMERICAL PROTECTION:
Introduction – over current relays –impedance relay – directional relay – reactance relay. Numerical Protection: Introduction - numerical relay - numerical relaying algorithms – Mann Morrison technique - Differential equation technique and discrete fourier transform technique numerical over current protection - numerical distance protection.

Text Books:

1. Power System Protection with Static Relays – by TSM Rao, TMH.
2. Power system protection & switchgear by Badri Ram & D N Vishwakarma, TMH.

Reference Books:

1. Protective Relaying Vol-II Warrington, Springer.
2. Art & Science of Protective Relaying - C R Mason, Willey.
3. Power System Stability KimbarkVol-II, Willey.
4. Electrical Power System Protection –C.Christopoulos and A.Wright- Springer
5. Protection & Switchgear –Bhavesh Bhalaja, R.PMaheshwari, NileshG.Chothani-Oxford publisher

POOL-1: POWER SYSTEMS	L	T	P	INTERNAL MARKS	EXTERNAL MARKS	Total Marks	CREDITS
	3	1	0	30	70	100	4
Code:R20EEHN02	Power System Reliability						

Course Objectives:
The objectives of this course is to acquire knowledge on
- different distribution functions of basic probability
- basics of network modelling and reliability.
- understanding of Markov chains.
- basic understanding of Reliability analysis of generation systems.
- applications of Decomposition techniques

Course Outcomes:
After successful completion of this course, the students will be able to:
CO 1: apply distribution functions of basic probability
CO 2: know about the reliability analysis applied to power systems.
CO 3: Markov Chains and application to power systems.
CO 4: Perform stability analysis of generation systems.
CO 5: decomposition techniques applied to power system.

UNIT-I:
Basic probability theory-rules for combining probabilities of events-Bernoulli`s trials-probability density and distribution functions-binomial-distributions-expected value and standard deviation of binomial distribution.

UNIT-II:
Network Modelling and Reliability Analysis of Series, Parallel, Series-Parallel networks-complex networks-decomposition method Reliability functions F(t), R(t), h(t) and their relationship-exponential distributions – Expected value and standard deviation of exponential distribution – Bath tub curve– reliability analysis of series parallel networks using exponential distribution – reliability measures MTTF, MTTR, MTBF

UNIT-III:
Markov chains – concept of stochastic transitional probability Matrix, Evaluation of limiting state Probabilities– Markov processes one component repairable system – time dependent probability evaluation using Laplace transform approach – evaluation of limiting state probabilities using STPM – two component repairable models– Frequency and duration concept – Evaluation of frequency of encountering state, mean cycle time, for one, two component repairable models –evaluation of cumulative probability and cumulative frequency of encountering merged states

UNIT-IV:
Generation system reliability analysis – reliability model of a generation system – recursive relation for unit addition and removal – load modelling – merging of generation load model – evaluation of transition rates for merged state model – cumulative Probability, cumulative frequency of failure evaluation – LOLP, LOLE.

UNIT-V:

Composite system reliability analysis decomposition method – distribution system reliability analysis – radial networks – weather effects on transmission lines – Evaluation of load and energy indices.

Text Books:

1. Reliability Evaluation of Engg. System – R.Billinton, R.N.Allan, Plenum Press, New York.
2. Reliability Modeling in Electric Power Systems - J. Endrenyi, John Wiley, 1978, Newyork.

Reference Books

3. An Introduction to Realiability and Maintainability Engineering. Sharies E Ebeling, TATA McGraw Hill – Edition

POOL-1: POWER SYSTEMS	L	T	P	INTERNAL MARKS	EXTERNAL MARKS	Total Marks	CREDITS
	3	1	0	30	70	100	4
Code:R20EEHN03	Power Systems Dynamics and Stability						

Course Objectives:

The objectives of this course is to acquire knowledge on

- model of synchronous machines.
- stability studies of synchronous machines.
- solution method of transient stability.
- different effects of stability on power system
- effect of different excitation systems.

Course Outcomes:

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

CO 1: determine the model of synchronous machines.
CO 2: know the stability studies of synchronous machines.
CO 3: get the knowledge of solution methods of transient stability.
CO 4: analyze the different effects of power system
CO 5: know the effect of different excitation systems in power systems.

UNIT – I: System Dynamics:

Synchronous machine model in state space from computer representation for excitation and governor system – modelling of loads and induction machines.

UNIT – II: Steady state stability:

Steady state stability limit – Dynamics Stability limit – Dynamic stability analysis – State space representation of synchronous machine connected to infinite bus-time response – Stability by eigen value approach.

UNIT – III: Digital Simulation of Transient Stability:

Swing equation machine equations – Representation of loads – Alternate cycle solution method – Direct method of solution – Solution Techniques: Modified Euler method – Runge Kutta method – Concept of multi machine stability.

UNIT – IV: Effects on Stability

Effect of governor action and excite on power system stability effect of saturation, saliency & automatic voltage regulators on stability.

UNIT – V: Excitation Systems

Rotating Self-excited Exciter with direct acting Rheostatic type voltage regulator – Rotating main and Pilot Exciters with Indirect Acting Rheostatic Type Voltage Regulator – Rotating Main Exciter, Rotating Amplifier and Static Voltage Regulator – Static excitation scheme – Brushless excitation system.

Text Books:

1. Power System Stability by Kimbark Vol. I&II, III, Willey.
2. Power System control and stability by Anderson and Fund, IEEE Press.

Reference Books:

1. Power systems stability and control by PRABHA KUNDUR, TMH.
2. Computer Applications to Power Systems–Glenn.W.Stagg & Ahmed. H.El.Abiad, TMH.
3. Computer Applications to Power Systems – M.A.Pai, TMH.
4. Power Systems Analysis & Stability – S.S.Vadhera Khanna Publishers

POOL-1: POWER SYSTEMS	L	T	P	INTERNAL MARKS	EXTERNAL MARKS	Total Marks	CREDITS
	3	1	0	30	70	100	4
Code:R20EEHN04	Economic Operation of Power System						

Course Objectives:

The objectives of this course is to acquire knowledge on

- formulate and derive the necessary conditions for economical load scheduling problem.
- various constraints, problem formulation and methods to solve the unit commitment problem.
- constraints related to hydel power plants, problem formulation and solution techniques for hydrothermal scheduling problem.
- necessity factors governing the frequency control and analyze the uncontrolled and controlled LFC system.
- basic difference between ELS and OPF problem, formulation of the OPF problem and solution techniques.

Course Outcomes:

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

CO 1: solve the economic load scheduling with and without network losses both in classical method and iterative methods.

CO 2: solve the unit commitment problem using priority-list method and forward dynamic method.

CO 3: solve hydro-thermal scheduling problem for short-term and long-term range.

CO 4: analyze the single area and two area systems for frequency deviation under sudden change in load.

CO 5: solve the OPF problem using ac and dc load flow methods.

UNIT-I: ECONOMIC LOAD SCHEDULING

Characteristics of Steam Turbine, Variations in steam unit characteristics, Economic dispatch with piecewise linear cost functions, Lambda Iterative method, LP method, Economic dispatch under composite generation production cost function, Base point and Participation factors, Thermal system Dispatching with Network losses considered.

UNIT-II: UNIT COMMITMENT

Unit Commitment – Definition – Constraints in Unit Commitment–Unit Commitment solution methods-Priority–List Methods – Dynamic Programming Solution.

UNIT-III: HYDRO THERMAL SCHEDULING

Characteristics of Hydroelectric units, Introduction to Hydrothermal coordination, Long-Range and Short-Range Hydro-Scheduling, Hydroelectric plant models, Hydrothermal scheduling with storage limitations, Dynamic programming solution to hydrothermal scheduling

UNIT-IV: LOAD FREQUENCY CONTROL

Control of generation – models of power system elements – single area and two area block diagrams –generation control with PID controllers – implementation of Automatic Generation control (AGC) –AGC features.

UNIT-V: OPTIMAL POWER FLOW

Introduction to Optimal power flow problem, OPF calculations combining economic dispatch and power flow, OPF using DC power flow, Algorithms for solution of the ACOPF, Optimal Reactive Power Dispatch.

Text Books:

1. J.J. Grainger &W.D.Stevenson, "Power system analysis ", McGraw Hill ,2003
2. Allen J. Wood, Bruce F. Wollenberg, Gerald B. Sheblé-Power Generation, Operation and Control-Wiley-Interscience (2013)

Reference Books:

1. Olle l. Elgerd, "Electric Energy Systems Theory an Introduction", TMH, 2nd Edition, 1983

POOL-1: POWER SYSTEMS	L	T	P	INTERNAL MARKS	EXTERNAL MARKS	Total Marks	CREDITS
	3	1	0	30	70	100	4
Code:R20EEHN05	Renewable Energy and Grid Integration						

COURSE OBJECTIVES:

- To provide knowledge about the stand alone and grid connected renewable energy systems.
- To equip with required skills to derive the criteria for the design of power converters for renewable energy applications.
- To analyse and comprehend the various operating modes of wind electrical generators and solar energy systems.
- To design different power converters namely AC to DC, DC to DC and AC to AC converters for renewable energy systems.
- To develop maximum power point tracking algorithms.

COURSE OUTCOMES:

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

CO 1: Relate the power generation of different renewable energy sources to grid impact and grid codes
CO 2: Explain the design principles of solar energy management systems
CO 3: Illustrate the power conversion system of wind generators
CO 4: Analyze the different Maximum Power Point Tracking Techniques
CO 5: Build grid connected and stand-alone renewable energy management system

UNIT-I INTRODUCTION

Introduction to renewable energy systems, environmental aspects of electric energy conversion, impacts of renewable energy penetration to grid. Grid Codes in India and other countries. Basic power electronic converters for renewable energy integration to grid-Qualitative analysis -Boost and buck-boost converters, three phase AC voltage controllers- AC-DC-AC converters, PWM Inverters, Grid Interactive Inverters-matrix converters.

UNIT-II PHOTO VOLTAIC ENERGY CONVERSION SYSTEMS

Introduction, Photo Voltaic (PV) effect, Solar Cell, Types, Equivalent circuit of PV cell, PV cell characteristics (I/V and P/V) for variation of insolation, temperature and shading effect, Stand-alone PV system, Grid connected PV system, Design of PV system-load calculation, array sizing, selection of converter/inverter, battery sizing.

UNIT-III WIND ENERGY CONVERSION SYSTEMS

Introduction, Power contained in wind, Efficiency limit in wind, types of wind turbines, Wind control strategies, Power curve and Operating area, Types of wind generators system based on Electrical Machines-Induction Generator and Permanent Magnet Synchronous Generator (PMSG), Grid Connected-Single and Double output system, Self-excited operation of Induction Generator and Variable Speed PMSG.

UNIT-IV MPPT TECHNIQUES IN SOLAR AND WIND SYSTEMS

Case studies of PV-Maximum Power Point Tracking (MPPT) and Wind Energy system

UNIT-V HYBRID STORAGE SYSTEMS AND GRID MANAGEMENT

Energy Storage systems, Need for Hybrid Systems, Features of Hybrid Systems, Range and types of Hybrid systems (Wind-Diesel, PV-Diesel and Wind-PV)

Text Books:

1. S.N.Bhadra, D. Kastha, & S. Banerjee "Wind Electrical Systems", Oxford University Press, 2009.
2. Haitham Abu-Rub, Mariusz Malinowski and Kamal Al-Haddad, "Power Electronics for
3. Renewable Energy Systems, Transportation and Industrial Applications", IEEE Press and John Wiley & Sons Ltd Press, 2014.

Reference Books:

1. Rashid. H. "power electronics Hand book", Academic press, 2001.
2. Rai. G.D, "Non-conventional energy sources", Khanna publishes, 1993
3. Gray, L. Johnson, "Wind energy system", prentice hall linc, 1995
4. Non-conventional Energy sources B.H.Khan Tata McGraw-hill Publishing Company, New Delhi.

POOL-2: Power Electronics and Drives	L	T	P	INTERNAL MARKS	EXTERNAL MARKS	Total Marks	CREDITS
	3	1	0	30	70	100	4
Code:R20EEHN06	Analysis of Power Electronic Converters						

COURSE OBJECTIVES:

- To provide the mathematical fundamentals necessary for deep understanding of power converter operating modes.
- To introduce the electrical circuit concepts behind the different working modes of power converters so as to enable deep understanding of their operation.
- To impart required skills to formulate and design inverters for generic load and for machine loads.
- To equip with required skills to derive the criteria for the design of power converters starting from basic fundamentals.
- To inculcate knowledge to perform analysis and comprehend the various operating modes of different configurations of power converters

COURSE OUTCOMES:

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

CO 1: Acquire and apply knowledge of mathematics in power converter analysis

CO 2: Model and analyze power electronic systems and equipment.

CO 3: Formulate, design and simulate phase-controlled rectifiers for generic load and for machine loads

CO 4: Design and simulate switched mode inverters for generic load and for machine loads Select device and calculate performance parameters of power converters under various operating modes

UNIT I SINGLE PHASE AC-DC CONVERTER

Static Characteristics of power diode, SCR and GTO, half controlled and fully controlled converters with R-L, R-L-E loads and freewheeling diodes-continuous and discontinuous modes of operation-inverter operation and its limit-Sequence control of converters-performance parameters-effect of source impedance and overlap-reactive power and power balance in converter circuit.

UNIT II THREE PHASE AC-DC CONVERTER

Half controlled and fully controlled converters with R, R-L, R-L-E loads and freewheeling diodes - inverter operation and its limit-performance parameters - effect of source impedance and overlap - 12 pulse converter - Applications - Excitation system, DC drive system.

UNIT III SINGLE PHASE INVERTERS

Introduction to self-commutated switches: MOSFET and IGBT- Principle of operation of half and full bridge inverters - Performance parameters -Voltage control of single-phase inverters using various PWM techniques - various harmonic elimination techniques-Design of UPS - VSR operation

UNIT IV THREE PHASE INVERTERS

180 degree and 120 degree conduction mode inverters with star and delta connected loads - voltage control of three phase inverters: single, multi pulse, sinusoidal, space vector modulation techniques - VSR operation-Application - Induction heating, AC drive system - Current source inverters.

UNIT V MODERN INVERTERS 12

Multilevel concept - diode clamped - flying capacitor - cascaded type multilevel inverters - Comparison of multilevel inverters - application of multilevel inverters - PWM techniques for MLI - Single phase &Three phase Impedance source inverters - Filters.

Text Books:

1. Rashid M.H., "Power Electronics Circuits, Devices and Applications ", Pearson, fourth Edition, 10th Impression 2021.
2. Bimal.K.Bose "Modern Power Electronics and AC Drives", Pearson Education, Second Edition, 2003

Reference Books:

1. Jai P. Agrawal, "Power Electronics System Theory and Design", Pearson Education, First Edition, 2015
2. Ned Mohan, T.M.Undeland and W.P.Robbins, "Power Electronics: converters, Application and design", 3rd edition Wiley, 2007.
3. Philip T. Krein, "Elements of Power Electronics" Indian edition Oxford University Press-2017
4. P.C.Sen, "Modern Power Electronics", S.Chand Publishing 2005.
5. P.S.Bimbra, "Power Electronics", Khanna Publishers, Eleventh Edition, 2003
6. Bin Wu, Mehdi Narimani, "High-Power Converters and AC Drives", Wiley, 2nd Edition, 2017

POOL-2: Power Electronics and Drives	L	T	P	INTERNAL MARKS	EXTERNAL MARKS	Total Marks	CREDITS
	3	1	0	30	70	100	4
Code:R20EEHN07	Advanced Electric Drives						

COURSE OBJECTIVES:

- To understand steady state operation and transient dynamics of a motor load system
- To study and analyze the operation of the converter / chopper fed DC drive, both qualitatively and quantitatively
- To analyze and design the current and speed controllers for a closed loop solid state DC motor drive.
- To understand the drive characteristics for different load torque profiles and quadrants of operation
- To understand the speed control of induction motor drive from stator and rotor sides.
- To study and analyze the operation of VSI &CSI fed induction motor control and pulse width modulation techniques

COURSE OUTCOMES:

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

CO 1: Ability to acquire and apply knowledge of mathematics and converter/machine dynamics in Electrical engineering.

CO 2: Ability to formulate, design, simulate power supplies for generic load and for machine loads.

CO 3: Ability to analyze, comprehend, design and simulate direct current motor based adjustable speed drives.

CO 4: Ability to analyze, comprehend, design and simulate induction motor based adjustable speed drives.

CO 5: Ability to design a closed loop motor drive system with controllers for the current and speed control operations.

UNIT I DC MOTORS FUNDAMENTALS AND MECHANICAL SYSTEMS

DC motor- Types, induced emf, speed-torque relations; Speed control - Armature and field speed control; Ward Leonard control - Constant torque and constant horse power operation - Introduction to high-speed drives and modern drives. Characteristics of mechanical system - dynamic equations, components of torque, types of load; Requirements of drives characteristics - stability of drives - multi-quadrant operation; Drive elements, types of motor duty and selection of motor rating.

UNIT II CONVERTER AND CHOPPER CONTROL

Principle of phase control - Fundamental relations; Analysis of series and separately excited DC motor with single-phase and three-phase converters - performance parameters, performance characteristics. Introduction to time ratio control and frequency modulation; chopper-controlled DC motor - performance analysis, multi-quadrant control - Chopper based implementation of braking schemes; Related problems

UNIT III CLOSED LOOP CONTROL

Modeling of drive elements - Equivalent circuit, transfer function of self, separately excited DC motors; Linear Transfer function model of power converters; Sensing and feeds back elements -

Closed loop speed control - current and speed loops, P, PI and PID controllers - response comparison. Simulation of converter and chopper fed DC drive

UNIT IV VSI AND CSI FED STATOR CONTROLLED INDUCTION MOTOR CONTROL

AC voltage controller - six step inverter voltage control - closed loop variable frequency PWM inverter fed induction motor (IM) with braking - CSI fed IM variable frequency motor drives - pulse width modulation techniques - simulation of closed loop operation of stator-controlled induction motor drives

UNIT V ROTOR CONTROLLED INDUCTION MOTOR DRIVES

Static rotor resistance control - injection of voltage in the rotor circuit - static scherbius drives - static and modified Kramer drives - sub-synchronous and super-synchronous speed operation of induction machines - simulation of closed loop operation of rotor-controlled induction motor drives

Text Books:

1. Gopal K Dubey, "Power Semiconductor controlled Drives", Prentice Hall Inc., NewYersy, 1989
2. R.Krishnan, "Electric Motor Drives – Modeling, Analysis and Control",Prentice-Hall of India Pvt. Ltd., New Delhi,2010
3. Bimal K Bose, "Modern Power Electronics and AC Drives", Pearson Education Asia2002

Reference Books:

1. Gopal K.Dubey, "Fundamentals of Electrical Drives", Narosal Publishing House, New Delhi, Second Edition, 2009.
2. Vedam Subramanyam, "Electric Drives - Concepts and Applications", Tata McGraw- Hill publishing company Ltd., New Delhi, 2002.
3. P.C Sen "Thyristor DC Drives", John wiely and sons, New York, 1981.
4. W.Leonhard, "Control of Electrical Drives", Narosa Publishing House, 1992.
5. Murphy J.M.D and Turnbull, "Thyristor Control of AC Motors", Pergamon Press, Oxford, 1988.

POOL-2: Power Electronics and Drives	L	T	P	INTERNAL MARKS	EXTERNAL MARKS	Total Marks	CREDITS
	3	1	0	30	70	100	4
Code:R20EEHN08	Analysis of Electrical Machines						

COURSE OBJECTIVES:

- To understand the principles of electromechanical energy conversion in electrical machines and to know the dynamic characteristics of DC motors
- To study the concepts related with AC machines, magnetic noise and harmonics in rotating electrical machines.
- To interpret the principles of reference frame theory
- To study the principles of three phase, doubly fed and 'n' phase induction machine in machine variables and reference variables.
- To understand the principles of three phase, synchronous machine in machine variables and reference variables.

COURSE OUTCOMES:

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

CO 1: Demonstrate the principles of electromechanical energy conversion and characteristics of DC motors

CO 2: Know the concepts related with AC machines and modeling of 'n' phase machines

CO 3: Interpret the concepts of reference frame theory.

CO 4: Apply procedures to develop induction machine model in both machine variable form and reference variable forms

CO 5: Follow the procedures to develop synchronous machine model in machine variables form and reference variable form.

UNIT-I: ELECTROMECHANICAL ENERGY CONVERSION and DC MACHINES

Magnetic circuits, permanent magnet, Energy conservation - stored magnetic energy, co-energy - force and torque in singly and doubly excited systems - Elementary DC machine and analysis of steady state operation - Voltage and torque equations - dynamic characteristics - DC motors - Time domain block diagrams - solution of dynamic characteristic by Laplace transformation

UNIT-II: AC MACHINES -CONCEPTS

Distributed Windings - Winding Functions - Air-Gap Magnetomotive Force -Rotating MMF - Flux Linkage and Inductance -Resistance -Voltage and Flux Linkage Equations for Distributed Winding Machines - magnetic noise and harmonics in rotating electrical machines. Modeling of 'n' phase machine.

UNIT-III: REFERENCE FRAME THEORY

Historical background - phase transformation and commutator transformation - transformation of variables from stationary to arbitrary reference frame - transformation of balanced set-variables observed from several frames of reference.

UNIT-IV: INDUCTION MACHINES

Three phase induction machine and doubly fed induction machine- equivalent circuit and analysis of steady state operation - free acceleration characteristics - voltage and torque equations in machine variables and arbitrary reference frame variables - analysis of dynamic performance for load torque variations- Transformation theory for 'n' phase induction machine.

UNIT-V: SYNCHRONOUS MACHINES

Three phase synchronous machine and analysis of steady state operation - voltage and torque equations in machine variables and rotor reference frame variables (Park's equations) - analysis of dynamic performance for load torque variations - Krons primitive machine

Text Books:

1. Stephen D. Umans, "Fitzgerald & Kingsley's Electric Machinery", Tata McGraw Hill, 7th Edition, 2020.
2. Bogdan M. Wilamowski, J. David Irwin, The Industrial Electronics Handbook, Second Edition,
3. Power Electronics and Motor Drives, CRC Press, 2011

Reference Books:

1. Paul C. Krause, Oleg Wasynczuk, Scott D. Sudhoff, Steven D. Pekarek, "Analysis of Electric Machinery and Drive Systems", 3rd Edition, Wiley-IEEE Press, 2013.
2. R. Krishnan, Electric Motor & Drives: Modeling, Analysis and Control, Pearson Education, 1st Imprint, 2015.
3. R.Ramanujam,Modeling and Analysis of Electrical Machines,I.k.International Publishing House Pvt.Ltd,2018

POOL-2: Power Electronics and Drives	L	T	P	INTERNAL MARKS	EXTERNAL MARKS	Total Marks	CREDITS
	3	1	0	30	70	100	4
Code:R20EEHN09	SMPS and UPS						

COURSE OBJECTIVES:

- Modern power electronic converters and its applications in electric power utility.
- Resonant converters and UPS

COURSE OUTCOMES:

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

CO 1: Ability to analyze the state space model for DC – DC converters
CO 2: Ability to acquire knowledge on switched mode power converters.
CO 3: Ability to understand the importance of Resonant Converters.
CO 4: Ability to analyze the PWM techniques for DC-AC converters
CO 5: Ability to acquire knowledge on filters and UPS

UNIT-I: DC-DC CONVERTERS

Principles of step down and step-up converters - Analysis and state space modeling of Buck, Boost, Buck- Boost and Cuk converters.

UNIT-II: SWITCHED MODE POWER CONVERTERS

Analysis and state space modeling of fly back, Forward, Push pull, Luo, Half bridge and full bridge converters - control circuits and PWM techniques.

UNIT-III: RESONANT CONVERTERS

Introduction - classification- basic concepts - Resonant switch - Load Resonant converters- ZVS, clamped voltage topologies - DC link inverters with Zero Voltage Switching - Series and parallel Resonant inverters - Voltage control.

UNIT-IV: DC-AC CONVERTERS

Single phase and three phase inverters, control using various (sine PWM, SVPWM and PSPWM) techniques, various harmonic elimination techniques - Multilevel inverters - Concepts - Types: Diode clamped - Flying capacitor - Cascaded types - Applications.

UNIT-V: POWER CONDITIONERS, UPS & FILTERS

Introduction - Power line disturbances - Power conditioners - UPS: offline UPS, Online UPS, Applications - Filters: Voltage filters, Series-parallel resonant filters, filter without series capacitors, filter for PWM VSI, current filter, DC filters - Design of inductor and transformer for PE applications - Selection of capacitors.

TEXT BOOKS:

1. Simon Ang, Alejandro Oliva," Power-Switching Converters", Third Edition, CRC Press, 2010.
2. Kjeld Thorborg, "Power Electronics -In theory and Practice", Overseas Press, First Indian Edition 2005.
3. M.H. Rashid – Power Electronics handbook, Elsevier Publication, 2001.

Reference Books:

1. Philip T Krein, “Elements of Power Electronics”, Oxford University Press
2. Ned Mohan, Tore.M.Undeland, William.P.Robbins, Power Electronics converters, Applications and design- Third Edition- John Wiley and Sons- 2006
3. M.H. Rashid – Power Electronics circuits, devices and applications- third edition Prentice Hall of India New Delhi, 2007.
4. Erickson, Robert W, “Fundamentals of Power Electronics”, Springer, second edition, 2010

POOL-2: Power Electronics and Drives	L	T	P	INTERNAL MARKS	EXTERNAL MARKS	Total Marks	CREDITS
	3	1	0	30	70	100	4
Code:R20EEHN10	Power Electronics for Renewable Energy Systems						

COURSE OBJECTIVES:

- To Provide knowledge about the stand alone and grid connected renewable energy systems.
- To equip with required skills to derive the criteria for the design of power converters for renewable energy applications.
- To analyse and comprehend the various operating modes of wind electrical generators and solar energy systems.
- To design different power converters namely AC to DC, DC to DC and AC to AC converters for renewable energy systems.
- To develop maximum power point tracking algorithms.

COURSE OUTCOMES:

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

CO 1: analyze different energy conversion techniques
CO 2: analyze machines for renewable energy conversion and its stability, control and protection.
CO 3: analyze suitable power converters
CO 4: Design wind and PV system
CO 5: analyze MPPT in wind and PV system

UNIT-I: INTRODUCTION

Environmental aspects of electric energy conversion: impacts of renewable energy generation on environment (cost-GHG Emission) - Qualitative study of different renewable energy resources: Solar, wind, ocean, Biomass, Fuel cell, Hydrogen energy systems and hybrid renewable energy systems.

UNIT-II ELECTRICAL MACHINES FOR RENEWABLE ENERGY CONVERSION

Reference theory fundamentals-principle of operation and analysis: IG, PMSG, SCIG and DFIG.

UNIT-III POWER CONVERTERS

Solar: Block diagram of solar photo voltaic system -Principle of operation: line commutated converters (inversion-mode) - Boost and buck-boost converters- selection of inverter, battery sizing, array sizing Wind: Three phase AC voltage controllers- AC-DC-AC converters: uncontrolled rectifiers, PWM Inverters, Grid Interactive Inverters-matrix converters.

UNIT-IV ANALYSIS OF WIND AND PV SYSTEMS

Stand-alone operation of fixed and variable speed wind energy conversion systems and solar system- Grid connection Issues -Grid integrated PMSG, SCIG Based WECS, grid Integrated solar system

UNIT-V HYBRID RENEWABLE ENERGY SYSTEMS

Need for Hybrid Systems- Range and type of Hybrid systems- Case studies of Wind-PV Maximum Power Point Tracking (MPPT).

Text Books:

1. S. N. Bhadra, D.Kastha, S.Banerjee, "Wind Electrical Systems", Oxford University Press, 2005.
2. B.H.Khan Non-conventional Energy sources Tata McGraw-hill Publishing Company, New Delhi,2009.

References Books:

1. Rashid .M. H "power electronics Hand book", Academic press, 2001.
2. Ion Boldea, "Variable speed generators", Taylor & Francis group, 2006.
3. Rai. G.D, "Non-conventional energy sources", Khanna publishes, 1993.

POOL-3: Advanced Control Systems	L	T	P	INTERNAL MARKS	EXTERNAL MARKS	Total Marks	CREDITS
	3	1	0	30	70	100	4
Code:R20EEHN11	Intelligent Controllers						

COURSE OBJECTIVES:

To educate the students on

- Design of ANN and fuzzy set theory.
- Analysis and implementation of ANN and Fuzzy logic for modeling and control of Non-linear system and to get familiarized with the Matlab toolbox.
- Impart the knowledge of various optimization techniques and hybrid schemes with the ANFIS tool box.

COURSE OUTCOMES:

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

CO 1: Understand the basic architectures of NN and Fuzzy sets
CO 2: Design and implement ANN architectures, algorithms and know their limitations.
CO 3: Identify and work with different operations on the fuzzy sets.
CO 4: Develop ANN and fuzzy logic-based models and control schemes for non-linear systems.
CO 5: Understand and explore hybrid control schemes and PSO

UNIT I OVERVIEW OF ARTIFICIAL NEURAL NETWORK & FUZZY LOGIC

Review of fundamentals - Biological neuron, Artificial neuron, Activation function, Single Layer Perceptron – Limitations – Multi Layer Perceptron – Back propagation algorithm (BPA); Fuzzy set theory – Fuzzy sets – Operation on Fuzzy sets - Scalar cardinality, fuzzy cardinality, union and intersection, complement (yager and sugeno), equilibrium points, aggregation, projection, composition, fuzzy relation – Fuzzy membership functions.

UNIT II NEURAL NETWORKS FOR MODELLING AND CONTROL

Generation of training data - optimal architecture – Model validation- Control of non-linear system using ANN- Direct and Indirect neuro control schemes- Adaptive neuro controller –Case study - Familiarization of Neural Network Control Tool Box.

UNIT III FUZZY LOGIC FOR MODELLING AND CONTROL

Modeling of nonlinear systems using fuzzy models (Mamdani and Sugeno) –TSK model – Fuzzy Logic controller – Fuzzification – Knowledge base – Decision making logic – Defuzzification- Adaptive fuzz y systems-Case Study-Familiarization of Fuzzy Logic Tool Box.

UNIT IV GENETIC ALGORITHM

Basic concept of Genetic algorithm and detail algorithmic steps, adjustment of free parameters. Solution of typical control problems using genetic algorithm. Concept on some other search techniques like Tabu search, Ant-colony search and Particle Swarm Optimization.

UNIT V HYBRID CONTROL SCHEMES

Fuzzification and rule base using ANN–Neuro fuzzy systems-ANFIS –Optimization of membership function and rule base using Genetic Algorithm and Particle Swarm Optimization - Case study– Familiarization of ANFIS Tool Box.

Text Books:

1. LaureneV.Fausett, "Fundamentals of Neural Networks, Architecture, Algorithms, and Applications", Pearson Education, 2008.
2. Timothy J.Ross, "Fuzzy Logic with Engineering Applications", Wiley, Third Edition, 2010.

Reference books:

1. David E.Goldberg, "Genetic Algorithms in Search, Optimization, and Machine Learning", Pearson Education, 2009.
2. W.T.Miller, R.S.Sutton and P.J.Webrose, "Neural Networks for Control", MIT Press, 1996.
3. George J.Klir and Bo Yuan, "Fuzzy Sets and Fuzzy Logic: Theory and Applications", Prentice HalI, First Edition, 1995.

POOL-3: Advanced Control Systems	L	T	P	INTERNAL MARKS	EXTERNAL MARKS	Total Marks	CREDITS
	3	1	0	30	70	100	4
Code:R20EEHN12	Non-Linear control						

COURSE OBJECTIVES

To educate the students on

- Theory of perturbation
- Gain scheduling and feedback linearization
- input-output stability and passivity
- theory and design of back stepping controllers.

COURSE OUTCOMES

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

CO 1: Identify different types of perturbation models.
CO 2: Analysis of Stability of various perturbation models.
CO 3: Apply gain schedule all kind of perturbation systems.
CO 4: Apply L stability and lyapunov stability conditions for systems
CO 5: Apply Bakstepping control algorithms.

UNIT-I PERTURBATION THEORY

Vanishing and Non vanishing Perturbations - Continuity of solutions on the infinite interval - Interconnected systems - Slowly varying systems - Perturbation method - Averaging - Weakly nonlinear second-order oscillators - Exercises

UNIT-II SINGULAR PERTURBATIONS

Standard singular perturbation model - Time scale properties - Singular perturbation on the infinite interval - Slow and fast manifolds - stability analysis - exercises

UNIT-III GAIN SCHEDULING AND FEEDBACK LINEARIZATION

Control problem - stabilization via linearization - integral control via linearization - gain scheduling - Input output linearization - Full state linearization - state feedback control - tracking- exercises

UNIT-IV INPUT-OUTPUT STABILITY

L stability - L stability of state models - L2 gain - feedback system: small gain theorem - exercises - Passivity - State models - L2 and Lyapunov stability

UNIT-V BAKSTEPPING CONTROL ALGORITHMS

Passivity based control - High gain observers - stabilization - Regulation via integral control - Exercises

Text Books:

1. Hasan Khalil," Nonlinear systems and control", 3rd ed, PHI,
2. Slotine, J A E Slotine and W Li, "Applied Nonlinear control",1991, PHI

References Books

1. S.H. Zak," Systems and control", Oxford University Press

POOL-3: Advanced Control Systems	L	T	P	INTERNAL MARKS	EXTERNAL MARKS	Total Marks	CREDITS
	3	1	0	30	70	100	4
Code:R20EEHN13	INDUSTRIAL AUTOMATION SYSTEMS						

COURSE OBJECTIVES:

To educate the fundamental and programming concepts of conventional electronic instrumentation and virtual instrumentation in the areas of:

- Electronic instruments
- Computer based instruments
- Virtual instrumentation programming
- Latest industrial PLCs and SCADA

COURSE OUTCOMES:

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

CO 1: gain the knowledge on various types of analyzers.
CO 2: analyse Computer controlled instrument systems
CO 3: apply Virtual Instrumentation for engineering processes.
CO 4: gain the knowledge on various types of sensors & sensor technologies, signal conditioning for interface applications and PC based instrumentation.
CO 5: acquire a detailed knowledge on data acquisition system interface with systems

UNIT-I ELECTRONIC INSTRUMENTATION

Circuit and element measurement instruments-Semiconductor test instruments-Network Analyzers-Logic Analyzers-Protocol Analyzers-Impedance considerations - Electrical Grounding

UNIT-II INSTRUMENTS IN SYSTEMS

Introduction to instruments in systems - Switches in automated test systems - Instrument System elements - Computer controlled instrument systems

UNIT-III INTRODUCTION TO VIRTUAL INSTRUMENTATION

Evolution and challenges of Virtual Instrumentation (VI) - Architecture - Programming - Distributed Virtual Instrumentation - Virtual instruments Vs. Traditional instruments - Virtual Instrumentation for engineering processes.

UNIT-IV SOFTWARE PROGRAMMING IN VIRTUAL INSTRUMENTATION

Programming Techniques - Front Panel and Block diagram - Data flow programming - G programming concepts - Creating and saving VIs - Wiring, Editing and Debugging of Vis - Creating Sub Vis - Control structures - Nodes - Arrays - Cluster controls and indicators - Error handling - String controls - File I/O VIs and functions.

UNIT-V PLC AND SCADA BASED INSTRUMENTATION

Evolution of PLC - Sequential and Programmable controllers - Architecture - Programming of PLC - Relay logic and Ladder logic - Functional blocks - Communication Networks for PLC. PLC based control of processes SCADA: - Remote terminal units, Master station, Communication architectures and Open SCADA protocols.

Text Books:

1. Clyde F Coombs, Jr., Electronic Instrument Handbook, Mc.Graw Hill Inc., 2018 Edition
2. Labview based Advanced Instrumentation systems, S. Sumathi& P. Surekha, Springer Publications, 2018 Edition
3. Dag H. Hanssen, Programmable Logic Controllers, A Practical Approach to IEC 61131-3 using CODESYS, John Wiley & Sons Ltd., 2015
4. David Bailey & Edwin Wright,"Practical SCADA for Industry'', Elsevier 2010.

References Books:

1. Handbook on "Practical Design Techniques for Sensor signal Conditioning" published by Analog Devices, Vernvice hall.
2. The Software Environment and Programming of PLCs – Version-2, An NPTEL Courseware, EE IIT Kharagpur.
3. SrinivasMedida, Pocket Guide on Industrial Automation for Engineers and Technicians, IDC Technologies

POOL-3: Advanced Control Systems	L	T	P	INTERNAL MARKS	EXTERNAL MARKS	Total Marks	CREDITS
	3	1	0	30	70	100	4
Code:R20EEHN14	Digital Instrumentation						

COURSE OBJECTIVES:

- To expose the students to the fundamentals of wired embedded networking techniques.
- To expose the students to the fundamentals of wireless embedded networking
- To study on design of automation tools to model instrumentation
- To introduce design wireless networking for monitoring grid
- To involve Discussions/ Practice/Exercise onto revising & familiarizing the concepts for improved employability skills

COURSE OUTCOMES:

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

CO 1: The concepts of Time and frequency analysis of Signal Transforms based on signal types.
CO 2: The fundamentals of Time-Frequency Transforms are introduced
CO 3: Analyze the quality and properties of speech based on DSP
CO 4: Study through comparison on commercial available DSProcessors
CO 5: Improved Employability and entrepreneurship capacity due to knowledge up gradation on recent trends in embedded systems design.

UNIT-I DIGITAL METER INFRASTRUCTURE

Building blocks of automated instruments - Calibration, Overview of A/D converter - Data acquisition - Sampling, Errors -Signal conditioners - Counters - Modes of operation - Frequency, Period, Time interval measurements, autorange setting, Prescaler - Heterodyne converter for frequency measurement - Single and Multi-channel Data Acquisition systems - Digital Modulation - serial wired Instrument bus protocols- RS 232C, RS 485 and USB standards –digital display.

UNIT-II DIGITAL METERING OF PROCESS

Introduction - sensors and Digital Meters for vibration, temperature, pressure measurement of system - Multichannel DSO -Data loggers -meter data analytics - PC based process measurements - Digital Signal Sources- automating meter with Data analysis & display control.

UNIT-III METERING WITH VIRTUAL INSTRUMENTATION

VI-Introduction, Block diagram and Architecture -VI for testing Real time process – Graphical programming using GUI – ADC/DAC – Digital I/O - Counter, Timer-I/O GUI-VI for Intelligent metering and control – Software and hardware of I/O communication blocks-peripheral interface

UNIT-IV METERING BASED ON WIRELESS NETWORK

Wireless sensor networks-Introduction– performance of Zigbee sensor network for metering – challenges in wireless Meters- IoT in metering-Design challenges in IoT, - overview on ANSI, IEC smart metering standards as case study.

UNIT-V AUTOMATED METERING OF ELECTRICAL SYSTEMS

Digital meters and Instrumentation for electrical measurements- metering to test electrical components - meters for Smart grid management-AMI needs in smart grid- Meter data management - communication enabled metering.

Text Books:

1. Lars Torsten Berger, Krzysztof Iniewski, Smart Grid-Applications, Communications and Security, Wiley, 2015.
2. Stuart Borlase,"Smart Grids Infrastructure,Technology and Solutions",CRC Press,2013.
3. Mathivanan, "PC based Instrumentation Concepts and practice", Prentice-Hall India, 2009
4. Jovitha Jerome,"Virtual Instrumentation using LabView,PHI 2010.
5. A.J. Bouwens, "Digital Instrumentation" , TATA McGraw-Hill Edition, 1998.

Reference Books:

1. Ernest O Doebelin and Dhanesh N Manik, "Measurement Systems Application and Design", 5thEdition, Tata Mc-Graw Hill, 2011.
2. Cory L. Clark," Labview Digital Signal Processing & Digital Communication, TMcH,2005.
3. Patrick H.Garrett "High Performance Instrumentation And Automation" CRC Press, Taylor & Francis Group, 2005

POOL-3: Advanced Control Systems	L	T	P	INTERNAL MARKS	EXTERNAL MARKS	Total Marks	CREDITS
	3	1	0	30	70	100	4
Code:R20EEHN15	Control of Electrical Drives						

COURSE OBJECTIVES

- To introduce the PWM converters and their analysis.
- To educate on modeling of dc motor, drives and control techniques
- To educate on dynamic modeling of Induction motor drive.
- To educate on the V/f and vector control of Induction motor.
- To educate on generation of firing pulses and control algorithms in embedded platforms.

COURSE OUTCOMES

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

CO 1: analyze Power Electronic Converter Switches and different PWM approach.
CO 2: design and analyze converter and chopper driven dc drives.
CO 3: analyze converter and chopper driven dc drives.
CO 4: explain conventional control techniques of Induction motor drive.
CO 5: apply V/f Control using PIC Micro Controller and Vector control using Embedded processor.

UNIT-I POWER ELECTRONIC CONVERTERS FOR DRIVES

Power electronic switches-state space representation of switching converters-Fixed frequency PWM variable frequency PWM- space vector PWM- Hysteresis current control-dynamic analysis of switching converters-PWM modulator model.

UNIT II CONTROL OF DC DRIVES

Modelling of DC machines-block diagram/transfer function-phase control-1phase/3phase converter fed DC drives- Chopper fed DC drives-four quadrant chopper circuit-closed loop control-speed control current control-cascade control –constant torque/power operation-comparison of chopper/converter fed drives- techniques-merits/demits.

UNIT-III ANALYSIS AND MODELLING OF INDUCTION MOTOR DRIVE

Basics of induction motor drive-classification – equivalent circuit- torque Vs slip characteristics - steady state performance- Dynamic modeling of induction motor, Three phase to two phase transformation stator, rotor, synchronously rotating reference frame model.

UNIT-IV CONTROL OF INDUCTION MOTOR DRIVE

VSI fed induction motor drives- waveforms for 1-phase, 3-phase Non-PWM and PWM VSI fed induction motor drives -principles of V/F control- principle of vector control-direct vector control – space vector modulation- indirect vector control

UNIT-V EMBEDDED CONTROL OF DRIVES

Generation of firing pulses- generation of PWM pulses using embedded processors-IC control of DC drives- fixed frequency/variable frequency/current control- V/F control using PIC microcontroller vector control using embedded processors.

Text Books

1. R.Krishnan, "Electric Motor Drives, Modeling, Analysis and Control" Prentice Hall of India, 2002.
2. Thyristor control of Electric drives, Vedam Subrahmanyam, Tata McGraw Hill, 1988
3. Ion Boldea & S.A.Nasar "ELECTRIC DRIVES", CRC Press, 2006

References Books

1. Simon Ang, Alejandro Oliva "POWER SWITCHING CONVERTERS", CRC Press, 2005
2. Buxbaum, A. Schierau, and K.Staughen, "A design of control systems for DC Drives", Springer- Verlag, Berlin, 1990.

POOL-4: Electric Vehicle Technology	L	T	P	INTERNAL MARKS	EXTERNAL MARKS	Total Marks	CREDITS
	3	1	0	30	70	100	4
Code:R20EEHN16	Electric Vehicle Mechanics and Control						

COURSE OBJECTIVES

- To provide knowledge of the operation and dynamics of electrical vehicles
- To impart knowledge on vehicle control for standard drive cycles of electrical vehicles (EVs)
- To estimate the energy requirement of EVs and Hybrid Electric Vehicles (HEVs)
- To provide knowledge about different energy sources and energy management in HEVs o provide knowledge of supervisory control of EVs

COURSE OUTCOMES:

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

CO 1: illustrate the architecture and dynamics of EVs and HEVs
CO 2: Design an EV for standard drive cycle
CO 3: apply the electrical motors' characteristics and its application for vehicle dynamics
CO 4: Workout the energy requirements and energy sources for EV application
CO 5: Mode of operation and control architecture

UNIT I ELECTRIC VEHICLE ARCHITECTURE

History of evolution of Electric Vehicles - Series parallel architecture of Hybrid Electric Vehicles (HEV) – Plug-in Hybrid Electric Vehicles (PHEV)- Power train components and sizing, Gears, Clutches, Transmission and Brakes.

UNIT II MECHANICS OF ELECTRIC VEHICLES

Fundamentals of vehicle mechanics - tractive force, power and energy requirements for standard drive cycles of EV's - motor torque and power rating and battery capacity.

UNIT III CONTROL OF DC AND AC MOTOR DRIVES

Speed control for constant torque, constant HP operation of all electric motors - DC/DC chopper based four quadrant operation of DC motor drives, inverter-based V/f Operation (motoring and braking) of induction motor drives, vector control operation of Induction motor and PMSM, Brushless DC motor drives, Switched reluctance motor (SRM) drives.

UNIT IV ENERGY STORAGE SYSTEMS

Battery: Principle of operation, types, models, SOC of battery, Traction Batteries and their capacity for standard drive cycles. Alternate sources: Fuel cells, Ultra capacitors, Fly wheels

UNIT V HYBRID VEHICLE CONTROL STRATEGY

HEV supervisory control - Selection of modes - power spilt mode - parallel mode - engine brake mode - regeneration mode - series parallel mode.

Text Books

1. Iqbal Husain, "Electric and Hybrid Electric Vehicles", CRC Press, 2011.
2. Wei Liu, "Hybrid Electric Vehicle System Modeling and Control", Second Edition, WILEY, 2017.

Reference Books

1. James Larminie and John Lowry, "Electric Vehicle Technology Explained", Second Edition 2012.
2. Christopher D Rahn, Chao-Yang Wang, "Battery Systems Engineering", Wiley, 2013.

POOL-4: Electric Vehicle Technology	L	T	P	INTERNAL MARKS	EXTERNAL MARKS	Total Marks	CREDITS
	3	1	0	30	70	100	4
Code:R20EEHN17	Electric Vehicle Dynamics						

COURSE OBJECTIVES

- To study basic fundamentals of electric vehicle
- To understand the Electric vehicle Architecture
- Design & analysis of vehicle performance parameters
- Design of transmission system for electric vehicle
- To understand the Current scenario of electric vehicle in India

COURSE OUTCOMES

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

CO 1: analyze the Current scenario of electric vehicle in India
CO 2: compare various types of vehicles on road
CO 3: identify electric vehicle components and architectures
CO 4: evaluate & analyze the vehicle performance parameters
CO 5: identify various systems of electric vehicles

UNIT-I: Current scenario & Future of electric vehicle in India:
Technology scenario, Market scenario, Paris climate agreement, social and environmental importance of electric vehicles, impact of modern drive-trains on energy supplies. Policies & regulation, Indian policies, Challenges, National Electric Mobility Mission Plan, FAME 1 and 2 India Scheme

UNIT-II: Overview of Electric vehicle (EV):
History, Components of Electric vehicles, EV Layouts, EV classification, Working of EV, Comparison with IC Engine, Advantages and disadvantages of EV, Well-to-Wheel Efficiency, Tank-to-Wheel Efficiency, Energy flow analysis for EV & ICEV

UNIT-III: Electric vehicle Architecture:
Battery electric vehicle (BEV), Electric Vehicle Architectures, Powertrains: Electric motor, Battery pack, Inverter, Charger, converter, Regenerative braking

UNIT-IV: Vehicle Dynamics: Vehicle resistance, Rolling resistance, Grading Resistance, Aerodynamic drag, Dynamic Equation, Vehicle performance (Maxi. Speed, Gradeability & acceleration), Calculation of acceleration force, maximum speed. Tractive effort, Torque required on the wheel, Torque speed characteristics of electric vehicle

UNIT-V: Vehicle Systems:
Transmission system: Need, Torque Speed Characteristics of IC Engine and Motor, Comparison with ICEV Transmission system, Selection of transmission system, Estimation of gear ratio, Differential, Brake system, Steering system, Suspension system

Text Books:

1. Modem Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory, and Design, Mehrdad Ehsani and Yimin Gao, Power Electronics and application series
2. Build Your Own Electric Vehicle, Seth Leitman arid Bob Brant
3. Electric and Hybrid Vehicles: Design Fundamentals, Iqbal Husain, CRC Press, 2003

Reference Books:

1. Fundamental of vehicle dynamics, Thomas D Gillipse, Society of Automotive Engineers, second edition
2. James Larminie, John Lowry, Electric Vehicle Technology Explained, Wiley, 2003.
3. Theory of Ground Vehicles. Third Edition. J.Y Wong. John Wiley ISBN: 0-471-35461-9

POOL-4: Electric Vehicle Technology	L	T	P	INTERNAL MARKS	EXTERNAL MARKS	Total Marks	CREDITS
	3	1	0	30	70	100	4
Code:R20EEHN18	Battery Technologies for Electric Vehicles						

COURSE OBJECTIVES

- To make the learners conversant with various battery chemistries used for Electric Vehicles
- To impart through understanding of Lithium Ion Battery
- To understand the various battery performance parameters and testing procedures
- To make the learners aware of thermal issues of Lithium-ion battery and thermal management system
- To understand the requirements and functioning of battery management system
- To make the learners conversant with Equivalent Circuit Cell Modeling of Battery

COURSE OUTCOMES:

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

CO 1: select suitable battery for EV application
CO 2: compare the materials used for the components of the battery
CO 3: conduct tests on battery cells to determine various performance and operating parameters
CO 4: Estimate heat generation inside battery and propose cooling strategy for the battery pack.
CO 5: select BMS for given battery pack

Unit 1 Overview of Battery Technology of Electric vehicle (EV):

History of Battery cells, Primary Battery, Secondary Battery, Performance parameters and operating variables of Battery, Electric vehicle (EV) requirements, Battery Technologies for EV applications, Lead Acid battery, Nickel Cadmium, Nickel Metal Hydrite, Lithium-Ion Batteries: Working, chemical reactions, comparison, future battery trends and challenges, Metal-Air Batteries, fuel cells, ultra-capacitors

Unit 2 Lithium-Ion Batteries

Introduction, Components, Functions, Cathode Materials, Anode Materials, Electrolytes: salts and solvents, separators, advantages and drawbacks, Battey cell Manufacturing: Cylindrical, prismatic and Pouch cells**,** recycling/disposal of batteries

Unit 3 Battery Performance and Testing

Battery operating and performance parameters**,** Charge-discharge characteristics of batteries, Measurement of current, voltage, temperature, Estimation of SOC: Coulomb Counting method, OCV method, Estimation of SoH, Capacity, efficiency

Unit 4 Battery Thermal Management

Heat Generation inside battery, Thermal issues of Lithium-Ion Battery, impact of temperature on capacity, cycle life, Thermal Runaway, Cooling strategies: Direct/indirect cooling, Air cooling, liquid cooling, PCM based cooling, advanced colling methods

Unit 5 Battery Electric Management

Primary functions of BMS, sensing voltage, current and temperature of cell and battery pack, estimation of cell SOC and battery pack SOC, Estimation of available energy and power of cell and

battery pack, criteria of selection of BMS battery pack balancing: Reasons, balancing set point and when to balance a battery pack, Passive and active balancing methods, Active balancing methods for battery packs: capacitor-based circuits, transformer-based circuits, Estimation of available battery power using a simplified cell mode

Text Books:

1. Gregory L. Plett, Battery Management Systems, Volume I: Battery Modeling, Artech House, London
2. Gregory L. Plett, Battery Management Systems Volume II, Equivalent-Circuit Methods, Artech House, London
3. Gianfranco Pistoia, Boryann Liaw (eds.), Behaviour of Lithium-Ion Batteries in Electric Vehicles_ Battery Health, Performance, Safety, and Cost, Springer International Publication

Reference Books:

1. Reiner_Korthauer, Li-I Batteries Basics and Applications, Springer International Publication
2. Jiuchun Jiang, Caiping Zhang - Fundamentals and Application of Lithium-ion Batteries in Electric Drive Vehicles-Wiley

POOL-4: Electric Vehicle Technology	L	T	P	INTERNAL MARKS	EXTERNAL MARKS	Total Marks	CREDITS
	3	1	0	30	70	100	4
Code:R20EEHN19	Charging Infrastructure for EVs						

COURSE OBJECTIVES

- To familiarise the learner with selection and sizing of an electric vehicle charging system
- To make the learner conversant with the basic elements constituting the charging system of an electric vehicle
- To make the learner aware of types of chargers and their standards
- To familiarise the learner with testing standards and instrumentation required for

COURSE OUTCOMES

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

CO 1: differentiate between types of chargers and their characteristics
CO 2: select and size the chargers along with their connectors
CO 3: classify battery and motor testing standards
CO 4: demonstrate of standards related to electric vehicle testing
CO 5: demonstrate of standards related to charging stations
CO 6: demonstrate of vehicle to grid Technology

UNIT-I Introduction to EV Charging Infrastructure

Ministry of Power guidelines for public EV charging stations for safe, reliable and affordable charging, Basic charging Block Diagram of Charger, Difference between Slow charger and fast charger Slow charger design rating, Fast charger design rating, AC charging and DC charging, Inboard and off board charger specification

Charging Connectors for Electric Vehicles: EV charger classification: Based on IEC61851 (International Electrotechnical Commission Standard), Classification based on connector configuration: AC chargers: Type 1,2, DC Chargers: AA(CHAdeMO), BB(GB/T), EE(CCS1), FF(CCS2), General Topology: AC charger and DC Fast charger Selection sizing of Charger connector cable

UNIT-II Battery and Motor testing standards

Battery Testing: AIS048: Safety requirements of traction battery: Mechanical and Electrical Abuse Tests Motor Testing**:** Common Motor types used in EVs, AIS041: Max power and nominal power test,

UNIT-III Electric Vehicle Testing standards:

Electric vehicle standardization in India, categories of EVs in India EV regulation reference standards: AIS 038, 039,040,041,049,, below 250W EV certification, E-Rikshaw, E-cart certification, CMVR approval of retro fitment kits

Electro Magnetic Compatibility (EMC) regulations for EVs (AIS 004, part3)

Procedure for approval of Retro-fitment kits (ASI-123: Part 1, 2.3)

UNIT-IV Charging station testing standards

Requirement as per IEC 61851-1 for charging system apparatus, Periodic maintenance and assessment of electric vehicle charging stations, Solar powered electric vehicle charging station Calculation and selection - Components of charging station, AIS 138 part-1, Wireless charging

UNIT-V Vehicle to grid Technology

Current scenario of power generation and distribution in India, centralized and distributed generation of electric power, concept of micro-grid, renewable energy generation integration to grid , Impact of Electric Vehicles on Power Grid , Ability of EV to supply power to grid , (EVs and their battery capacities), Role of EV as a energy storage device for power grid and participation in frequency regulation and emergency power supply, EV Charging strategies: uncontrolled and controlled (Unidirectional and Bidirectional) charging , V2G charging stations, Effect of integrating EVs into power grid, frequency regulation in EV integrated grid, challenges for V2G, Future technology: Wireless Charging, Battery Swap Technology, Charging EVs From Renewables

Reference Books:

1. “Vehicle Inspection Handbook”, American Association of Motor Vehicle Administrators
2. Michael Plint& Anthony Martyr, “Engine Testing & Practice”, Butterworth Heinmenn, 3rd ed, 2007
Automotive Industry Standards (AIS)-048, 038, 039, 040, 041, 049, 138, 004(Part3), 123 (Part 1, 2, 3)

POOL-4: Electric Vehicle Technology	L	T	P	INTERNAL MARKS	EXTERNAL MARKS	Total Marks	CREDITS
	3	1	0	30	70	100	4
Code:R20EEHN20	Hybrid Electric Vehicles						

COURSE OBJECTIVES

- Explain electric, hybrid electric and plug-in hybrid electric vehicle (PHEV), their architecture, technologies and fundamentals
- Explain the design, component sizing of the power electronics converters and various electric drives suitable for hybrid electric vehicles
- Discuss different energy storage technologies used for hybrid electric vehicles and their control and energy balancing techniques
- Demonstrate different configurations of electric vehicles and charging techniques

COURSE OUTCOMES

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

CO 1: Explain the basics of electric and hybrid electric vehicles, their architecture, technologies and fundamentals.

CO 2: Analyze Hybridization of the Automobile

CO 3: Analyze the use of different power electronics converters and electrical machines in hybrid electric vehicles.

CO 4: Able to interpret the working of different configurations of electric vehicles and its components, hybrid vehicle configurations

CO 5: Ability to understand the control and configurations of HEV charging stations.

UNIT-I: HEV Fundamentals:

Vehicle Basics, vehicle model, Vehicle Resistance: Rolling Resistance, Aerodynamic Drag, Grading Resistance, Dynamic Equation Tire–Ground Adhesion and Maximum Tractive Effort, Power Train Tractive Effort and Vehicle Speed, EV Powertrain Component Sizing.

UNIT-II: Hybridization of the Automobile:

Basics of the EV, Basics of the HEV, Basics of Plug-In Hybrid Electric Vehicle (PHEV) and vehicle architectures: Series Hybrid Vehicle, Parallel Hybrid Vehicle, Basics of Fuel Cell Vehicles (FCVs).

UNIT-III: Power Electronics in HEVs:

Power electronics circuits used for control and distribution of electric power in DC-DC, AC-DC, DC-AC converters used for HEV.

UNIT-IV: Electric Machines and Drives in HEVs:

Fundamental of Drives and Control of EV Using DC motor, Induction Motor, Permanent Magnet Motor, Switched Reluctance Motor, BLDC motor, Design and Sizing of Traction Motors.

UNIT-V: EV Charging Technologies:

Classification of different charging technology for EV charging station, introduction to Grid-to-Vehicle, Vehicle to Grid (V2G) or Vehicle to Buildings (V2B) or Vehicle to Home (V2H) operations, bi-directional EV charging systems, energy management strategies used in hybrid and electric vehicle, Wireless power transfer (WPT) technique for EV charging.

Text books

1. Mehrdad Ehsani, Yimi Gao, Sebastian E. Gay, Ali Emadi, Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design, CRC Press, 2004
2. Iqbal Hussein, Electric and Hybrid Vehicles: Design Fundamentals, CRC Press, 2003

Reference Books

1. James Larminie, John Lowry, Electric Vehicle Technology Explained, Wiley, 2003
2. Chris Mi, M. Abul Masrur, David Wenzhong Gao, Hybrid Electric Vehicles: Principles and Applications with Practical Perspectives, John Wiley & Sons Ltd., 2011

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