ACADEMIC REGULATIONS (BH23)
COURSE STRUCTURE AND
DETAILED SYLLABUS

ELECTRICAL AND ELECTRONICS ENGINEERING

B.Tech. Four Year Degree Course

(Applicable for the batches admitted from AY 2023-24 onwards)

VISHNU
UNIVERSAL LEARNING

BVRIT H

BVRIT HYDERABAD College of Engineering for Women
(UGC Autonomous Institution | Approved by AICTE | Affiliated to JNTUH)
(NAAC Accredited – A Grade | NBA Accredited B.Tech. (EEE, ECE, CSE and IT))
Bachupally, Hyderabad -500 090
www.bvrithyderabad.edu.in

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BVRIT HYDERABAD College of Engineering for Women

VISION

To emerge as the best among the institutes of technology and research in the country dedicated to the cause of promoting quality technical education.

MISSION

At BVRITH, we strive to

- Achieve academic excellence through innovative learning practices.
- Enhance intellectual ability and technical competency for a successful career.
- Encourage research and innovation.
- Nurture students towards holistic development with emphasis on leadership skills, life skills and human values.

CORE VALUES

1. Holistic Development
2. Excellence in Education
3. Women Empowerment
4. Integrity
5. Social Responsibility
6. Accountability and Transparency
7. Freedom of Expression

Department of Electrical & Electronics Engineering

VISION

To develop comprehensively trained and socially responsible women electrical and electronics engineers with competencies and capabilities to adapt to new challenges.

MISSION

M1: To empower the students adept at latest technologies by providing innovative learning environment.

M2: To cultivate interdisciplinary research mindset and outlook to develop engineering solutions.

M2: To inculcate ethical behaviour and professional attitude in order to embrace holistic concept of living.

PROGRAM EDUCATIONAL OBJECTIVES (PEOs)

After three to six years of graduation, the graduates of this program will be able to

PEO-1: Propose effective solutions for complex electrical and electronics engineering problems using modern techniques.

PEO-2: Excel in their career and compete with their global peers in Techno-Scientific fields.

PEO-3: Exhibit good communication skills, ethical behaviour & social perception.

PEO-4: Stimulate economic growth and job opportunities through entrepreneurship.

PROGRAM SPECIFIC OUTCOMES (PSOs)

PSO-1: Apply fundamental knowledge to analyse and implement solutions for societal challenges through enhanced experience.

PSO-2: Attain competence in using novel tools for the design and analysis of grid connected renewable energy systems towards research activities.

PROGRAM OUTCOMES (POs)

Engineering Graduates will be able to

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

Academic Regulations (BH23) for B.Tech. Regular Students with effect from Academic Year 2023-24

The B.Tech. degree of Jawaharlal Nehru Technological University Hyderabad shall be conferred on candidates, admitted to the Programme and fulfill all the requirements for the award of the Degree.

1.0 Under Graduate Degree Programme in Engineering & Technology (UGP in E & T)

BVRIT HYDERABAD College of Engineering for Women (Autonomous) – BVRITHCEW(A) offers 4 Year (8 Semesters) **Bachelor of Technology** (B.Tech.) Degree Programme, under **Choice Based Credit System** (CBCS) with effect from the Academic Year 2023-24 onwards, in the following branches of Engineering.

S. No.	Branch Code	Branch Name
1	02	Electrical and Electronics Engineering (EEE)
2	04	Electronics and Communication Engineering (ECE)
3	05	Computer Science and Engineering (CSE)
4	12	Information Technology (IT)
5	66	Computer Science and Engineering (AI & ML)

2.0 Eligibility for admission

2.1 Admission to the undergraduate (UG) Programme shall be made either on the basis of the merit rank obtained by the qualified student in entrance test conducted by the Telangana State Government (TSEAMCET) or the University or on the basis of any other order of merit approved by the University, subject to reservations as prescribed by the government from time to time.

2.2 The medium of instructions for the entire undergraduate programme in Engineering & Technology will be English only.

3.0 B.Tech. Programme structure

3.1 A student after securing admission shall complete the B.Tech. Programme in a minimum period of **four** academic years (8 semesters), and a maximum period of **eight** academic years (16 semesters) starting from the date of commencement of first year first semester, failing which student shall forfeit seat in B.Tech. course. Each student shall secure 160 credits (with CGPA $\geq$ 5) required for the completion of the undergraduate programme and award of the B.Tech. degree.

3.2 UGC / AICTE specified definitions / descriptions are adopted appropriately for various terms and abbreviations used in these academic regulations / norms, which are listed below.

3.2.1 Semester scheme

Each undergraduate programme is of 4 academic years (8 semesters) with the academic year divided into two semesters of 22 weeks (≥ 90 instructional days) each, each semester having - 'Continuous Internal Evaluation (CIE)' and 'Semester End Examination (SEE)' under **Choice Based Credit System** (CBCS) and **Credit Based Semester System** (CBSS) indicated by UGC, and curriculum / course structure as suggested by AICTE are followed.

3.2.2 Credit courses

All subjects / courses are to be registered by the students in a semester to earn credits which shall be assigned to each subject / course in an L: T: P: C (Lecture periods: Tutorial periods : Practical periods : Credits) structure based on the following general pattern.

- One credit for one hour / week / semester for theory / lecture (L) courses or tutorials.
- One credit for two hours / week / semester for laboratory/ practical (P) courses.

Courses like Environmental Science, Constitution of India, Intellectual Property Rights, and Gender Sensitization lab are mandatory courses. These courses will not carry any credits.

3.2.3 Subject / Course Classification

All subjects / courses offered for the undergraduate Programme in E & T (B.Tech. degree Programmes) are broadly classified as follows. The BVRITHCEW(A) has followed almost all the guidelines issued by AICTE / UGC.

S. No.	Broad Course Classification	Course Group /Category	Course Description
1	Foundation Courses (FnC)	BS – Basic Sciences	Includes Mathematics, Physics and Chemistry Courses
2		ES – Engineering Sciences	Includes Fundamental Engineering Courses
3		HS – Humanities and Social sciences	Includes Courses related to Humanities, Social Sciences and Management
4	Core Courses (CoC)	PC – Professional Core	Includes core courses related to the parent discipline / department / branch of Engineering.
5	Elective Courses(EℓC)	PE – Professional Electives	Includes elective courses related to the parent discipline / department / branch of Engineering.
6		OE – Open Electives	Elective offered by all the disciplines / departments / branches of Engineering.

7	Core Courses	Project Work	B.Tech. project or UG project or UG major Project or Project Stage I & II
8		Industry Training / Internship / Industry Oriented Mini-project / Mini- Project / Skill Development Courses	Industry Training / Internship / Industry Oriented Mini-Project / Mini-Project / Skill Development Courses
9		Real-time Research Project/ Field Based Project	Real-time Research Project / Field Based Project
10		Seminar	Seminar / Colloquium based on core contents related to parent discipline/ department/ branch of Engineering.
11	Minor courses	-	1 or 2 Credit Courses (subset of HS)
12	Mandatory Courses (MC)	-	Mandatory Courses (non-credit)

4.0 Course registration

4.1 The academic section of the college invites **'registration forms'** from students before the beginning of the semester through **'online registration'**, ensuring **'date and time stamping'.** The online registration requests for any **'current semester'** shall be completed before the commencement of SEEs (Semester End Examinations) of the **'preceding semester'**.

4.2 A student can apply for on-line registration by consulting Faculty Advisor / Counselor / Head of the Department (HoD).

4.3 A student may be permitted to register for all the subjects / courses in a semester as specified in the course structure with maximum additional subject (s) / course (s) limited to 6 Credits (any 2 elective subjects), based on progress and SGPA / CGPA, and completion of the '**prerequisites'** as indicated for various subjects / courses, in the department course structure and syllabus contents.

4.4 Choice for '**additional subjects / courses'**, not more than any 2 elective subjects in any semester, must be clearly indicated.

4.5 If the student submits ambiguous choices or multiple options or erroneous entries during online registration for the subject (s) / course (s) under a given / specified course group / category as listed in the course structure, only the first mentioned subject / course in that category will be taken into consideration.

4.6 Subject / course options exercised through online registration are final and cannot be changed or inter-changed; further, alternate choices also will not be considered. However, if the subject / course that has already been listed for registration by the Head of the Department in a semester could not be offered due to any inevitable or unexpected reasons, then the student shall be allowed to have alternate choice either for a new subject (subject to offering of such a subject), or for another existing subject (subject to availability of seats). Such alternate arrangements will be made by the Head of the Department, with due notification and time-framed schedule, within a week after the commencement of class-work for that semester.

4.7 Dropping of subjects / courses may be permitted, only after obtaining prior approval from the faculty counselor and HoD **'within a period of 15 days'** from the beginning of the current semester.

4.8 **Open Electives:** The students have to choose three Open Electives (OE-I, II & III) from the list of Open Electives given by other departments. However, the student can opt for an Open Elective subject offered by her own (parent) department, if the student has not registered and not studied that subject under any category (Professional Core, Professional Electives, Mandatory Courses, etc.) offered by parent department in any semester. Open Elective subjects already studied should not repeat / should not match with any category (Professional Core, Professional Electives, Mandatory Courses, etc.) of subjects even in the forthcoming semesters.

4.9 **Professional Electives:** The students have to choose six Professional Electives (PE-I to VI) from the list of professional electives given.

5.0 Subjects / courses to be offered

5.1 An Elective Course may be offered to the students, only if a minimum of 30 students opt for it. The maximum strength of a section is limited to 75.

5.2 In case of options coming from students of other departments / branches / disciplines (not considering **open electives**), first priority shall be given to the student of the '**parent department'**.

6.0 Attendance requirements

6.1 A student shall be eligible to appear for the semester end examinations, if the student acquires a minimum of 75% of attendance in aggregate of all the subjects / courses (excluding attendance in mandatory courses like Environmental Science, Constitution of India, Intellectual Property Rights, and Gender Sensitization lab) for that semester. Two periods of attendance for each theory subject shall be considered, if the student appears for the mid-term examination of that subject. **This attendance should also be included in the fortnightly upload of attendance to the Academic Section.**

6.2 Shortage of attendance in aggregate up to 10% (65% and above, and below 75%) in each semester may be condoned by the Academic Council on genuine and valid grounds, based on the student's representation with supporting evidence.

6.3 A stipulated fee shall be payable for condoning of shortage of attendance.

6.4 Shortage of attendance below 65% in aggregate shall in no case be condoned.

6.5 Students whose shortage of attendance is not condoned in any semester are not eligible to take their end examinations of that semester. They get detained and their registration for that semester shall stand cancelled, including all academic credentials (internal marks, etc.) of that semester. They will not be promoted to the next semester. They may seek re-registration for all those subjects registered in that semester, in which the student is detained, by seeking re-admission into that semester as and when offered; if there are any professional electives and / or open electives, the same may also be re-registered if offered. However, if those electives are not offered in later semesters, then alternate electives may be chosen from the same set of elective subjects offered under that category.

6.6 A student fulfilling the attendance requirement in the present semester shall not be eligible for readmission into the same class.

7.0 Academic requirements

The following academic requirements have to be satisfied, in addition to the attendance requirements mentioned in item no.**6.**

7.1 A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject / course, if the student secures not less than 35% (14 marks out of 40 marks) in the Continuous Internal Evaluation (CIE), not less than 35% (21 marks out of 60 marks) in the semester end examinations (SEE), and a minimum of 40% (40 marks out of 100 marks) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together; in terms of letter grades, this implies securing **'C'** grade or above in that subject / course.

7.2 A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to Real-Time Research Project (or) Field Based Research Project (or) Industry Oriented Mini Project (or) Internship (or) Seminar, if the student secures not less than 40% marks (i.e. 40 out of 100 allotted marks) in each of them. The student is deemed to have failed, if she (i) does not submit a report on Industry Oriented Mini Project / Internship, or (ii) not make a presentation of the same before the evaluation committee as per schedule, or (iii) secures less than 40% marks in Real-Time Research Project (or) Field Based Research Project (or) Industry Oriented Mini Project (or) Internship evaluations.

A student may reappear once for each of the above evaluations, when they are scheduled again; if the student fails in such **'one re-appearance'** evaluation also, the student has to reappear for the same in the next subsequent semester, as and when it is scheduled.

7.3 Promotion Rules

S. No.	Promotion	Conditions to be fulfilled
1	First year first semester to first year second semester	Regular course of study of first year first semester.
2	First year second semester to second year first semester	(i) Regular course of study of first year second semester. (ii) Must have secured at least 20 credits out of 40 credits i.e., 50% credits up to first year second semester from all the relevant regular and supplementary examinations, whether the student takes those examinations or not.
3	Second year first semester to second year second semester	Regular course of study of second year first semester.
4	Second year second semester to third year first semester	(i) Regular course of study of second year second semester. (ii) Must have secured at least 48 credits out of 80 credits i.e., 60% credits up to second year second semester from all the relevant regular and supplementary examinations, whether the student takes those examinations or not.
5	Third year first semester to third year second semester	Regular course of study of third year first semester.
6	Third year second semester to fourth year first semester	(i) Regular course of study of third year second semester. (ii) Must have secured at least 72 credits out of 120 credits i.e., 60% credits up to third year second semester from all the relevant regular and supplementary examinations, whether the student takes those examinations or not.
7	Fourth year first semester to fourth year second semester	Regular course of study of fourth year first semester.

7.4 A student (i) shall register for all courses / subjects covering 160 credits as specified and listed in the course structure, (ii) fulfills all the attendance and academic requirements for 160 credits, (iii) earn all 160 credits by securing SGPA ≥ 5.0 (in each semester), and CGPA ≥ 5.0 (at the end of 8 semesters), (iv) **passes all the mandatory courses**, to successfully complete the undergraduate Programme. The performance of the student in these 160 credits shall be considered for the calculation of the final CGPA **(at the end of undergraduate Programme)**, and shall be indicated in the grade card / marks memo of IV-year II semester.

7.5 If a student registers for '**extra subjects'** (in the parent department or other departments / branches of Engineering.) other than those listed subjects totaling to 160 credits as specified in the course structure of her department, the performance in those '**extra subjects**' (although evaluated and graded using the same procedure as that of the required 160 credits) will not be taken into account while calculating the SGPA and CGPA. For such '**extra subjects'** registered, percentage of marks and letter grade alone will be indicated in the grade card as a performance measure, subject to completion of the attendance and academic requirements as stated in regulations 6 and 7.1-7.4 above.

7.6 A student eligible to appear in the semester end examination for any subject / course, but absent from it or failed (thereby failing to secure 'C' grade or above) may reappear for that subject / course in the supplementary examination as and when conducted. In such cases, internal marks (CIE) assessed earlier for that subject / course will be carried over, and added to the marks to be obtained in the SEE supplementary examination for evaluating performance in that subject.

7.7 A student **detained in a semester due to shortage of attendance may be re-admitted in the same semester in the next academic year for fulfillment of academic requirements.** The academic regulations under which a student has been readmitted shall be applicable. However, no grade allotments or SGPA / CGPA calculations will be done for the entire semester in which the student has been detained.

7.8 A student detained **due to lack of credits, shall be promoted to the next academic year only after acquiring the required academic credits.** The academic regulations under which the student has been readmitted shall be applicable to her.

8.0 Evaluation-Distribution and Weightage of marks

8.1 The performance of a student in every subject / course (including practicals and Project Stage - I & II) will be evaluated for 100 marks each, with 40 marks allotted for CIE (Continuous Internal Evaluation) and 60 marks for SEE (Semester End-Examination).

8.2 In CIE, for theory subjects, during a semester, there shall be two mid-term examinations. Each Mid-Term examination consists of two parts i) **Part – A** for 10 marks, ii) **Part – B** for 20 marks with a total duration of 2 hours as follows:

1. Mid Term Examination for 30 marks:

a. Part-A: Objective / quiz paper for 10 marks.
b. Part-B: Descriptive paper for 20 marks.

The objective / quiz paper is set with multiple choices, fill - in the blanks and match the following type of questions for a total of 10 marks. The descriptive paper shall contain 6 full questions out of which, the student has to answer 4 questions, each carrying 5 marks. The **average of the two Mid Term Examinations** shall be taken as the final marks for Mid Term Examination (for 30 marks).

The remaining 10 marks of Continuous Internal Evaluation are distributed as

2. Assignment for 5 marks. (**Average of 2 Assignments** each for 5 marks)
3. Subject Viva-Voce / PPT / Poster Presentation / Case Study on a topic in the concerned subject for 5 marks.

While the first mid-term examination shall be conducted on 50% of the syllabus, the second mid-term examination shall be conducted on the remaining 50% of the syllabus.

Five (5) marks are allocated for assignments (as specified by the subject teacher concerned). The first assignment should be submitted before the conduct of the first mid-term examination, and the second assignment should be submitted before the conduct of the second mid-term examination. The average of the two assignments shall be taken as the final marks for assignment (for 5 marks).

Subject Viva-Voce / PPT / Poster Presentation / Case Study on a topic in the subject concerned for 5 marks before II Mid-Term Examination.

- The student, in each subject, shall have to earn 35% of marks (i.e. 14 marks out of 40 marks) in CIE, 35% of marks (i.e. 21 marks out of 60) in SEE and overall, 40% of marks (i.e. 40 marks out of 100 marks) both CIE and SEE marks put together.

The student is eligible to write Semester End Examination of the concerned subject, if the student scores ≥ 35% (14 marks) of 40 Continuous Internal Examination (CIE) marks.

In case, the student appears for Semester End Examination (SEE) of the concerned subject but not scored minimum 35% of CIE marks (14 marks out of 40 internal marks), her performance in that subject in SEE shall stand cancelled in spite of appearing the SEE.

There is NO Computer Based Test (CBT) for BH23 regulations.

The details of the end semester question paper pattern are as follows:

8.2.1 The Semester End Examinations (SEE), for theory subjects, will be conducted for 60 marks consisting of two parts viz. i) **Part-A** for 10 marks, ii) **Part-B** for 50 marks.

- Part-A is a compulsory question which consists of ten sub-questions from all units carrying equal marks.
- Part-B consists of five questions (numbered from 2 to 6) carrying 10 marks each.

Each of these questions is from each unit and may contain sub-questions. For each question there will be an "either" "or" choice, which means that there will be two questions from each unit and the student should answer either of the two questions.

The duration of Semester End Examination is 3 hours.

8.2.2 For the subject, **Computer Aided Engineering Graphics**, the Continuous Internal Evaluation (CIE) and Semester End Examinations (SEE) evaluation pattern is same as for other theory subjects.

8.3 For practical subjects there shall be a Continuous Internal Evaluation (CIE) during the semester for 40 marks and 60 marks for semester end examination. Out of the 40 marks for internal evaluation:

1. A write-up on day-to-day experiment in the laboratory (in terms of aim, components / procedure, expected outcome) which shall be evaluated for 10 marks
2. 10 marks for viva-voce **(**or) tutorial (or) case study (or) application (or) poster presentation of the course concerned.
3. Internal practical examination conducted by the laboratory teacher concerned shall be evaluated for 10 marks.
4. The remaining 10 marks are for Laboratory Report / Project and Presentation, which consists of the Design (or) Software / Hardware Model Presentation (or) App Development (or) Prototype Presentation submission which shall be evaluated after completion of laboratory course and before semester end practical examination.

The Semester End Examination shall be conducted with an external examiner and the laboratory teacher. The external examiner shall be appointed by the Controller of Examinations / Chief Superintendent on the recommendation of BoS chairman of the concerned department.

In the Semester End Examination held for 3 hours, total 60 marks are divided and allocated as shown below:

1. 10 marks for write-up
2. 15 for experiment / program
3. 15 for evaluation of results
4. 10 marks for presentation on another experiment / program in the same laboratory course and
5. 10 marks for viva-voce on concerned laboratory course.

- The Student, in each subject, shall have to earn 35% of marks (i.e. 14 marks out of 40 marks) in CIE, 35% of marks (i.e. 21 marks out of 60) in SEE and overall, 40% of marks (i.e. 40 marks out of 100 marks) both CIE and SEE marks put together.

The student is eligible to write Semester End Examination of the concerned subject, if

the student scores ≥ 35% (14 marks) of 40 Continuous Internal Examination (CIE) marks.

In case, the student appears for Semester End Examination (SEE) of the concerned subject but not scored minimum 35% of CIE marks (14 marks out of 40 internal marks), her performance in that subject in SEE shall stand cancelled in spite of appearing the SEE.

8.4 The evaluation of courses having ONLY internal marks in I Year I Semester and II Year II Semester is as follows:

1. I Year I Semester course (*ex.,* ***Elements of EEE / ECE / CSE*** *etc*): The internal evaluation is for 50 marks and it shall take place during I Mid-Term examination and II Mid-Term examination. The average marks of two Mid-Term examinations are the final for 50 marks. Student shall have to earn 40%, i.e. 20 marks out of 50 marks from average of the two examinations. There shall be NO external evaluation. The student is deemed to have failed, if she (i) is absent as per schedule, or (ii) secures less than 40% marks in this course.

   For CSE / IT and allied branches the Continuous Internal Evaluation (CIE) will be for 50 marks. Each Mid-Term examination consists of two parts **i) Part – A** for 20 marks, ii) **Part–B** for 20 marks with a total duration of 2 hours.

   Part A: Objective / quiz paper is set with multiple choice, fill-in the blanks and match the following type of questions for a total of 20 marks. **Part B:** Descriptive paper shall contain 6 full questions out of which, the student has to answer 4 questions, each carrying 5 marks.

   The remaining 10 marks of Continuous Internal Evaluation are for Assignment (5 marks) and Subject Viva-Voce / PPT / Poster Presentation / Case Study (5 marks) and the evaluation pattern will remain same as for other theory subjects.

   For all other branches, the Continuous Internal Evaluation (CIE) will be for 50 marks. Out of the 50 marks for internal evaluation:

   a) A write-up on day-to-day experiment in the laboratory (in terms of aim, components/ procedure, expected outcome) which shall be evaluated for 10 marks

   b) **10 marks for viva-voce (**or) tutorial (or) case study (or) application (or) poster presentation of the course concerned.

   c) Internal practical examination conducted by the laboratory teacher concerned shall be evaluated for15 marks.

   d) The remaining 15 marks are for Laboratory Report/Project and Presentation, which consists of the Design (or) Software/Hardware Model Presentation (or) App Development (or) Prototype Presentation submission which shall be evaluated after completion of laboratory course and before semester end practical examination.

2. II Year II Semester *Real-Time (or) Field-based Research Project* course: The internal evaluation is for 50 marks and it shall take place during I Mid-Term examination and II Mid-Term examination. The average marks of two Mid-Term examinations are the final for 50 marks. Student shall have to earn 40%, i.e. 20 marks out of 50 marks from average of the two examinations. There shall be NO external evaluation. The student is deemed to have failed, if she (i) does not submit a report on the Project, or (ii) does not make a presentation of the same before the internal committee as per schedule, or (iii) secures less than 40% marks in this course.

8.5 There shall be Industry training (or) Internship (or) Industry oriented Mini-project (or) Skill Development Courses (or) Paper presentation in reputed journal (or) Industry Oriented Mini Project in collaboration with an industry of their specialization. Students shall register for this immediately after II-Year II Semester Examinations and pursue it during summer vacation / semester break & during III Year without effecting regular course work. Internship at reputed organization (or) Skill development courses (or) Paper presentation in reputed journal (or) Industry Oriented Mini Project shall be submitted in a report form and presented before the committee in III-year II semester before end semester examination. It shall be evaluated for 100 external marks. The committee consists of an External Examiner, Head of the Department, Supervisor of the Industry Oriented Mini Project (or) Internship etc, Internal Supervisor and a Senior Faculty Member of the Department. There shall be **NO internal marks** for Industry Training (or) Internship (or) Mini-Project (or) Skill Development Courses (or) Paper Presentation in reputed journal (or) Industry Oriented Mini Project.

8.6 The UG project shall be initiated in the IV Year I Semester and the duration of the project work is one year. The student must present Project Stage - I during IV Year I Semester before II Mid examinations, in consultation with her Supervisor, the title, objective and plan of action of her Project work to the departmental committee for approval before commencement of IV Year II Semester. Only after obtaining the approval of the departmental committee, the student can start her project work.

8.7 UG project work shall be carried out in two stages: Project Stage - I for approval of project before Mid-II examinations in IV Year I Semester and Project Stage - II during IV Year II Semester. Student has to submit project work report at the end of IV Year II Semester. The project shall be evaluated for 100 marks before commencement of SEE Theory examinations.

8.8 For Project Stage – I, the departmental committee consisting of Head of the Department, project supervisor and a senior faculty member shall approve the project work to begin before II Mid-Term examination of IV Year I Semester. The student is deemed to be not eligible to register for the Project work, if he does not submit a report on Project Stage - I or does not make a presentation of the same before the evaluation committee as per schedule.

A student who has failed may reappear for the above evaluation, when it is scheduled again; if she fails in such **'one reappearance'** evaluation also, she has to reappear for the same in the next subsequent semester, as and when it is scheduled.

8.9 For Project Stage –II, the external examiner shall evaluate the project work for 60 marks and the internal project committee shall evaluate it for 40 marks. Out of 40 internal marks, the departmental committee consisting of Head of the Department, Project Supervisor and a Senior Faculty Member shall evaluate the project work for 20 marks and Project Supervisor shall evaluate for 20 marks. The topics for Industry Oriented Mini Project / Internship / SDC etc. and the main Project shall be different from the topic already taken. The student is deemed to have failed, if she (i) does not submit a report on the Project, or (ii) does not make a presentation of the same before the External Examiner as per schedule, or (iii) secures less than 40% marks in the sum total of the CIE and SEE taken together.

For conducting viva-voce of project, Controller of Examinations / Chief Superintendent select an external examiner from the list of experts in the relevant branch submitted by the BoS Chairman of the concerned department.

A student, who has failed, may reappear once for the above evaluation, when it is scheduled again; if the student fails in such **'one reappearance'** evaluation also, she has to reappear for the same in the next subsequent semester, as and when it is scheduled.

8.10 A student shall be given only one time chance to re-register for a maximum of two subjects in a semester:

- If the internal marks secured by a student in the Continuous Internal Evaluation marks for 40 (Sum of average of two mid-term examinations consisting of Objective & descriptive parts, Average of two Assignments & Subject Viva-voce / PPT / Poster presentation / Case Study on a topic in the concerned subject) are less than 35% and failed in those subjects.

A student must re-register for the failed subject (s) for 40 marks within four weeks of commencement of the class work in next academic year.

In the event of the student taking this chance, her Continuous Internal Evaluation marks for 40 and Semester End Examination marks for 60 obtained in the previous attempt stand cancelled.

8.11 For mandatory courses of Environmental Science, Constitution of India, Intellectual Property Rights, and Gender Sensitization lab, a student has to secure 40 marks out of 100 marks (i.e. 40% of the 100 marks allotted) in the Continuous Internal Evaluation for passing the subject / course. These marks should also be uploaded along with the internal marks of other subjects.

8.12 No marks or letter grades shall be allotted for mandatory / non-credit courses. Only Pass / Fail shall be indicated in Grade Card.

9.0 Grading procedure

9.1 Grades will be awarded to indicate the performance of students in each Theory Subject, Laboratory / Practical's, Seminar, Industry Oriented Mini Project, and Project Stage-I & II. Based on the percentage of marks obtained (Continuous Internal Evaluation plus Semester End Examination, both taken together) as specified in item 8 above, a corresponding letter grade shall be given.

9.2 As a measure of the performance of a student, a 10-point absolute grading system using the following letter grades (as per UGC/AICTE guidelines) and corresponding percentage of marks shall be followed:

% of Marks Secured in a Subject/Course (Class Intervals)	Letter Grade (UGC Guidelines)	Grade Points
Greater than or equal to 90%	**O (Outstanding)**	**10**
80 and less than 90%	**A^+ (Excellent)**	**9**
70 and less than 80%	**A (Very Good)**	**8**
60 and less than 70%	**B^+ (Good)**	**7**
50 and less than 60%	**B (Average)**	**6**
40 and less than 50%	**C (Pass)**	**5**
Below 40%	**F (FAIL)**	**0**
Absent	**Ab**	**0**

9.3 A student who has obtained an '**F'** grade in any subject shall be deemed to have '**failed'** and is required to reappear as a **'supplementary student'** in the semester end examination, as and when offered. In such cases, internal marks in those subjects will remain the same as those obtained earlier.

9.4 To a student who has not appeared for an examination in any subject, '**Ab'** grade will be allocated in that subject, and she is deemed to have '**failed'**. A student will be required to reappear as a **'supplementary student'** in the semester end examination, as and when offered next. In this case also, the internal marks in those subjects will remain the same as those obtained earlier.

9.5 A letter grade does not indicate any specific percentage of marks secured by the student, but it indicates only the range of percentage of marks.

9.6 A student earns grade point (GP) in each subject / course, on the basis of the letter grade secured in that subject/ course. The corresponding **'credit points'** (CP) are computed by multiplying the grade point with credits for that particular subject/ course.

Credit Points (CP) = Grade Point (GP) x Credits for a course

9.7 A student passes the subject / course only when **GP ≥ 5 ('C' grade or above)**

9.8 The Semester Grade Point Average (SGPA) is calculated by dividing the sum of credit points (∑CP) secured from all subjects / courses registered in a semester, by the total number of credits registered during that semester. SGPA is rounded off to **two** decimal places. SGPA is thus computed as

SGPA = { $\sum_{i=1}^{N} C_i G_i$ } / { $\sum_{i=1}^{N} C_i$ } …. for each semester

where 'i' is the subject indicator index (takes into account all subjects in a semester), 'N' is the no. of subjects '**registered'** for the semester (as specifically required and listed under the course structure of the parent department), C_i is the no. of credits allotted to the i^{th} subject, and G_i represents the grade points (GP) corresponding to the letter grade awarded for that i^{th} subject.

9.9 The Cumulative Grade Point Average (CGPA) is a measure of the overall cumulative performance of a student in all semesters considered for registration. The CGPA is the ratio of the total credit points secured by a student in all registered courses in all semesters, and the total number of credits registered in all the semesters. CGPA is rounded off to **two** decimal places. CGPA is thus computed from the I year II semester onwards at the end of each semester as per the formula

CGPA = { $\sum_{j=1}^{M} C_j G_j$ } / { $\sum_{j=1}^{M} C_j$ } … for all S semesters registered (i.e., up to and inclusive of S semesters, S≥2),

where '**M'** is the **total** no. of subjects (as specifically required and listed under the course structure of the parent department) the student has '**registered'** i.e., from the 1^{st} semester onwards up to and inclusive of the 8^{th} semester, 'j' is the subject indicator index (takes into account all subjects from 1 to 8 semesters), C_j is the no. of credits allotted to the j^{th} subject, and G_j represents the grade points (GP) corresponding to the letter grade awarded for that j^{th} subject. After registration and completion of I year I semester, the SGPA of that semester itself may be taken as the CGPA, as there are no cumulative effects.

Illustration of calculation of SGPA:

Course / Subject	Credits	Letter Grade	Grade Points	Credit Points
Course 1	4	A	8	4 x 8=32
Course 2	4	O	10	4 x 10 =40
Course 3	4	C	5	4 x 5=20
Course 4	3	B	6	3 x 6=18
Course 5	3	A+	9	3 x 9=27
Course 6	3	C	5	3 x 5=15
	21			152

SGPA = 152 / 21 = 7.24

Illustration of calculation of CGPA up to 3rd Semester:

Semester	Course/ Subject Title	Credits Allotted	Letter Grade Secured	Corresponding Grade Point (GP)	Credit Points (CP)
I	Course1	3	A	8	24
I	Course2	3	O	10	30
I	Course3	3	B	6	18
I	Course4	4	A	8	32
I	Course5	3	A+	9	27
I	Course6	4	C	5	20
II	Course7	4	B	6	24
II	Course8	4	A	8	32
II	Course9	3	C	5	15
II	Course10	3	O	10	30
II	Course11	3	B+	7	21
II	Course12	4	B	6	24
II	Course13	4	A	8	32
II	Course14	3	O	10	30
III	Course 15	2	A	8	16
III	Course 16	1	C	5	5
III	Course 17	4	O	10	40
III	Course 18	3	B+	7	21
III	Course 19	4	B	6	24
III	Course 20	4	A	8	32
III	Course 21	3	B+	7	21
	Total Credits	**69**		**Total Credit Points**	**518**

CGPA = 518 / 69 = 7.51

The above illustrated calculation process of CGPA will be followed for each subsequent semester until 8th semester. The CGPA obtained at the end of 8th semester will become the final CGPA secured for entire B.Tech. Programme.

9.10 For merit ranking or comparison purposes or any other listing, **only** the '**rounded off**' values of the CGPAs will be used.

9.11 SGPA and CGPA of a semester will be mentioned in the semester Memorandum of Grades if all subjects of that semester are passed in first attempt. Otherwise, the SGPA and CGPA shall be mentioned only on the Memorandum of Grades in which sitting she passed her last exam in that semester. However, mandatory courses will not be taken into consideration.

10.0 Passing standards

10.1 A student shall be declared successful or 'passed' in a semester, if she secures a GP≥5.0 (**'C'** grade or above) in every subject / course in that semester (i.e. when the student gets an SGPA ≥ 5.0 at the end of that particular semester); and she shall be declared successful or 'passed' in the entire undergraduate Programme, only when gets a CGPA ≥ 5.0 (**'C'** grade or above) for the award of the degree as required.

10.2 After the completion of each semester, a grade card or grade sheet shall be issued to all the registered students of that semester, indicating the letter grades and credits earned. It will show the details of the courses registered (course code, title, no. of credits, grade earned, etc.), credits earned. **There is No exemption of credits in any case**.

11.0 Declaration of results

11.1 Computation of SGPA and CGPA are done using the procedure listed in 9.6 to 9.9.

11.2 For final percentage of marks equivalent to the computed final CGPA, the following formula may be used.

$$\% \text{ of Marks} = (\text{final CGPA} - 0.5) \times 10$$

12.0 Award of degree

12.1 A student who registers for all the specified subjects / courses as listed in the course structure and secures the required number of 160 credits (with CGPA ≥ 5.0), within 8 academic years from the date of commencement of the first academic year, shall be declared to have '**qualified'** for the award of B.Tech. degree in the chosen branch of Engineering selected at the time of admission.

12.2 A student who qualifies for the award of the degree as listed in item 12.1 shall be placed in the following classes.

12.3 A student with final CGPA (at the end of the undergraduate Programme) ≥ 8.00, and fulfilling the following conditions-shall be placed in '**first class with distinction'**.

However, she

(i) Should have passed all the subjects / courses in '**first appearance'** within the first 4 academic years (or 8 sequential semesters) from the date of commencement of first year first semester.

(ii) Should not have been detained or prevented from writing the semester end examinations in any semester due to shortage of attendance or any other reason.

A student not fulfilling any of the above conditions with final CGPA ≥8.00 shall be placed in **'First Class'.**

12.4 Students with final CGPA (at the end of the undergraduate Programme) ≥ 7.00 but <8.00 shall be placed in **'First Class'.**

12.5 Students with final CGPA (at the end of the undergraduate Programme) ≥6.00 but <7.00, shall be placed in '**Second Class'**.

12.6 All other students who qualify for the award of the degree (as per item 12.1), with final CGPA (at the end of the undergraduate Programme) ≥ 5.00 but < 6.00, shall be placed in '**Pass Class**'.

12.7 A student with final CGPA (at the end of the undergraduate Programme) < 5.00 will not be eligible for the award of the degree.

12.8 Students fulfilling the conditions listed under item 12.3 alone will be eligible for award of '**Gold Medal**'.

12.9 Award of 2-Year B.Tech. Diploma Certificate

1. A student is awarded 2-Year UG Diploma Certificate in the concerned engineering branch on completion of all the academic requirements and earned all the 80 credits (within 4 years from the date of admission) up to B.Tech. II Year II Semester, if the student wants to exit the 4-Year B.Tech. Programme and *requests for the 2 –Year* B.Tech. (*UG) Diploma Certificate.*

2. The student **once opted and awarded 2-Year UG Diploma Certificate, the student will be permitted to join** in B.Tech. III Year I Semester and continue for completion of remaining years of study for 4-Year B.Tech. Degree ONLY in the next academic year along with next batch students. *However, if any student wishes to continue the study after opting for exit, she should register for the subjects / courses in III Year I Semester before commencement of class work for that semester.*

3. *The students, who exit the 4-Year B.Tech. Programme after II Year of study and wish to re-join the B.Tech. Programme, must submit the 2 - Year* B.Tech. (*UG) Diploma Certificate awarded to her, subject to the eligibility for completion of Course / Degree.*

4. A student may be permitted to take one year break after completion of II Year II Semester or B.Tech. III Year II Semester (with university permission through the principal of the college well in advance) and can re-enter the course in **next Academic Year in the same college** and complete the course on fulfilling all the academic credentials within a stipulated duration i.e. double the duration of the course (Ex. within 8 Years for 4-Year Programme).

13.0 Withholding of results

13.1 If the student has not paid the fees to the college at any stage, or has dues pending due to any reason whatsoever, or if any case of indiscipline is pending, the result of the student may be withheld, and the student will not be allowed to go into the next higher semester. The award or issue of the degree may also be withheld in such cases.

14.0 Transitory Regulations

A. For students detained due to shortage of attendance:

1. A student, who has been detained in I Year of R18/R22 Regulations due to lack of attendance, shall be permitted to join I Year I Semester of BH23 Regulations and she is required to complete the study of B.Tech. Programme within the stipulated period of eight academic years from the date of first admission in I Year.
2. A student, who has been detained in any semester of II, III and IV years of R18/R22 regulations for want of attendance, shall be permitted to join the corresponding semester of BH23 Regulations and is required to complete the study of B.Tech. Within the stipulated period of eight academic years from the date of first admission in I Year. The BH23 Academic Regulations under which a student has been readmitted shall be applicable to that student from that semester. See rule (C) for further Transitory Regulations.

B. For students detained due to shortage of credits:

3. A student of R18/R22 Regulations, who has been detained due to lack of credits, shall be promoted to the next semester of BH23 Regulations only after acquiring the required number of credits as per the corresponding regulations of her first admission. The total credits required are 160 including both R18/R22 & BH23 regulations. The student is required to complete the study of B.Tech. within the stipulated period of eight academic years from the year of first admission. The BH23 Academic Regulations are applicable to a student from the year of readmission. See rule (C) for further Transitory Regulations.

C. For readmitted students in BH23 Regulations:

4. A student who has failed in any subject under any regulation has to pass those subjects in the same regulations.
5. The maximum credits that a student acquires for the award of degree, shall be the sum of the total number of credits secured in all the regulations of her study including BH23 Regulations. **There is NO exemption of credits in any case**.
6. If a student is readmitted to BH23 Regulations and has any subject with 80% of syllabus common with her previous regulations, that particular subject in BH23 Regulations will be substituted by another subject to be recommended by the Academic Council (AC), and approved by Governing Body (GB).

Note: If a student readmitted to BH23 Regulations and has not studied any subjects / topics in her earlier regulations of study which is prerequisite for further subjects in BH23 Regulations, the concerned department HoD shall conduct remedial classes to cover those subjects / topics for the benefit of the students.

15.0 Student Transfers

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

15.2 The students seeking transfer to BVRITHCEW(A) from various other Universities /

Institutions have to pass the failed subjects which are equivalent to the subjects of BVRITHCEW(A), and also pass the subjects of BVRITHCEW(A) which the students have not studied at the earlier institution. Further, though the students have passed some of the subjects at the earlier institutions, if the same subjects are prescribed in different semesters of BVRITHCEW(A), the students have to study those subjects in BVRITHCEW(A) in spite of the fact that those subjects are repeated.

15.3 The BVRITHCEW(A) will provide one chance to write the internal examinations in the equivalent subject (s) to the students transferred from other universities / institutions, as per the clearance (equivalence) letter issued by the University.

16.0 Scope

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

16.2 In case of any doubt or ambiguity in the interpretation of the above rules, the decision of the AC is final.

16.3 The AC 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 dates notified by the AC.

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Academic Regulations (BH23) for B.Tech. (Lateral Entry Scheme) from the AY 2024-25

1. **Eligibility for award of B.Tech. Degree (LES)**

   The LES students after securing admission shall pursue a course of study for not less than three academic years and not more than six academic years.

2. The student shall register for 120 credits and secure 120 credits with CGPA ≥ 5.0 from II year to IV year B.Tech. Programme (LES) for the award of B.Tech. degree.

3. The students, who fail to fulfil the requirement for the award of the degree in six academic years from the year of admission, shall forfeit their seat in B.Tech.

4. The attendance requirements of B.Tech. (Regular) shall be applicable to B.Tech. (LES).

5. **Promotion rules**

S. No.	Promotion	Conditions to be fulfilled
1	**Second year first semester to second year second semester**	**Regular course of study of second year first semester.**
2	**Second year second semester to third year first semester**	**(i) Regular course of study of second year second semester.** **(ii) Must have secured at least 24 credits out of 40 credits i.e., 60% credits up to second year second semester from all the relevant regular and supplementary examinations, whether the student takes those examinations or not.**
3	**Third year first semester to third year second semester**	**Regular course of study of third year first semester.**
4	**Third year second semester to fourth year first semester**	**(i) Regular course of study of third year second semester.** **(ii) (ii) Must have secured at least 48 credits out of 80 credits i.e., 60% credits up to third year second semester from all the relevant regular and supplementary examinations, whether the student takes those examinations or not.**
5	**Fourth year first semester to fourth year second semester**	**Regular course of study of fourth year first semester.**

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

7. LES students are not eligible for 2-Year B.Tech. Diploma Certificate.

Malpractices Rules

Disciplinary Action for Malpractices / Improper Conduct in Examinations

	Nature of Malpractices / Improper conduct	**Punishment**
	If the student:	
1.(a)	Possesses or keeps accessible in examination hall, any paper, note book, programmable calculators, cell phones, pager, palm computers or any other form of material concerned with or related to the subject of the examination (theory or practical) in which student is appearing but has not made use of (material shall include any marks on the body of the student which can be used as an aid in the subject of the examination)	Expulsion from the examination hall and cancellation of the performance in that subject only.
(b)	Gives assistance or guidance or receives it from any other student orally or by any other body language methods or communicates through cell phones with any student 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 students involved. In case of an outsider, she will be handed over to the police and a case is registered against her.
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 student is appearing.	Expulsion from the examination hall and cancellation of the performance in that subject and allot her subjects the student 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 student is to be cancelled.
3.	Impersonates any other student in connection with the examination.	The student who has impersonated shall be expelled from examination hall. The student is also debarred and forfeits the seat. The performance of the original student, who has been impersonated, shall be cancelled in all the subjects of the examination (including practicals and project work) already appeared and shall not be allowed to appear for examinations of the remaining subjects of that semester / year. The student is also debarred for two consecutive semesters from class work and all examinations. The continuation of the course by the student is subject to the academic regulations in connection with forfeiture of seat. If the imposter is an outsider, she will be handed over to the police and a case is registered against her.

4.	Smuggles in the answer book or additional sheet or takes out or arranges to send out the question paper during the examination or answer book or additional sheet, during or after the examination.	Expulsion from the examination hall and cancellation of performance in that subject and all the other subjects the student 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 student is also debarred for two consecutive semesters from class work and all examinations. The continuation of the course by the student 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 her 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 walkout, or threatens the officer-in charge or any person on duty in or outside the examination hall of any injury to her person or to any of her 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 her 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 student(s) has (have) already appeared and shall not be permitted to appear for the remaining examinations of the subjects of that semester/year. The students 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 off the script or any part there of inside or outside the examination hall.	Expulsion from the examination hall and cancellation of performance in that subject and all the other subjects the student 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 student is also debarred for two consecutive semesters from class work and all examinations. The continuation of the course by the student is subject to the academic regulations in connection with forfeiture of seat.

8.	Possesses any lethal weapon or fire arm in the examination hall.	Expulsion from the examination hall and cancellation of the performance in that subject and all other subjects the student 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 student is also debarred and forfeits the seat.
9.	If student of the college, who is not a student for the particular examination or any person not connected with the college indulges in any malpractice or improper conduct mentioned in clause 6 to 8.	Expulsion from the examination hall and cancellation of the performance in that subject and all other subjects the student 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 student is also debarred and forfeits the seat. Person(s) who do not belong to the college will be handed over to the 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 student has already appeared for 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 student has appeared for 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 Chief Superintendent for further action to award a suitable punishment.	

Malpractices identified by squad or special invigilators

1. Punishments to the students as per the above guidelines.

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Academic Regulations for B.Tech. with Minor program

1. Introduction

The philosophy behind Engineering as an academic discipline has been to orient the knowledge seekers in a manner that shatters the theoretical boundaries and pushes them into the realms of a practical world view.

The emphasis of BVRITHCEW has always been to orient the students towards the technologies that shall drive the world in the years to come; with this philosophy the Institution has decided to launch the **Bachelor of Technology in a particular branch with minor in a specified program** (Ex. B.Tech. in ECE / EEE with Minor in AI&ML) from the AY 2025-26 onwards.

The **Bachelor of Technology (B.Tech.) with Minor** program focuses on the fundamental principles of multiple Engineering disciplines, critical & analytical thinking and the ability to develop a distinctive approach to the interdisciplinary problems.

2. Objectives

The key objectives of offering B.Tech. with Minor program are:

- To expand the domain knowledge of the students in one of the other branches of engineering.
- To increase the employability of undergraduate students keeping in view of better opportunity in inter-disciplinary areas of engineering & technology.
- To provide an opportunity to students to pursue their higher studies in the inter-disciplinary areas in addition to their own branch of study.
- To offer the knowledge in the areas which are identified as emerging technologies / thrust areas of Engineering.

3. Minor courses and the offering departments

S. No.	Minor Program	Eligible branch of students	@Offering Department	Award of Degree
1.	Data Science	All branches, except B.Tech. in CSE (Data Science) / B.Tech. (Data Science)	CSE	"B.Tech. in branch name with Minor in Data Science"
2.	IOT	All branches, except B.Tech. in CSE (IOT) / B.Tech. (IOT)	ECE	"B.Tech. in branch name with Minor in IOT"
3.	Innovation and Entrepreneurship	All branches	Management Science / MBA	"B.Tech. in branch name with Minor in Innovation and Entrepreneurship"

Note: @As per AICTE guidelines.

4. Academic Regulations for B.Tech. Degree with Minor programs

1. The weekly instruction hours, internal & external evaluation and award of grades are on par with regular 4-Years B.Tech. program.
2. For B.Tech. with Minor, a student needs to earn additional 18 credits (over and above the required 160 credits for B.Tech degree). All these 18 credits need to be completed in III year and IV year only.
3. After registering for the Minor program, if a student is unable to earn all the required 18 credits in a specified duration (twice the duration of the course), she shall not be awarded Minor degree. However, if the student earns all the required 160 credits of B.Tech., she will be awarded only B. Tech degree in the concerned branch.
4. There is no transfer of credits from Minor program courses to regular B.Tech. degree course & vice versa.
5. These 18 credits are to be earned from the additional courses offered by the host department in the college as well as from the MOOCs platform.
6. For the course selected under MOOCs platform following guidelines may be followed:
    a) Prior to registration of MOOCs courses, formal approval of the courses, by the Academic Council is essential. Academic Council considers the parameters viz., the institute / agency which is offering the course, syllabus, credits, duration of the Programme and mode of evaluation, etc. before the issue of approval.
    b) Minimum credits for MOOCs course must be equal to or more than the credits specified in the Minor course structure provided by the University.
    c) Only Pass-grade / marks or above shall be considered for inclusion of grades in minor grade memo.
    d) Any expenses incurred for the MOOCs courses are to be met by the students only.
7. The choice to opt/ take a Minor program is purely on the choice of the students.
8. The student shall be given a choice of withdrawing all the courses registered and/or the credits earned for Minor program at any time; and in that case the student will be awarded only B.Tech. degree in the concerned branch on earning the required credits of 160.
9. The student can choose only one Minor program along with her basic engineering degree. **A student, who chooses an Honors program, is not eligible to choose a Minor program and vice-versa.**
10. The B.Tech. with a Minor program shall be offered from the AY 2025-26 onwards. The students, pursuing their III year I semester from the AY 2025-26 onwards can register for the Minor program if they fulfill the eligibility criteria.

11. A student can graduate with a Minor if she fulfils the requirements for her regular B.Tech. program as well as fulfils the requirements for Minor program.
12. The institute shall maintain a record of students registered and pursuing their Minor programs, minor program-wise and parent branch-wise.
13. The concerned department shall prepare the time-tables for each Minor course offered at without any overlap / clash with other courses of study in the respective semesters.

5. Eligibility conditions for the student to register for Minor course

a) A student can opt for B.Tech. degree with Minor program if she has no active backlogs till II Year I Semester (III semester) at the time of entering into III year I semester.

b) Prior approval of mentor and Head of the Department for the enrolment into Minor program, before commencement of III year I Semester (V Semester), is mandatory

c) If more than 50% of the students in a branch fulfil the eligibility criteria (as stated above), the number of students given eligibility should be limited to 50%.

6. Registration for the courses in Minor Program

d) At the beginning of each semester, just before the commencement of classes, students shall register for the courses which they wish to take in semester.

e) The students should choose a course from the list against each semester (from Minors course structure) other than the courses they have studied / registered for regular B.Tech. programme. No course should be identical to that of the regular B.Tech. course. The students should take the advice of faculty mentors while registering for a course at the beginning of semester.

f) The maximum no. of courses for the Minor is limited to two (three in case of inclusion of lab) in a semester along with regular semester courses.

g) The registration fee to be collected from the students by the College is **Rs. 1000/-** per one credit.

h) A fee for late registration may be imposed as per the norms.

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Academic Regulations (BH23) for B.Tech. with Honors program

1. Objectives

The key objectives of offering B.Tech. with Honors program are:

- To expand the domain knowledge of the students laterally and vertically.
- To increase the employability of undergraduate students with expanded knowledge in one of the core Engineering disciplines.
- To provide an opportunity for the students to pursue their higher studies in wider range of specializations.

2. Academic Regulations for B.Tech. Honors degree

1) The weekly instruction hours, internal & external evaluation and award of grades are on par with regular 4-Years B.Tech. program.
2) For B.Tech with Honors program, a student needs to earn additional 20 credits (over and above the required 160 credits for B.Tech. degree). All these 20 credits need to be completed in III year and IV year only.
3) After registering for the Honors program, if a student is unable to pass all courses in first attempt and earn the required 20 credits, she shall not be awarded Honors degree. However, if the student earns all the required 160 credits of B.Tech., she will be awarded only B.Tech. degree in the concerned branch.
4) There is no transfer of credits from courses of Honors program to regular B.Tech. degree course & vice versa.
5) These 20 credits are to be earned from the additional courses offered by the host department in the college or from a closely related department in the college as well as from the MOOCs platform.
6) For the courses selected under MOOCs platform following guidelines may be followed:
    a) Prior to registration of MOOCS courses, formal approval of the courses, by the Academic Council is essential. The Academic Council considers the parameters viz., the institute / agency, offering the course, syllabus, credits, duration of the Programme and mode of evaluation, etc., before the issue of approval
    b) Minimum credits for a MOOCS course must be equal to or more than the credits specified in the Honors course structure provided by the Institution.
    c) Only Pass-grade / marks or above shall be considered for inclusion of grades in the Honors grade memo.
    d) Any expenses incurred for the MOOCS courses are to be met by the students only.
7) The choice to opt / take the Honors program is purely on the choice of the students.

8) The student shall be given a choice of withdrawing all the courses registered and/or the credits earned for Honors program at any time; and in that case the student will be awarded only B.Tech. degree in the concerned branch on earning the required credits of 160.

9) The students of every branch can choose Honors program in their respective branches if they are eligible for the Honors program. A student who chooses an Honors program is not eligible to choose a Minor program and vice-versa.

10) The B.Tech. with Honors program shall be offered from the AY 2025-26 onwards. The students, pursuing their III year I semester from the AY 2025-26 onwards can register for the Honors program if they fulfill the eligibility criteria.

11) A student can graduate with Honors if she fulfils the requirements for her regular B.Tech. program as well as fulfils the requirements for Honors program.

12) The Institution shall maintain a record of students registered and pursuing their Honors programs branch-wise.

13) The department shall prepare the time-tables for each Honors program offered at their respective departments without any overlap / clash with other courses of study in the respective semesters.

3. Eligibility conditions of the students for the Honors degree

a) A student can opt for B.Tech. degree with Honors, if she passed all subjects in first attempt in all the semesters till the results announced and maintaining 7.5 or more CGPA.

b) If a student fails in any registered course of either B.Tech. or Honors in any semester of four years program, she will not be eligible for obtaining Honors degree. She will be eligible for only B.Tech. degree

c) Prior approval of mentor and Head of the Department for the enrolment into Honors program, before commencement of III year I Semester (V Semester), is mandatory.

d) If more than 30% of the students in a branch fulfil the eligibility criteria (as stated above), the number of students given eligibility should be limited to 30%. The criteria to be followed for choosing 30% candidates in a branch may be the CGPA secured by the students till II year I semester.

e) The department concerned should be preferably NBA accredited and shall offer at least one M.Tech. Program.

f) Successful completion of 20 credits earmarked for Honors program with at least 7.5 CGPA along with successful completion of 160 credits earmarked for regular B.Tech. Program with at least 7.5 CGPA and passing all subjects in first attempt gives the eligibility for the award of B. Tech. (Honors) degree.

g) For CGPA calculation of B.Tech. course, the 20 credits of Honors program will not be considered.

4. Registration for the course in Honors program

a) At the beginning of each semester, just before the commencement of classes, students shall register for the courses which they wish to take in that semester.

b) The students should choose a course from the list against each semester (from Honors course structure) other than the courses they have studied / registered for regular B.Tech. Programme. No course should be identical to that of the regular B.Tech. course. The students should take the advice of faculty mentors while registering for a course at the beginning of semester.

c) The maximum no. of courses for the Honors is limited to two (three in case of inclusion of lab) in a semester along with regular semester courses.

d) The registration fee to be collected from the students by the College is **Rs. 1000/-** per one credit.

e) A fee for late registration may be imposed as per the norms.

5. The broad guidelines for the courses of Honors program, their respective credits weightage and semester-wise break-up of the course are:

S. No.	Year /Semester	Course to be chosen from/studied	Mode of Learning	No. of Credits
1	III-I	PE-I or PE-II	Blended/Conventional	3
2	III-II	Research Methodologies	Conventional	3
3	III-II	PE-III	Conventional	3
4	IV-I	PE-IV	Conventional	3
5	IV-I	PE-V	Conventional	3
6	IV-II	Technical Paper writing	Under the mentorship of a supervisor	2
7	IV-II	PE-VI or an Inter-disciplinary subject as suggested by the Academic Council	MOOCs	3
	Total Credits			20

Note:

i. Professional Elective (PE) course should be selected (which is not studied) from each Professional Electives' list provided in regular B.Tech. course.

ii. Courses can be chosen as in above table.

1. **Technical paper writing:**

   a) The student shall take up a problem / topic of engineering branches (inter-disciplinary nature) and apply the knowledge which they acquired while pursuing their engineering branch. It is expected to analyze, design and develop an application for the identified problem and write a technical paper / document.

   Alternatively, the student i) shall identify a research topic, analyze the problem, carryout the experiments, write a technical paper and publish in / communicate for a Scopus indexed journal / any journal with decent reputation or ii) Demonstrate a talent / an idea / development of an innovative product.

   b) The evaluation shall be done by the same committee which is constituted for project evaluation, along with the final semester project work.

   c) The students should start exploration for the Technical Paper Writing immediately after the semester exams of III-II semester. Only the evaluation part shall be carried in IV-II semester.

2. The institute shall offer a course on Research Methodologies by combining the students of all branches (if the number of students is more, multiple parallel sessions may be conducted). The time slots in the time-tables of respective branches should be aligned. Both the CIE and SEE for the Research Methodologies course shall be done as regular B.Tech. courses.

3. If the blended course option is chosen, for the subject in III-I semester, the learning should be partially in online mode and partially in offline mode. The external evaluation shall be done as regular B.Tech. courses; however, for the CIE component, online assessment should also be taken into account while finalizing the internal marks by the course teacher.

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Academic Regulations for B.Tech. - MOOCs

1. Introduction

As per NEP, to inculcate the habit of self-learning and in compliance with the UGC guidelines, MOOC (Massive Open Online Courses) have been introduced.

The proposed MOOCs would be additional choices, proposed by concern department BoS (having credits >= the required credits) and approved by the Academic Council, in all the elective group courses subjected to the availability in the MOOC platforms during the respective semesters.

After the approval, at the beginning of the semester, the concerned departments shall declare the list of permitted courses to the student.

The progress of the MOOCs shall be monitored by the course coordinator of the department, nominated by the concerned HoD.

2. Eligibility

A student is eligible to register for OE / PE in Third Year First semester by having a CGPA of ≥ 6.5 without any active backlogs up to II Year I Semester. Similarly, the eligibility to register for OE / PE, in the Third Year Second semester by having a CGPA of ≥ 6.5 without any active backlogs up to II Year II Semester and to register for OE / PE, in the Fourth Year First semester by having a CGPA of ≥ 6.5 without any active backlogs up to III Year I Semester.

3. Course Registration

Students interested in pursuing MOOCs shall register the course title at their department office before the start of the semester.

A student can register at most two MOOCs throughout the course of study after approval from Faculty Advisor / Counselor / HoD.

Detailed guidelines regarding credit transfer of the courses pursued through MOOC (NPTEL-SWAYAM) shall be issued time to time by the Institution.

Academic Regulations for B.Tech. - Acceleration of Course Work

1. Introduction

In order to allow the bright and motivated students, a provision is made to complete the final semester three elective subjects in advance. These subjects are offered through MOOCs / additional subjects and credit transfer is permitted.

These credits are shown in the Final Semester Grade card in order to calculate SGPA and CGPA. This provision is made to allow the students for industry internship or to undertake projects in industry in the final semester.

2. Eligibility

A student is eligible to register for OE / PE in Third Year First semester by having a CGPA of ≥ 6.5 without any active backlogs up to II Year I Semester. Similarly, the eligibility to register for OE / PE, in the Third Year Second semester by having a CGPA of ≥ 6.5 without any active backlogs up to II Year II Semester and to register for OE / PE, in the Fourth Year First semester by having a CGPA of ≥ 6.5 without any active backlogs up to III Year I Semester.

3. Course Registration

A student can register at most two additional PE / OE in a semester after approval from Faculty Advisor / Counselor / HoD.

These additional courses have to be completed either through regular class work / MOOCs as per the directions of College Academic Committee.

The list of electives offered will be notified by the departments at the time of course work registration.

COURSE STRUCTURE (BH23 Regulations)
Applicable from A.Y. 2023-24 Batch

I Year I – Semester

S.No	Course Code	Course Title	L	T	P	Credits
1	**MA101BS**	Matrices and Calculus	3	1	0	4
2	**CH102BS**	Engineering Chemistry	3	1	0	4
3	**EE103ES**	C Programming and Data structures	3	0	0	3
4	**EE104ES**	Electrical Circuit Analysis -1	3	0	0	3
5	**EN105HS**	English for Skill Enhancement	2	0	0	2
6	**EE106ES**	Elements of Electrical and Electronics Engineering	0	0	2	1
7	**CH107BS**	Engineering Chemistry Laboratory	0	0	2	1
8	**EE108ES**	C Programming and Data structures Laboratory	0	0	2	1
9	**EN109HS**	English Language and Communication Skills Laboratory	0	0	2	1
		Induction Program				
		Total	**14**	**2**	**8**	**20**

I Year II - Semester

S.No	Course Code	Course Title	L	T	P	Credits
1	**MA201BS**	Ordinary Differential Equations and Vector Calculus	3	1	0	4
2	**PH202BS**	Applied Physics	3	1	0	4
3	**ME203ES**	Computer Aided Engineering Graphics	1	0	4	3
4	**ME204ES**	Engineering Workshop	0	1	3	2.5
5	**EE205ES**	Electrical Circuit Analysis-II	2	0	0	2
6	**EE206ES**	Applied Python Programming Laboratory	0	1	2	2
7	**PH207BS**	Applied Physics Laboratory	0	0	3	1.5
8	**EE208ES**	Electrical Circuit Analysis Laboratory	0	0	2	1
		Total	**9**	**4**	**14**	**20**

II Year I - Semester

S.No	Course Code	Course Title	L	T	P	Credits
1	**MA301BS**	Numerical Methods and Complex Variables	3	1	0	4
2	**EE302PC**	Electrical Machines-I	3	1	0	4
3	**EE303PC**	Analog Electronic Circuits	3	0	0	3
4	**EE304PC**	Power System-I	3	0	0	3
5	**EE305PC**	Electro Magnetic Fields	3	0	0	3
6	**EE306PC**	Electrical Machines Laboratory-I	0	0	2	1
7	**EE307PC**	Analog Electronic Circuits Laboratory	0	0	2	1
8	**EE308PC**	Electrical Simulation tools Laboratory	0	0	2	1
9	***MC311**	Environmental Science	3	0	0	0
		Total	**18**	**2**	**6**	**20**

II Year II – Semester

S.No	Course Code	Course Title	L	T	P	Credits
1	**ME401ES**	Solid Mechanics and Hydraulic Machines	3	1	0	4
2	**EE402PC**	Measurements and Instrumentation	3	0	0	3
3	**EE403PC**	Electrical Machines–II	3	0	0	3
4	**EE404PC**	Digital Electronics	2	0	0	2
5	**EE405PC**	Power System-II	3	0	0	3
6	**EE406PC**	Digital Electronics Laboratory	0	0	2	1
7	**EE407PC**	Measurements and Instrumentation Laboratory	0	0	2	1
8	**EE408PC**	Electrical Machines Laboratory-II	0	0	2	1
9	**EE409PC**	Real-time Research Project / Field Based Project	0	0	4	2
10	***MC410**	Gender Sensitization Lab	0	0	2	0
		Total	**14**	**1**	**12**	**20**

III Year I – Semester

S.No	Course Code	Course Title	L	T	P	Credits
1	**EE501PC**	Power Electronics	3	1	0	4
2	**EE502PC**	Control Systems	3	1	0	4
3	**EE503PC**	Microprocessors and Microcontrollers	3	0	0	3
4	**EE504PC**	Power System Protection	3	0	0	3
5		**Professional Elective – I**	3	0	0	3
6	**EE505PC**	Power Electronics Laboratory	0	0	2	1
7	**EE506PC**	Control Systems Laboratory	0	0	2	1
8	**EE507PC**	Microprocessors and Microcontrollers Laboratory	0	0	2	1
9	***MC508**	Intellectual Property Rights	3	0	0	0
		Total	**18**	**2**	**6**	**20**

III Year II – Semester

S.No	Course Code	Course Title	L	T	P	Credits
1	**SM601MS**	Business Economics and Financial Analysis	3	0	0	3
2	**EE602PC**	Digital Signal Processing	3	0	0	3
3	**EE603PC**	Power System Operation and Control	3	0	0	3
4		**Professional Elective-II**	3	0	0	3
5		**Open Elective-I**	3	0	0	3
6	**EE604PC**	Power System Laboratory	0	0	2	1
7	**EN605HS**	Advanced English Communication Skills Laboratory	0	0	2	1
8	**EE606PC**	Digital Signal Processing Lab	0	0	2	1
9	**EE607PC**	Industry Oriented Mini Project/ Internship	0	0	4	2
10	***MC608**	Constitution of India	3	0	0	0
		Total	**18**	**0**	**10**	**20**

IV Year I – Semester

S.No	Course Code	Course Title	L	T	P	Credits
1	**SM701MS**	Fundamentals of Management for Engineers	2	0	0	2
2	**EE702PC**	Power Electronic Applications to Renewable Energy Systems	3	1	0	4
3		**Professional Elective-III**	3	0	0	3
4		**Professional Elective-IV**	3	0	0	3
5		**Open Elective-II**	3	0	0	3
6	**EE703PC**	Simulation of Renewable Energy Systems Laboratory	0	0	4	2
7	**EE704PC**	Project Stage - I	0	0	6	3
		Total	**14**	**1**	**10**	**20**

IV Year II – Semester

S. No	Course Code	Course Title	L	T	P	Credits
1		**Professional Elective-V**	3	0	0	3
2		**Professional Elective-VI**	3	0	0	3
3		**Open Elective-III**	3	0	0	3
4	**EE801PC**	Project Stage – II including Seminar	0	0	22	11
		Total	**9**	**0**	**22**	**20**

Professional Electives

Professional Elective	Course Code	Course Name
PE-I	**EE511PE**	Programmable Logic Controller
	EE512PE	AI Techniques in Electrical Engineering
	EE513PE	Special Machines
	EE514PE	Signals and Systems
PE-II	**EE611PE**	Wind and Solar Energy systems
	EE612PE	IoT Applications in Electrical Engineering
	EE613PE	Computer Aided Electrical Machine Design
	EE614PE	Fundamentals of Electric and Autonomous Vehicles
PE-III	**EE711PE**	Industrial Drives & Control
	EE712PE	Advanced EV and Autonomous Vehicle
	EE713PE	Energy Storage Systems & Management
	EE714PE	DSP Controller and Applications
PE-IV	**EE721PE**	HVDC Transmission
	EE722PE	Embedded Systems applications
	EE723PE	Flexible AC Transmission Systems
	EE724PE	Power System Stability
PE-V	**EE811PE**	Power Quality
	EE812PE	Solar Power Batteries
	EE813PE	High Voltage Engineering
	EE814PE	Electrical Energy Conservation and Auditing
PE-VI	**EE821PE**	Smart Grid Technologies
	EE822PE	Electrical Distribution Systems
	EE823PE	Machine Learning Applications to Electrical Engineering
	EE824PE	Cyber-Physical Systems

Open Electives

Open Electives	Department Offering	Course Code	Course Name
OE-I	EEE	EE600OE	Renewable Energy Sources
		EE601OE	Green Energy Technologies
		EE602OE	Fundamentals of Electric Vehicles
	ECE	EC600OE	Microcontrollers
		EC601OE	Fundamentals of IoT
		EC602OE	VLSI Design
	CSE/ CSE(AIML) /IT	CS600OE	Problem Solving using Data Structure
		CS601OE	Java Programming
		CS602OE	Fundamentals of AI
OE-II	EEE	EE700OE	Utilization of Electrical Energy
		EE701OE	Electric Drives and Control
		EE702OE	Principles of Power Systems
	ECE	EC700OE	Electronic Sensors
		EC701OE	Digital Image Processing
		EC702OE	Principles of Communications
	CSE/ CSE(AIML) /IT	CS700OE	Scripting Languages
		CS701OE	Database Management Systems
		CS702OE	Machine Learning
OE-III	EEE	EE800OE	Basics of Power Plant Engineering
		EE801OE	Energy Sources and Applications
		EE802OE	Battery Management Systems
	ECE	EC800OE	Electronic Measurements and Instrumentation
		EC801OE	Embedded System Design
		EC802OE	FPGA based System Design
	CSE/ CSE(AIML) /IT	CS800OE	Operating Systems
		CS801OE	Software Engineering
		CS802OE	Computer Networks

B.Tech. I Year I Semester

Course Code	Course Title	L	T	P	Credits
MA101BS	MATRICES AND CALCULUS	3	1	0	4

Prerequisites Mathematical Knowledge at pre-university level

Course Description: The course contains various topics related to Rank of the Matrix and their related properties, Echelon form, Normal form, Solving linear system of equations, Eigen values and vectors, Reduction of Quadratic form to canonical forms, Mean value theorems, Improper Integration and their applications of beta, gamma functions, Maxima and minima of functions of two variables and three variables, Partial Differentiation, Evaluation of Double Integrals (Cartesian and polar coordinates), Change of order of integration, Evaluation of triple Integrals.

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

C101.1: Apply matrix techniques to solve system of linear equations.

C101.2: Find the Eigen values and Eigen vectors and reduce the Quadratic form to canonical Form.

C101.3: Apply Mean value theorems for given functions

C101.4: Evaluate the improper integrals using Beta and Gamma functions

C101.5: Find the extreme values of functions of two variables with/ without constraints.

C101.6: Evaluate the multiple integrals and apply the concept to find areas, volumes

Unit - I Matrices

Rank of a matrix by Echelon form and Normal form, Inverse of Non-singular matrices by Gauss- Jordan method, System of linear equations: Solving system of Homogeneous and Non-Homogeneousequations by Gauss elimination method, Gauss Seidel Iteration Method.

Unit - II Eigen Values and Eigen Vectors

Linear Transformation and Orthogonal Transformation: Eigenvalues, Eigenvectors and their properties, Diagonalization of a matrix, Cayley-Hamilton Theorem (without proof), finding inverse and power of a matrix by Cayley-Hamilton Theorem, Quadratic forms and Nature of the Quadratic Forms, Reduction of Quadratic form to canonical forms by Orthogonal Transformation.

Unit - III Single Variable Calculus

Mean value theorems: Rolle's theorem, Lagrange's Mean value theorem with their Geometrical Interpretation and applications, Cauchy's Mean value Theorem, Taylor's Series, Maclaurin Series.

Definition of Improper Integrals: Beta, Gamma functions and their properties, Relation between Beta & Gamma functions and their applications.

Unit - IV Multivariable Calculus (Partial Differentiation And Applications)

Definitions of Limit and continuity. Partial Differentiation: Introduction to Partial Differentiation,

Euler's Theorem, Total derivative, Jacobian, Functional dependence & independence. Applications: Maxima and minima of functions of two variables and three variables using method of Lagrange multipliers.

Unit - V Multivariable Calculus (Integration)

Evaluation of Double Integrals (Cartesian and polar coordinates), change of order of integration (only Cartesian form), Change of variables (Cartesian to polar) for double integrals. Evaluation of triple integrals (Cartesian Coordinates) Applications: Areas (by double integrals) and volumes (by triple integrals).

TEXT BOOKS

1. B.S. Grewal, Higher Engineering Mathematics, 36th Edition, 2010, Khanna Publishers.
2. R.K. Jain and S.R.K. Iyengar, Advanced Engineering Mathematics, 5th Edition, 2016, Narosa Publications.

REFERENCE BOOKS

1. Erwin Kreyszig, Advanced Engineering Mathematics, 9th Edition, 2006, John Wiley & Sons.
2. G.B. Thomas and R.L. Finney, Calculus and Analytic Geometry, 9th Edition, 2002, Pearson.
3. N.P. Bali and Manish Goyal, A text book of Engineering Mathematics, 2008, Laxmi Publications, Reprint.
4. H. K. Dass and Er. Rajnish Verma, Higher Engineering Mathematics, S Chand and Company Limited, New Delhi.

B.Tech. I Year I Semester

Course Code	Course Title	L	T	P	Credits
CH102BS	ENGINEERING CHEMISTRY	3	1	0	4

Prerequisites Fundamental knowledge and solid understanding of chemistry

Course Description: Engineering Chemistry is a fundamental course designed to provide students with a solid foundation in the principles and applications of chemistry relevant to engineering disciplines. The course aims to equip students with the knowledge and skills necessary to understand the chemical properties of materials, analyze chemical reactions, and apply chemical concepts in engineering practice.

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

C102.1: Analyze the basic properties of water and its usage in domestic and industrial purposes.

C102.2: Inspect the working principles and reaction mechanisms of various energy storage devices

C102.3: Acquire the basic knowledge of electrochemical procedures related to corrosion and its control.

C102.4: Impart the fundamental knowledge and sustainability implemented through smart engineering materials.

C102.5: Distinguish various energy sources to prioritise eco-friendly fuels for environmentally sustainable development.

C102.6: Discriminate the limitations of conventional basic engineering materials for developing multiphase materials.

Unit - I Water and its Treatment

Hardness of water – Types of hardness, Units, Estimation of hardness of water by complexometric method; numerical problems. Potable water and its specifications - Steps involved in the treatment of potable water - Disinfection of potable water by ozonisation and chlorination - breakpoint chlorination. Defluoridation - Determination of F^- ion by ion-selective electrode method. Boiler troubles: Sludges, Scales and Caustic embrittlement. Internal treatment of Boiler feed water - Calgon conditioning - Phosphate conditioning - Colloidal conditioning, External treatment methods - Softening of water by ion- exchange processes. Desalination of Brackish water – Reverse osmosis.

Unit - II Battery Chemistry and Corrosion

Introduction to Electrochemistry- Galvanic Cells, Electrode Potentials, Nernst Equation, EMF of the cell, Cell representation. Classification of batteries- primary, secondary, flow and reserve batteries with examples. Basic requirements for commercial batteries. Construction, working and applications of Zn-air, Pb/$HClO_4$ and Lithium-ion battery, Applications of Li-ion battery to electrical vehicles. Fuel Cells- Differences between battery and a fuel cell, Construction and applications of Methanol Oxygen fuel cell and Solid oxide fuel cell.

Corrosion: Causes and effects of corrosion – theories of chemical and electrochemical corrosion – mechanism of electrochemical corrosion. Types of corrosion: Galvanic, Water line and Pitting corrosion. Factors affecting rate of corrosion, Corrosion control methods-Cathodic protection – Sacrificial anode and impressed current methods.

Unit - III Polymeric Materials

Definition – Classification of polymers with examples – Types of polymerization – addition (free radical addition) and condensation polymerization with examples – Nylon 6:6, Terylene

Plastics: Definition and characteristics- thermoplastic and thermosetting plastics, Preparation, Properties and engineering applications of PVC and Bakelite, Teflon, Fiber reinforced plastics (FRP).

Rubbers: Natural rubber and its vulcanization.

Elastomers: Characteristics –preparation – properties and applications of Buna-S, Butyl and Thiokol rubber.

Conducting polymers: Characteristics and Classification with examples-mechanism of conduction in trans-polyacetylene and applications of conducting polymers.

Biodegradable polymers: Concept and advantages - Polylactic acid and poly vinyl alcohol and their applications.

Unit - IV Energy Sources

Calorific value of fuel – HCV, LCV- Dulongs formula. Classification- solid fuels: coal – analysis of coal – Proximate and Ultimate analysis and their significance. Liquid fuels – petroleum and its refining, cracking types – moving bed catalytic cracking. Knocking – octane and cetane rating, Gaseous fuels – composition and uses of natural gas, LPG and CNG, Biodiesel – Transesterification, advantages. Hydrogen as fuel-Production, Storage & applications.

Unit - V Engineering Materials

Composites: Introduction- Constituents of composites – advantages, classification and constituents of composites. Applications of composites.

Smart Materials and Engineering Applications: Smart Materials- Classification- (Piezo-electric materials, Shape Memory Alloys, Thermo response Materials, Magnet orhetroic Materials, Smart Polymers) SMAs-Nitinol. Thermo response materials- Poly vinyl amides.

Lubricants: Classification of lubricants with examples-characteristics of a good lubricants - mechanism of lubrication (thick film, thin film and extreme pressure)- properties of lubricants: viscosity, cloud point, pour point, flash point and fire point.

TEXT BOOKS

1. P.C. Jain and M. Jain, Engineering Chemistry, 16th Edition, 2010, Dhanpatrai Publishing.
2. Shashi Chawla, A textbook of Engineering Chemistry, 3rd Edition, 2011, Dhanpatrai and Company (P) Ltd. Delhi.

3. Shikha Agarwal, Engineering Chemistry-Fundamentals and Applications, 2nd Edition, 2015, Cambridge University Press, Delhi.
4. B. Rama Devi, P. Aparna, Prasanta Rath, Engineering Chemistry, 1st Edition, 2022, Cengage Publications.

REFERENCE BOOKS

1. H.D. Gesser, Applied Chemistry: A Textbook for Engineers and Technologists, 1st Edition, 2002, Springer New York.
2. Jaya Shree Anireddy, Textbook of Engineering Chemistry, 1st Edition, 2018, Wiley.
3. M. Thirumala Chary, E. Laxminarayana, Engineering Chemistry, 3rd Edition, 2016, Scitech Publishers.

B.Tech. I Year I Semester

Course Code	Course Title	L	T	P	Credits
EE103ES	**C PROGRAMMING AND DATA STRUCTURES**	3	0	0	3

Course Description: The course covers the fundamentals of C programming, control structures, functions, derived data types and files concepts. It also focuses on various data structures, such as linked lists, stacks, queues and their implementation in C.

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

C103.1: Explore the basic constructs of C Programming Language.

C103.2: Implement control structures & apply the concepts of modular programming.

C103.3: Develop C programs to demonstrate the applications of derived data types such as arrays and pointers

C103.4: Apply the knowledge of various string handling functions.

C103.5: Explore user defined data types and file handling functions using C.

C103.6: Describe Linear data structures used for problem solving.

Unit - I Introduction to Programming

Introduction to Computers – Computer Systems, Computing Environments, Computer Languages, Creating and running programs, Representation of an algorithm, flowchart and Pseudocode.

Introduction to C Language – Background, Simple C programs, Identifiers, Basic data types, Variables, Constants, Input / Output.

Structure of a C Program – Operators, Expressions, Precedence and Associatively, Expression Evaluation, Type conversions.

Unit - II Control Statements, Functions and Arrays

Statements – if and switch statements, Repetition statements – while, for, do-while statements, Loop examples, other statements related to looping – break, continue, go to.

Designing Structured Programs-Functions, basics, user defined functions, inter function communication, standard functions, Recursion.

Arrays – Concepts, using arrays in C, inter function communication, array applications, two – dimensional arrays, multidimensional arrays, searching and sorting.

Unit - III Pointers and Strings

Pointers – Introduction, Pointers for inter function communication, pointers to pointers, compatibility, Pointer Applications – Passing an array to a function, Memory allocation functions, array of pointers.

Strings – Concepts, C Strings, String Input / Output functions, arrays of strings, string manipulation functions, string / data conversion.

Unit - IV Structures and File Handling

Derived types –The Typedef, enumerated types, Structures – Declaration, definition and initialization of structures, accessing structures, operations on structures, complex structures.

Unions – Referencing unions, initializers, unions and structures.
Input and Output – Text vs Binary streams, standard library functions for files, converting file types, File programs – copy, merge files.

Unit - V Data Structures

Data Structures – Introduction to Data Structures, abstract data types, Linear list – singly linked list implementation, insertion, deletion and searching operations on linear list, Stacks-Operations, array and linked representations of stacks, stack applications, Queues-operations, array and linked representations.

TEXT BOOKS

1. B.A.Forouzan and R.F. Gilberg, C Programming & Data Structures, 3rd Edition, Cengage Learning.
2. J.R. Hanly and E.B. Koffman, Problem Solving and Program Design in C, 5th Edition, Pearson Education.
3. B.W. Kernighan and Dennis M.Ritchie, The C Programming Language, PHI/Pearson Education.

REFERENCE BOOKS

1. P. Padmanabham, C & Data structures, 3rd Edition, B.S. Publications.
2. J.A. Jones & K. Harrow, C Programming with problem solving, Dreamtech Press
3. Stephen G. Kochan, Programming in C, 3rd Edition, Pearson Education.
4. H. Cheng, C for Engineers and Scientists, McGraw-Hill International Edition
5. A. M. Tanenbaum, Y. Langsam, and M.J. Augenstein, Data Structures using C, Pearson Education / PHI
6. E. Balagurusamy, C Programming & Data Structures, TMH.
7. P. Dey, M Ghosh R Thereja, C Programming & Data Structures, Oxford University Press.
8. E V Prasad and N B Venkateswarlu, C & Data structures, S. Chand & Co.

B.Tech. I Year I Semester

Course code	Course Title	L	T	P	Credits
EE104ES	ELECTRICAL CIRCUIT ANALYSIS - I	3	0	0	3

Course Description: This is the first undergraduate course in electric circuits and it is a foundation course for all subjects of the Electrical Engineering discipline. This course begins with the basic introduction of all the elements in electrical Engineering and later with its connections and analysis. AC circuit analysis is studied for both single phase and Poly phase circuits too. Various electrical circuit theorems are analyzed in this subject.

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

C104.1: Analyze DC electrical networks using different approaches.

C104.2: Analyze AC electrical networks using different approaches.

C104.3: Solve the DC electrical circuits using various theorems.

C104.4: Solve the AC electrical circuits using various theorems.

C104.5: Analyze the Poly phase circuits for both balanced and unbalanced loads.

C104.6: Analyze magnetic circuits and form Dual Networks.

Unit - I Network Elements & Laws

Active elements, Independent and dependent sources. Passive elements - R, L and C, Energy stored in inductance and capacitance, Kirchhoff's laws, Source transformations, Star-delta transformations, Node voltage method, Mesh current method including super node and super mesh analysis.

Unit - II Single Phase Circuits and Resonance

RMS and Average values of periodic sinusoidal and non- sinusoidal waveforms, Phasor representation, Steady-state response of series, parallel and series-parallel circuits. Impedance, Admittance, Current locus diagrams of RL and RC series with variation of parameters.

Resonance: Series and parallel circuits, Bandwidth and Q-factor.

Unit - III Network Theorems

Superposition theorem, Thevenin's theorem, Norton's theorems, Maximum power transfer theorem, Tellegen's theorem, Compensation theorem, Millman's theorem and Reciprocity theorem. (AC &DC)

Unit - IV Poly Phase Circuits

Analysis of balanced and unbalanced 3-phase circuits, Star and delta connections, Measurement of Three Phase power for balanced and unbalanced loads.

Unit - V Coupled Circuits and Duality

Concept of self and mutual inductance, Dot convention, Coefficient of coupling, Analysis of circuits with mutual inductance, Applications to Transformers.

Concepts of Duality and Dual Networks.

TEXT BOOKS

1. Van Valkenburg M.E, Network Analysis, 3rd Edition, 2000, Prentice Hall of India.
2. Ravish R Singh, Network Analysis and Synthesis, 2nd Edition, 2019, McGraw Hill.

REFERENCE BOOKS

1. B. Subramanyam, Electric Circuit Analysis, 2021, Dreamtech Press & Wiley.
2. James W. Nilsson, Susan A.Riedel, Electric Circuits, 11th Edition, 2020, Pearson.
3. A Sudhakar, Shyammohan S Palli, Circuits and Networks: Analysis and Synthesis, 5th Edition, 2017, McGraw Hill.
4. Jagan N.C, Lakshminarayana C, Network Analysis, 3rd Edition, 2014, B.S. Publications.
5. William Hayt H, Kimmerly Jack E and Steven Durbin M, Engineering Circuit Analysis, 6th Edition, 2002, McGraw Hill.
6. Chakravarthy A., Circuit Theory, First Edition, 1999, Dhanpat Rai &Co.

B.Tech. I Year I Semester

Course Code	Course Title	L	T	P	Credits
EN105HS	**ENGLISH FOR SKILL ENHANCEMENT**	2	0	0	2

Course Description: With the growing importance of English as a tool for global technical communication and the consequent emphasis on training students to acquire language skills, the syllabus of English has been designed to develop the linguistic, communicative, creative and critical thinking competencies of Engineering students. In English classes, the focus should be on the skills development in the areas of vocabulary, grammar, reading and writing. For this, the teachers should use the prescribed text for detailed study. The students should be encouraged to read the texts leading to reading comprehension and different passages may be given for practice in the class. The time should be utilized for working out the exercises given after each excerpt, and also for supplementing the exercises with authentic materials of a similar kind, for example, newspaper articles, advertisements, promotional material etc. The focus in this syllabus is on skill development.

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

C105.1 Apply English language effectively in spoken and written forms

C105.2 Analyze the given texts and essence of poem, respond appropriately

C105.3 Apply various grammatical structures in personal and academic fronts.

C105.4 Develop appropriate vocabulary for professional communication

C105.5 Make use of competency in various forms of academic and professional writing.

C105.6 Improve language skills for the enhancement of employability opportunities.

Unit - I Toasted English by R.K. Narayan

Vocabulary: The concept of Word Formation, Prefixes and Suffixes

Grammar: Identifying Common Errors in Writing with Reference to Articles and prepositions

Reading Skills: Reading and Its Importance- Techniques for Effective Reading.

Writing Skills: Sentence Structures -Use of Phrases and Clauses in Sentences- Importance of Proper Punctuation- Techniques for Writing precisely – Paragraph Writing – Types, Structures and Features of a Paragraph - Creating Coherence-Organizing Principles of Paragraphs in Documents**.**

Unit - II Appro JRD by Sudha Murty

Vocabulary: Words Often Confused, Homophones, Homonyms and Homographs & collocations

Grammar: Identifying Common Errors in Writing with Reference to Noun-pronoun and Subject-verb Agreement.

Reading Skills: Sub-Skills of Reading – Skimming and Scanning – Exercises for Practice

Writing Skills: Nature and Style of Writing

Unit - III The Character of a Happy Life by Sir Henry Wotton(Poem)

Vocabulary: Words Often Misspelt, - Words from Foreign Languages and their Use in English.
Grammar: Identifying Common Errors in Writing with Reference to Misplaced Modifiers and Tenses.
Reading Skills: Sub-Skills of Reading – Intensive Reading and Extensive Reading – Exercises for Practice.
Writing Skills: Format of a Formal Letter-Writing Formal Letters E.g.., Letter of Complaint, Letter of Requisition, Email Etiquette, Job Application with CV/Resume.

Unit - IV Art and Literature by Abdul Kalam

Vocabulary: Standard Abbreviations in English.

Grammar: Redundancies and Clichés in Oral and Written Communication

Reading Skills: Reading Techniques- Survey, Question, Read, Recite and Review (SQ3R Method) - Exercises for Practice

Writing Skills: Writing Practices- Essay Writing-Writing Introduction, Body and Conclusion

Unit - V Go, Kiss the World by Subroto Bagchi

Vocabulary: Technical Vocabulary and their Usage

Grammar: Common Errors in English (*Covering all the other aspects of grammar which were not covered in the previous units*)

Reading Skills: Reading Comprehension-Exercises for Practice

Writing Skills: Technical Reports- Introduction – Characteristics of a Report – Categories of Formats- Structure of Reports (Manuscript Format) -Types of Reports - Writing a Report.

TEXT BOOKS

1. Board of Editors English: Language, Context and Culture, Orient Black Swan Pvt. Ltd, Hyderabad. 2022. Print.

REFERENCE BOOKS

1. Liss and Davis, Effective Academic Writing, 2nd Edition, 2017, Oxford University Press.
2. Wood F.T, Remedial English Grammar, 2017, 2nd Edition, Macmillan.
3. Wiley, Technical Communication, 2019, India Pvt. Ltd.
4. Swan, Michael, Practical English Usage, 4th Edition, 2016, Oxford University Press.

B. Tech. I Year I Semester

Course Code	Course Title	L	T	P	Credits
EE106ES	ELEMENTS OF ELECTRICAL AND ELECTRONICS ENGINEERING	0	0	2	1

Course Description: This lab deals with the understanding basic concepts in Electrical and Electronics Engineering. It begins with the basic electric circuits, covering theorems and then machines. Basic electronics circuits and PCB design of circuits are worked in this lab. Concepts of PV Cell, Control systems and Power system are also covered.

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

C106.1: Verify the basic Electrical circuits with theorems.

C106.2: Perform experiments on three phase systems.

C106.3: Perform experiments on basic electronic circuits.

C106.4: Evaluate the performance calculations of Electrical Machines and Transformers through various testing methods.

List of Experiments/Demonstrations:

PART-A (Compulsory)

1. Verification of KVL and KCL.
2. Verification of Thevenin's and Norton's theorem.
3. Performance Characteristics of a DC Shunt Motor.
4. Measurement of Active Power for Star and Delta connected balanced loads.
5. Determination of Co-efficient of Coupling and Separation of Self and Mutual inductance in a Coupled Circuits.
6. Characteristics of Full wave rectifier.
7. Build PCB for simple circuit.
8. I-V Characteristics of Solar Panel.

PART-B (any two experiments from the given list)

1. Verification of Superposition Theorem.
2. Measurement of Voltage, Current and Real Power in primary and Secondary Circuits of a Single Phase Transformer.
3. Single Phase Bridge inverter with R and RL loads.
4. Study on Single Phase energy Meter.
5. Demonstration of Temperature controller using PID.
6. Demonstration of transmission line model.
7. Demonstrate working function of SPST and DPST switches.

B.Tech. I Year I Semester

Course Code	Course Title	L	T	P	Credits
CH107BS	**ENGINEERING CHEMISTRY LABORATORY**	0	0	2	1

Prerequisites

Course Description: The Engineering Chemistry Laboratory is a practical course designed to provide students with hands-on experience in conducting chemical experiments relevant to engineering applications. This laboratory-based course aims to reinforce the theoretical concepts learned in the engineering chemistry lecture course and develop students' practical skills in chemical analysis, synthesis, and material testing.

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

- **C107.1:** Analysis of materials using small quantities of materials involved for quick and accurate results
- **C107.2:** Interpret a new application by the analysis of physical principle involved in various instruments.
- **C107.3:** Develop experimental skills in building technological advances by qualitative and quantitative analysis of materials.
- **C107.4:** Learn and apply basic techniques used in chemistry laboratory for preparation, purification and identification.

List of Experiments

1. Determination of total hardness of water by complex-metric method using EDTA.
2. Estimation of concentration of an acid by Conductometric titrations.
3. Estimation of concentration of an acid by pH metry.
4. Estimation of Concentration of Ferrous Iron (II) by Potentiometry using $KMnO_4$.
5. Estimation of Concentration of Fluoride ion by UV-Visible spectrometer.
6. Determination of viscosity of lubricant oil by using Ostwald's viscometer.
7. Preparation of Bakelite.
8. Determination of rate of corrosion of mild steel in presence and absence of inhibitor.
9. Determination of Acid value of given coconut oil.
10. Proximate analysis of solid fuel- Coal.

Virtual Lab Experiments

1. Batteries for Electric Vehicles.
2. Conducting Polymers-Study and Working.
3. Smart Materials-Engineering Applications.
4. Construction of Fuel Cell & It's Working.

TEXT BOOKS

1. J. Mendhem, RC. Denney, JD Barnes, M. Thomas, B. Sivasankar, Vogel's Text book of Quantitative Chemical Analysis, 6th Edition, 2009, Pearson Publishing.
2. S. S. Dhara, A Textbook on Experiments and Calculations in Engineering Chemistry, 9th Edition, 2015, S. Chand.
3. B. Ramadevi, P. Aparna, Laboratory Manual in Engineering Chemistry, Special Edition, 2022, S. Chand Publishing.
4. K. Mukkanti, Practical Engineering Chemistry, 1st Edition, 2009, BS Publications.

B.Tech. I Year I Semester

Course Code	Course Title	L	T	P	Credits
EE108ES	**C PROGRAMMING AND DATA STRUCTURES LABORATORY**	0	0	2	1

Course Description: Introduce the importance of programming, C language constructs, and program development. The lab also focuses on implementing various data structures, such as linked lists, stacks, queues.

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

- **C108.1:** Build programs using control structures to solve simple mathematical problems
- **C108.2:** Develop modular and readable C Programs.
- **C108.3:** Solve problems using derived, user defined data types and files
- **C108.4:** Implement linear data structures concepts.

List of Programs:

Cycle 1:

1. Write a C program to find the sum of individual digits of a positive integer.
2. Fibonacci sequence is defined as follows: the first and second terms in the sequence are 0 and 1. Subsequent terms are found by adding the preceding two terms in the sequence.
2. Write a C program to generate the first n terms of the sequence.
3. Write a C program to generate all the prime numbers between 1 and n, where n is a value supplied by the user.
4. Write a C program to find the roots of a quadratic equation.
5. Write a C program to find the factorial of a given integer.
6. Write a C program to find the GCD (greatest common divisor) of two given integers.
7. Write a C program to solve Towers of Hanoi problem.
8. Write a C program, which takes two integer operands and one operator from the user, performs the operation and then prints the result. (Consider the operators +, -, *, /, % and use Switch Statement)
9. Write a C program to find both the largest and smallest number in a list of integers.
10. Write a C program that uses functions to perform the following:
    i. Addition of Two Matrices
    ii. Multiplication of Two Matrices
11. Write a C program that implements the following sorting methods to sort a given list of integers in ascending order.
    i. Bubble sort
    ii. Selection sort
    iii. Insertion sort
12. Write C programs that use both recursive and non-recursive functions to perform the following searching operations for a Key value in a given list of integers:
    i. Linear search
    ii. Binary search

Cycle 2:

1. Write a C program that uses functions to perform the following operations:
   i. To insert a sub-string in to a given main string from a given position.
   ii. To delete n Characters from a given position in a given string.
2. Write a C program to determine if the given string is a palindrome or not
3. Write a C program that displays the position or index in the string S where the string T begins, or – 1 if S doesn't contain T.
4. Write a C program to count the lines, words and characters in a given text.
5. Write a C program to generate Pascal's triangle.
6. Write a C program to construct a pyramid of numbers.
7. Write a C program that uses functions to perform the following operations:
   i. Reading a complex number
   ii. Writing a complex number
   iii. Addition of two complex numbers
   iv. Multiplication of two complex numbers
   (Note: represent complex number using a structure.)
8. i) Write a C program which copies one file to another.
   ii) Write a C program to reverse the first n characters in a file.
   (Note: The file name and n are specified on the command line.)
9. i) Write a C program to display the contents of a file.
   ii) Write a C program to merge two files into a third file
   (i.e., the contents of the first file followed by those of the second are put in the third file)
10. Write a C program that uses functions to perform the following operations on singly linked list.
    i. Creation
    ii. Insertion
    iii. Deletion
    iv. Traversal
11. Write C programs that implement stack (its operations) using
    i. Arrays
    ii. Pointers
12. Write C programs that implement Queue (its operations) using
    i. Arrays
    ii. Pointers

TEXT BOOKS

1. B.A. Forouzan and R. F. Gilberg, C Programming & Data Structures, 3rd Edition, Cengage Learning.
2. Yeswanth Kanitkar, Let us C.
3. E. Balaguruswamy, C Programming.

B.Tech. I Year I Semester

Course Code	Course Title	L	T	P	Credits
EN109HS	ENGLISH LANGUAGE AND COMMUNICATION SKILLS LABORATORY	0	0	2	1

Course Description: The course aims an in-depth look into English articulation and its sound system, thus developing your sensitivity to all aspects of English pronunciation. Students develop their listening skills to appreciate its role in the LSRW skills approach to language and improve their pronunciation. Students able to express themselves fluently and appropriately in social and professional contexts.

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

C109.1: Understand the nuances of English language through audio - visual experience

C109.2: Apply soft skills effectively while working in group activities

C109.3: Create neutralize accent for intelligibility

C109.4: Understand and discuss with clarity and confidence which in turn enhances their employability skills

Listening Skills

Objectives

1. To enable students, develop their listening skills to appreciate its role in the LSRW skills approach to language and improve their pronunciation.
2. To equip students with necessary training in listening so that they can comprehend the speech of people of different backgrounds and regions.

Students should be given practice in listening to the sounds of the language, to be able to recognize them and find the distinction between different sounds, to be able to mark stress and recognize and use the right intonation in sentences.

- Listening for general content
- Listening to fill up information
- Intensive listening
- Listening for specific information

Speaking Skills

Objectives

1. To involve students in speaking activities in various contexts

2. To enable students express themselves fluently and appropriately in social and professional contexts

- Oral practice: Just A Minute (JAM) Sessions
- Describing objects/situations/people
- Role play – Individual/Group activities
- Group Discussions
- Debate

Exercise-1

CALL Lab:

Understand: Listening Skill- Its importance – Purpose- Process- Types- Barriers- Effective Listening.

Practice: Introduction to Phonetics–Speech Sounds–Vowels and Consonants–Minimal Pairs-Consonant Clusters-Past Tense Marker and Plural Marker-*Testing Exercises*

ICS Lab:

Understand: Spoken vs. Written language- Formal and Informal English.

Practice: Ice-Breaking Activity and JAM Session - Situational Dialogues–Greetings–Taking Leave – Introducing Oneself and Others.

Exercise II

CALL Lab:

Understand: Structure of Syllables –Word Stress–Weak Forms and Strong Forms–Stress pattern in sentences– Intonation.

Practice: Basic Rules of Word Accent– Contractions –Stress Shift-Weak Forms and Strong Forms – Intonation in context -*Testing Exercises*

ICS Lab:

Understand: Features of Good Conversation–Strategies for Effective Communication.

Practice: Situational Dialogues–Role Play-Expressions in Various Situations–Making Requests and Seeking Permission-Telephone Etiquette

Exercise III

CALL Lab:

Understand: Errors in Pronunciation-Neutralizing Mother Tongue Interference (MTI).

Practice: Common Indian Variants in Pronunciation–Differences between British and American Pronunciation-*Testing Exercises*

ICS Lab:

Understand: Descriptions-Narrations-GivingDirectionsandGuidelines–BlogWriting-Netiquette

Practice: Giving Instructions–Seeking Clarifications–Asking for and Giving Directions–Thanking and Responding in a forum–Agreeing and Disagreeing–Seeking and Giving Advice –Making Suggestions.

Exercise-IV

CALL Lab:

Understand: Listening for Specific Details.

Practice: Listening Comprehension Tests-*Testing Exercises*

ICS Lab:

Understand: Public Speaking–Structured Talks - signposting in speech-Non-verbal Communication-Presentation Skills.

Practice: Making a Short Speech – Extempore-Making a Presentation

Exercise-V

CALL Lab:

Understand: Listening for Inference *(focus on implicit meaning)*

Practice: Listening Comprehension Tests-*Testing Exercises*

ICS Lab:

Understand: Introduction to Group Discussion & Interview Skills

Practice: Group Discussion & Mock Interviews

Minimum Requirement of Infrastructural Facilities for ELCS Lab:

1. **Computer Assisted Language Learning (CALL) Lab:**

The Computer Assisted Language Learning Lab has to accommodate 40 students with 40 systems, with one Master Console, LAN facility and English language learning software for self- study by students.

System Requirement (Hardware component):

Computer network with LAN facility (minimum 40 systems with multimedia) with the following specifications:

i) Computers with Suitable Configuration

ii) High Fidelity Headphones

2. **Interactive Communication Skills (ICS) Lab:**

The Interactive Communication Skills Lab: A Spacious room with movable chairs and audio-visual aids with a Public Address System, a T. V. or LCD, a digital stereo –audio & video system and camcorder, etc.

Source of Material (Master Copy):

- *Exercises in Spoken English. Part1, 2, 3*. CIEFL and Oxford University Press

Note: Teachers are requested to make use of the master copy and get it tailor-made to suit the contents of the syllabus.

SUGGESTED SOFTWARE

- Cambridge Advanced Learners' English Dictionary with CD.
- Grammar Made Easy by Darling Kindersley.
- Punctuation Made Easy by Darling Kindersley.
- Oxford Advanced Learner's Compass, 10th Edition.
- English in Mind (Series1-4), Herbert Puchta and Jeff Stranks with Meredith Levy, Cambridge.
- English Pronunciation in Use (Elementary, Intermediate, Advanced) Cambridge University Press.
- English Vocabulary in Use (Elementary, Intermediate, Advanced) Cambridge University Press.
- TOEFL & GRE (KAPLAN, AARCO &BARRONS, USA, Cracking GRE by CLIFFS).
- Digital All
- Orell Digital Language Lab (Licensed Version)

REFERENCE BOOKS

1. Y. Prabhavathi, People Interface: English Language Communication Skills Manual / Workbook, 1st Edition, 2023, CL India.
2. Board of Editors, ELCS Lab Manual A Workbook for CALL and ICS Lab Activities Orient Black Swan Pvt. Ltd.
3. Shobha K.N & Rayen J.Lourdes, Communicative English A workbook, 2019, Cambridge University Press.

B.Tech. I Year II Semester

Course Code	Course Title	L	T	P	Credits
MA201BS	ORDINARY DIFFERENTIAL EQUATIONS AND VECTOR CALCULUS	3	1	0	4

Prerequisites Mathematical Knowledge at pre-university level

Course Description: The course contains various topics related to Exact differential equations, Orthogonal trajectories, Newton's law of cooling, Natural growth and decay, Second order linear differential equations with constant coefficients and their models, Equations reducible to linear ODE with constant coefficients, Applications to Electric Circuits, Laplace Transforms and their application, Vector point functions and scalar point functions, Vector Differentiation, Vector Integral theorems and their applications.

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

C201.1: Solve first order Ordinary differential equations by analytical methods.

C201.2: Solve higher Ordinary differential equations by analytical methods.

C201.3: Find Laplace and inverse Laplace transform of given functions and solve ODEs byapplying Laplace Transform

C201.4: Calculate divergence, curl of a vector point function and gradient of scalar point function.

C201.5: Apply and verify Gauss, Green's & Stoke's theorems and find volume, surface of the solid and work done by force.

C201.6: Evaluate the line, surface & volume integrals and converting them from one to another

Unit - I First Order Ordinary Differential Equations

Exact differential equations, Equations reducible to exact differential equations, linear and Bernoulli'sequations, Orthogonal Trajectories (only in Cartesian Coordinates). Applications: Newton's law of cooling, Law of natural growth and decay.

Unit - II Ordinary Differential Equations Of Higher Order

Second order linear differential equations with constant coefficients: Non-Homogeneous terms of thetype e^{ax}, sinax, cosax, polynomials in x, (x), and $x(x)$, Method of variation of parameters.

Equations reducible to linear ODE with constant coefficients: Legendre's equation, Cauchy-Eulerequation. Applications: Electric Circuits

Unit - III Laplace Transforms

Laplace Transforms: Laplace Transform of standard functions, First shifting theorem, Second shiftingtheorem, Unit step function, Dirac delta function, Laplace transforms of functions when they are multiplied and divided by 't', Laplace transforms of derivatives and integrals of function, Evaluation ofintegrals by Laplace transforms, Laplace transform of periodic functions, Inverse Laplace transform bydifferent methods, convolution theorem (without proof). Applications: solving Initial value problems by Laplace Transform method.

Unit - IV Vector Differentiation

Vector point functions and scalar point functions, Gradient, Divergence and Curl, Directional derivatives, Tangent plane and normal line, Vector Identities, Scalar potential functions, Solenoidal and Irrotational vectors.

Unit - V Vector Integration

Line, Surface and Volume Integrals, Vector Integral theorems: Green, Gauss and Stokes (without proofs) and their applications.

TEXT BOOKS

1. B.S. Grewal, Higher Engineering Mathematics, 36th Edition, 2010, Khanna Publishers.
2. R.K. Jain and S.R.K. Iyengar, Advanced Engineering Mathematics, 5th Edition, 2016 Narosa Publications.

REFERENCE BOOKS

1. Erwin Kreyszig, Advanced Engineering Mathematics, 9th Edition, 2006, John Wiley & Sons.
2. G.B. Thomas and R.L. Finney, Calculus and Analytic Geometry, 9th Edition, 2002, Pearson.
3. N.P. Bali and Manish Goyal, A text book of Engineering Mathematics, 2008, Laxmi Publications, reprint.
4. H. K. Dass and Er. Rajnish Verma, Higher Engineering Mathematics, S Chand and Company Limited, New Delhi.

B.Tech. I Year II Semester

Course Code	Course Title	L	T	P	Credits
PH202BS	**APPLIED PHYSICS**	3	1	0	4

Prerequisite Nil

Course Description: This course consists of principles of Quantum mechanics with advanced topics in their respective engineering branches. It introduces the principles of semiconductors and some widely used semiconductor devices for various applications. It introduces fundamental concepts related to the dielectric, magnetic and energy harvesting materials. It introduces the importance of Lasers, optical fibers with propagation characteristics. It also introduces the fundamentals of nanotechnology and various material growth and characterization techniques.

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

- **C202.1:** Understand the physical world from a fundamental point of view by the concepts of quantum mechanics.
- **C202.2:** Identify the role of semiconductor devices in science and technology applications.
- **C202.3:** Explore the fundamental properties of dielectric, magnetic and energy materials for device applications.
- **C202.4:** Understand various aspects of Lasers and their applications in diverse fields.
- **C202.5:** Explain the principle of optical fibres and their significance in communication
- **C202.6:** Appreciate the features and applications of nanomaterials.

Unit - I Principles Of Quantum Mechanics

Quantum Mechanics: Introduction, blackbody radiation – Stefan-Boltzmann's law, Wein's and Rayleigh-Jean's law (qualitative) - Planck's radiation law - photoelectric effect – De-Broglie hypothesis - matter waves - Davisson and Germer experiment –Heisenberg uncertainty principle – time independent Schrodinger wave equation - Born interpretation of the wave function - particle in a 1-D potential well.

Unit - II Semiconductors And Devices

Intrinsic and extrinsic semiconductors – Hall effect – construction, working principle and characteristics of P-N Junction diode, Zener diode and Bipolar Junction Transistor (BJT) – direct and indirect band gap semiconductors – LED – photodiodes: PIN photodiode, avalanche photodiode (APD) and solar cells: structure, materials, working principle and characteristics.

Unit - III Dielectric And Magnetic Materials

Dielectric Materials: Basic definitions - types of polarizations (qualitative) - ferroelectric, piezoelectric and pyroelectric materials – applications - liquid crystal displays (LCD) and crystal oscillators.

Magnetic Materials: Origin of the magnetic moment - classification of magnetic materials - domain theory of ferromagnetism - hysteresis - soft and hard magnetic materials – magneto-striction, magnetoresistance – applications – magnetic field sensors and multiferroics.

Unit - IV Lasers And Fiber Optics

Lasers: Laser beam characteristics - three quantum processes - Einstein coefficients and their relations - laser components - lasing action - pumping methods - Types of Lasers: Ruby laser, Nd:YAG laser, He-Ne laser, CO_2 laser - semiconductor laser – applications.

Fiber Optics: Introduction - total internal reflection - construction of optical fiber - acceptance angle - numerical aperture - classification of optical fibers - losses in optical fiber - optical fiber for communication system – advantages and applications.

Unit - V Nanotechnology

Introduction - Nanoscale, surface-to-volume ratio, quantum confinement - bottom-up approach: sol-gel and precipitation methods – top-down approach: ball milling, physical vapor deposition (PVD) and chemical vapor deposition (CVD) - characterization techniques - XRD, SEM &TEM - applications of nanomaterials.

TEXT BOOKS

1. M. N. Avadhanulu, P.G. Kshirsagar & TVS Arun Murthy, A Text book of Engineering Physics, 11th Edition, 2019, S.Chand Publications.
2. B.K. Pandey and S. Chaturvedi, Engineering Physics, 2nd Edition, 2022, Cengage Learning.
3. Donald A, Neamen, Semiconductor Physics and Devices - Basic Principle, 4th Edition, 2021Mc Graw Hill.
4. Narasimha Reddy Katta, Essentials of Nanoscience & Nanotechnology,1st Edition, 2021, Typical Creatives NANO DIGEST.

REFERENCE BOOKS

1. H.C. Verma, Quantum Physics, 2nd Edition, 2012, TB.
2. Halliday, Resnick and Walker, Fundamentals of Physics, 11th Edition, 2018, John Wiley &Sons.
3. A. K. Bandyopadhyay, Nano Materials, 1st Edition, 2007, New Age International.

B. Tech. I Year Semester II

Course Code	Course Title	L	T	P	Credits
ME203ES	COMPUTER AIDED ENGINEERING GRAPHICS	1	0	4	3

Prerequisite Nil

Course Description: To acquire computer-aided drafting skill set and to build the ability to visualize various objects through traditional drawing practice in order to communicate concepts and ideas in the design of engineering products.

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

C203.1: Construct different types of non-circular curves and scales used in various engineering applications.

C203.2: Analyze the projections of points and lines.

C203.3: Analyze the projections of planes and solids.

C203.4: Apply different types of sectional planes to get the interior features of the objects bymeans of sectional views.

C203.5: Develop the surfaces to fabricate the objects

C203.6: Identify orthographic, Isometric projections and various CAD commands.

Unit - I

Introduction to Engineering Graphics: Principles of Engineering Graphics and their Significance, Geometrical Constructions

Scales: Plain & diagonal

Conic Sections: Conic Sections including the rectangular hyperbola- General methods only

Cycloidal curves: Cycloid, Epicycloid and Hypocycloid -General methods only.

Unit - II

Orthographic Projections: Principles of orthographic projections- conventions- Projectionsof points in all positions.

Projection of straight lines: Line inclined to one reference plane and with two reference planes

Unit - III

Projections of Planes: Projections of Plane geometric figures.

Projections of Regular Solids: Projections of solids (prisms, pyramids, cylinders and cones) in simpleposition and axis inclined to one reference plane and with two reference plane.

Introduction to computer aided drafting: (For internal evaluation weightage only)

Introduction to AutoCAD Software: The Menu System, Toolbars (Standard, Object Properties, Draw)

Unit - IV

Section of Regular solids: Section or Sectional views of Right Regular Solids- Prism, Cylinder,Pyramid and Cone.

Development of Surfaces of Right Regular Solids

Unit - V

Isometric Projections: Principles of Isometric Projection – Isometric Scale Isometric Views – Isometric views of Lines, Planes and Simple Solids only. Orthographic Views: Conversion of Isometric Views to Orthographic Views and Vice-Versa.

Auto CAD Software: (For internal evaluation weightage only)

Toolbars (Modify and Dimension), Drawing Area (Background, Crosshairs, Coordinate System), Dialog boxes and windows, Shortcut menus (Button Bars), The Command Line, The Status Bar, Different methods of zoom as used in CAD, Select and erase objects.

TEXT BOOKS

1. N. D. Bhatt, V. M. Panchal and Pramod R. Ingle, Engineering Drawing, 53rd Edition, 2016, Charotar Publishing House Pvt. Limited.
2. Agrawal, Basant and C. M. Agrawal, Engineering Drawing, 3rd Edition, 2020, Tata McGraw Hill Education (India).
3. Venugopal. K, Sreekanjana. G, Engineering Drawing, 2nd Edition, 2011, New Age International.
4. Jeyapoovan, T, Engineering drawing & Graphics Using AutoCAD, 3rd Edition, 2010, Vikas Publishing House.

REFERENCE BOOKS

1. Parthasarathy N. S, and Vela Murali, Engineering drawing, 1st Edition, 2015, Oxford University Press.
2. Balaveera Reddy. K, Computer Aided Engineering Drawing, 2nd Edition, 2015, CBS Pvt. Limited.

Note: Syllabus for external examination will be from 1-5 units in conventional mode and introduction to computer aided drafting is exempted from the external examination.

B. Tech. I Year Semester II

Course Code	Course Title	L	T	P	Credits
ME204ES	**ENGINEERING WORKSHOP**	0	1	3	2.5

Course Description: Engineering workshop demonstrates about how different working tools, machinery, and equipment are operated, applied, and used. Acquire the essential knowledge necessary to manufacture a variety of engineering products. To provide students with hands-on practice using a variety of engineering materials, tools, equipment, and processes that is widely utilized in the engineering field. To encourage optimism, cooperation, accuracy, and safety at work. To gain knowledge of various hand-powered tools, their uses, and how they function.

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

C204.1: Distinguish carpentry, fitting, black smithy and welding manufacturing processes.

C204.2: Develop house hold and engineering goods from metallic sheets in tin smithy.

C204.3: Apply basic electrical engineering knowledge for house wiring practice.

C204.4: Construct a sand mould for a given pattern using foundry tools.

I-TRADES FOR EXERCISES: At least two exercises from each trade:

Cycle 1:

1. Tin Smithy – (Square Tin, Rectangular Tray & Conical Funnel)
2. Foundry – (Preparation of Green Sand Mould using Single Piece and Split Pattern)
3. Carpentry – (T-Lap Joint, Dovetail Joint, Mortise & Tenon Joint)
4. Black Smithy – (Round to Square, Fan Hook and S-Hook

Cycle 2:

5. Fitting – (Square fit, V-Fit & Dovetail Fit)
6. House-wiring – (Parallel & Series, Two-way Switch and Tube Light)
7. Welding Practice – (Arc Welding & Gas Welding)

II-TRADES FOR DEMONSTRATION & EXPOSURE:

Plumbing, Machine Shop, Metal Cutting, Power tools in construction and Wood Working.

TEXT BOOKS

1. Kannaiah. P, Narayana. K. L, Work shop Manual, 2nd Edition, 2013, Scitech.
2. Venkat Reddy, Workshop Manual, 6th Edition, 2008, BSP.

REFERENCE BOOKS

1. Juneja. B. L, Workshop Practice, 2nd Edition, 2016, Cengage Learning India Pvt. Limited.
2. Venugopal. K, Prabhu Raja. V, Sreekanjana. G, Workshop Manual, 1st Edition, 2012, Anuradha.

B.Tech. I Year II Semester

Course code	Course Title	L	T	P	Credits
EE205ES	**ELECTRICAL CIRCUIT ANALYSIS-II**	**2**	**0**	**0**	**2**

Prerequisites Electrical circuit analysis – I, Matrices and Calculus

Course Description: This is the second undergraduate course in electric circuits and it is a foundation course for all subjects of the Electrical Engineering discipline. The emphasis of this course is laid on the transient analysis of DC and AC circuits using classical and Laplace transform approach. This course also deals the significance of two port network parameters, design and analysis of filter circuits.

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

- **C205.1:** Analyze transient response of electrical networks using classical approach.
- **C205.2:** Analyze the networks for standard input functions using Laplace transforms
- **C205.3:** Evaluate two-port network parameters and effect of their inter connections
- **C205.4:** Analyze the effect of inter connections two port networks
- **C205.5:** Analyze the design aspects of various types of filters.
- **C205.6:** Formulate various types of network matrices using graph theory.

Unit - I Transient analysis

Transient response of R, L & C circuits, Formulation of integral differential equations, Initial conditions, Transient Response of RL, RC and RLC (series and parallel) networks subjected to internal energy, Response of RL, RC and RLC circuits to sudden sinusoidal excitations.

Unit - II Electrical Circuit Analysis using Laplace Transforms

Application of Laplace Transforms to RL, RC and RLC (series and parallel) Networks for impulse, step, and ramp, exponential and sudden sinusoidal excitations.

Unit - III Two Port Network Parameters

Open circuit impedance, Short-circuit admittance, Transmission, Hybrid parameters & inter-relationships, Series, Parallel and cascade connection of two port networks. Applications of two port networks.

Unit - IV Filters

Classification of filters – Low pass, High pass, Band pass and Band Elimination, Constant-k and M-derived filters (Elementary treatment only)

Unit - V Topological Description of Networks

Topological Description of Networks: Definitions, Graph, tree, chord, cut-set, tie-set incidence matrix, Basic cut-set and Basic Tie-set matrices for planar networks.

TEXT BOOKS

1. Van Valkenburg M.E, "Network Analysis", 3rd Edition, 2000, Prentice Hall of India.
2. Ravish R Singh, "Network Analysis and Synthesis", 2nd Edition,2019, McGrawHill.

REFERENCE BOOKS

1. James W. Nilsson, Susan A. Riedel, Electric Circuits, 11th Edition, 2020, Pearson.
2. A Sudhakar, Shyammohan S Palli, Circuits and Networks: Analysis and Synthesis, 5th Edition,2017, McGraw Hill.
3. Jagan N.C, Lakshrninarayana C, Network Analysis,3rd Edition, 2014, B.S. Publications.
4. William Hayt H, Kimmerly Jack E. and Steven Durbin M, Engineering Circuit Analysis, 6th Edition, 2002, McGraw Hill.
5. Chakravarthy A., Circuit Theory, First Edition, 1999, Dhanpat Rai &Co.
6. Charles K. Alexander & Matthew N. O. Sadiku, Fundamentals of Electric circuits, 5th edition, 2012, McGraw-Hill.

B.Tech. I Year II Semester

Course Code	Course Title	L	T	P	Credits
EE206ES	APPLIED PYTHON PROGRAMMING LABORATORY	0	1	2	2

Course Description: This Course Covers Installation procedure of python, packages and implementation of different control structures. This course also focuses on installation of OS on Raspberry Pi, importing packages and usage of GPIO pins for collecting sensor data.

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

C206.1: Build basic programs using fundamental programming constructs.
C206.2: Develop reusable code using standard library functions
C206.3: Use different packages for processing data from files and plotting graphs.
C206.4: Implement applications on hardware boards using Python.

List of Programs

Cycle 1:

1. Downloading and Installing Python and Modules
   a) Python 3 on Linux
      Follow the instructions given in the URL https://docs.python-guide.org/starting/install3/linux/
   b) Python 3 on Windows
      Follow the instructions given in the URL https://docs.python.org/3/using/windows.html (Please remember that Windows installation of Python is harder!)
   c) pip3 on Windows and Linux
      Install the Python package installer by following the instructions given in the URL https://www.activestate.com/resources/quick-reads/how-to-install-and-use-pip3/
   d) Installing numpy and scipy
      You can install any python3 package using the command pip3 install <packagename>
   e) Installing jupyterlab
      Install from pip using the command pip install jupyterlab
2. Introduction to Python3
   a) Printing your biodata on the screen
   b) Printing all the primes less than a given number
   c) Finding all the factors of a number and show whether it is a *perfect* number, i.e., the sum of all its factors (excluding the number itself) is equal to the number itself.
3. Defining and Using Functions
   a) Write a function to read data from a file and display it on the screen
   b) Define a boolean function *is palindrome*(<input>)
   c) Write a function *collatz(x)* which does the following: if x is odd, $x = 3x + 1$; if x is even, then $x = x/2$. Return the number of steps it takes for $x = 1$

d) Write a function $N(m, s) = exp(-(x-m)^2/(2s^2))/sqrt(2\pi)s$ that computes the Normal distribution

4. The package numpy
   a) Creating a matrix of given order *m x n* containing *random numbers* in the range 1 to 99999
   b) Write a program that adds, subtracts and multiplies two matrices. Provide an interface such that, based on the prompt, the function (addition, subtraction, multiplication) should be performed
   c) Write a program to solve a system of *n* linear equations in *n* variables using matrix inverse
5. The package scipy and pyplot
   a) Finding if two sets of data have the same *mean* value
   b) Plotting data read from a file
   c) Fitting a function through a set a data points using *polyfit* function
   d) Plotting a histogram of a given data set
6. The strings package
   a) Read text from a file and print the number of lines, words and characters
   b) Read text from a file and return a list of all *n* letter words beginning with a vowel
   c) Finding a secret message hidden in a paragraph of text
   d) Plot a histogram of words according to their length from text read from a file

Cycle 2:

7. Installing OS on Raspberry Pi
   a) Installation using PiImager
   b) Installation using image file
      i. Downloading an Image
      ii. Writing the image to an SD card
      iii. using Linux
      iv. using Windows
      v. Booting up
8. Accessing GPIO pins using Python
   a) Installing GPIO Zero library.
      i. First, update your repositories list:
      ii. sudo apt update
      iii. Then install the package for Python 3:
      iv. sudo apt install python3-gpiozero
   b) Blinking an LED connected to one of the GPIO pin
   c) Adjusting the brightness of an LED
   d) Adjust the brightness of an LED (0 to 100, where 100 means maximum brightness) using the in-built PWM wavelength
9. Collecting Sensor Data
   a) DHT Sensor interface

b) Connect the terminals of DHT GPIO pins of Raspberry Pi.
c) Import the DHT library using import Adafruit_DHT
d) Read sensor data and display it on screen.

REFERENCE BOOKS

1. Pethuru Raj and Anupama C. Raman, The Internet of Things: Enabling Technologies, Platforms, and Use Cases, CRC Press.
2. Vijay Madisetti, Arshdeep Bahga, Internet of Things: A Hands-On Approach
3. Kenneth A. Lambert, Introduction to Python, Cengage.
4. Vamsi Kurama, Python Programming: A Modern Approach, Pearson.
5. Mark Lutz, O'Really, Learning Python.

B.Tech. I Year II Semester

Course Code	Course Title	L	T	P	Credits
PH207BS	**APPLIED PHYSICS LABORATORY**	**0**	**0**	**3**	**1.5**

Prerequisite Nil

Course Description: This course is designed for the students to provide an opportunity for learning through observation, interpretation and application. It includes the instruments related to the Hall Effect, Photoelectric Effect, dielectric constant and B-H curve experiments and their measurements. It introduces the characteristics of various devices such as P-N junction diode, Zener diode, BJT, LED, solar cell, LASERs and optical fibers, measurement of energy gap and resistivity of semiconductor materials.

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

C207.1: estimate the work function of metal using Photoelectric effect and identify the type of semiconductor material whether it is n-type or p-type by Hall effect.

C207.2: determine energy gap and resistivity of semiconductors and draw the characteristics of semiconductor and optoelectronic devices.

C207.3: understand the electrical and magnetic properties of materials

C207.4: demonstrate the working principle of lasers and optical fibers

LIST OF EXPERIMENTS

1. Determination of work function of a metal and Planck's constant using photoelectric effect
2. Determination of Hall co-efficient, carrier concentration and carrier mobility of a given semiconductor
3. Characteristics of series and parallel LCR circuits
4. V-I characteristics of a p-n junction diode and Zener diode
5. Input and output characteristics of BJT (CE / CB configurations)
6. V-I and L-I characteristics of light emitting diode (LED)
7. V-I Characteristics of solar cell
8. Determination of energy gap of a semiconductor using p-n junction diode
9. Determination of the resistivity of semiconductor by two probe method
10. Study B-H curve characteristics of a magnetic material
11. Determination of dielectric constant of a given material
12. a) Determination of the beam divergence of a given LASER beam
    b) Determination of acceptance angle and numerical aperture of an optical fiber

Note: Any 8 experiments are to be performed.

REFERENCE BOOK

1. S. Balasubramanian, M. N. Srinivasan, A Textbook of Practical Physics, 2017, S. Chand.

B.Tech. I Year II Semester

Course code	Course Title	L	T	P	Credits
EE208ES	**ELECTRICAL CIRCUIT ANALYSIS LABORATORY**	**0**	**0**	**2**	**1**

Prerequisites **Electrical Circuit Analysis-I & II**

Course Description: This is the lab course in which course the transient analysis of with DC and AC excitations learned in theory are verified. This course also deals the significance of magnetically coupled circuits and effect of resonance circuits, graph theory, two port network parameters, design and analysis of filter circuits.

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

C208.1: Analyze the time response of R-L-C circuits with DC and AC sources

C208.2: Study the resonance phenomena and filter circuits characteristics

C208.3: Determine the active and reactive power of a three phase electrical networks.

C208.4: Calculate two port network parameters for a given electrical network.

The following experiments are required to be conducted as compulsory

1. To draw the locus Diagrams of RL (R-Varying) and RC (R-Varying) Series Circuits.
2. Transient Response of Series RL and RC circuits for DC excitation
3. Verification of Series and Parallel Resonance.
4. Determination of Two port network parameters – Z & Y parameters.
5. Determination of Two port network parameters – A, B, C, D parameters.
6. Measurement of active power for star and delta connected unbalanced loads.
7. Frequency domain analysis of low-pass filter.
8. Frequency domain analysis of band-pass filter.

In addition to the above eight experiments, at least any two of the experiments from the following list are required to be conducted

9. Measurement of reactive power for Star and Delta connected unbalanced loads.
10. Frequency domain analysis of high-pass filter.
11. Verification Two port network parameters - Hybrid parameters.
12. Locus Diagrams of RL (L-Varying) and RC (C-Varying) Series Circuits.
13. Determination of Time response of first order RL and RC circuit for periodic non – sinusoidal inputs – Time Constant and Steady state error

B.Tech. II Year I Semester

Course Code	Course Title	L	T	P	Credits
MA301BS	NUMERICAL METHODS AND COMPLEX VARIABLES	3	1	0	4

Prerequisites Mathematics courses of first year of study.

Course Description: The course contains the topics Fourier transforms and Fourier series, Solutions of Algebraic and Transcendental equations, Interpolation with equal and unequal intervals, Numerical Integration, Numerical solutions of first order ordinary differential equations, Complex number and their properties.Complex differentiation & related topics and Complex integration.

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

C301.1: Express any periodic function in terms of sine and cosine transforms.

C301.2: Find the root of a given polynomial and transcendental equations.

C301.3: Estimate the value for the given data using interpolation.

C301.4: Find the numerical solutions for a given first order ODE.

C301.5: Analyse the complex function with reference to their analyticity, integration using Cauchy's integral and residue theorems.

C301.6: Taylor's and Laurent's series expansions in complex function.

Unit - I Fourier series & Fourier Transforms

Fourier series - Dirichlet's Conditions - Half-range Fourier series - Fourier Transforms: Fourier Sine and cosine transforms - Inverse Fourier transforms.

Unit - II Numerical Solutions of Algebraic & Transcendental Equations and Interpolation

Solution of polynomial and transcendental equations: Bisection method, Iteration Method, Newton- Raphson method and Regula-Falsi method. Jacobi and Gauss-Seidel iteration methods for solving linear systems of equations. Finite differences: forward differences, backward differences, central differences, symbolic relations and separation of symbols, Interpolation using Newton's forward and backward difference formulae. Central difference interpolation: Gauss's forward and backward formulae, Lagrange's method of interpolation.

Unit - III Numerical Integration

Numerical integration: Trapezoidal rule, Simpson's 1/3rd and 3/8th rules.

Ordinary differential equations: Taylor's series, Picard's method, Euler and modified Euler's methods, Runge - Kutta method of fourth order for first order ODE

Unit - IV Complex Differentiation

Limit, Continuity and Differentiation of Complex functions. Cauchy-Riemann equations (without proof), Milne- Thomson methods, analytic functions, harmonic functions, finding harmonic conjugate, elementary analytic functions (exponential, trigonometric, logarithm) and their properties. (All theorems without Proofs), Conformal mappings, Mobius transformations.

Unit - V Complex Integration

Line integrals, Cauchy's theorem, Cauchy's Integral formula, zeros of analytic functions, singularities, Taylor's series, Laurent's series, Residues, Cauchy Residue theorem and their properties. (All theorems without Proofs)

TEXT BOOKS

1. B.S. Grewal, Higher Engineering Mathematics, 36th Edition,2010, Khanna Publishers.
2. S.S. Sastry, Introductory methods of numerical analysis, 4th Edition, 2005, PHI.

REFERENCE BOOKS

1. M. K. Jain, S.R.K. Iyengar, R.K. Jain, Numerical methods for Scientific andEngineering Computations, New Age International publishers.
2. Erwin Kreyszig, Advanced Engineering Mathematics, 9th Edition, 2006, John Wiley & Sons.
3. J. W. Brown and R. V. Churchill, Complex Variables and Applications, 7thEdition,2004, Mc Graw Hill Publications.

B.Tech. II Year I Semester

Course Code	Course Title	L	T	P	Credits
EE302PC	ELECTRICAL MACHINES-I	3	1	0	4

Prerequisites Electrical Circuit Analysis-I & Electrical Circuit Analysis-II

Course Description: Electrical machines course is one of the important courses of the Electrical discipline. In this course the different types of DC generators and motors which are widely used in industry are covered and their performance aspects will be studied. This course will also facilitate to study of the performance of Transformers.

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

C302.1: Assess the characteristics for different types of DC machines.

C302.2: Compute losses and efficiency of DC machines.

C302.3: Evaluate the types of starters and speed control techniques of DC motors.

C302.4: Illustrate the equivalent circuit parameters for single phase transformer.

C302.5: Evaluate the performance of Transformers under different loading conditions.

C302.6: Distinguish poly phase transformers based on connections.

Unit - I D.C. Generators

Introduction to basics of magnetic circuits - Principle of operation – Action of commutator – constructional features – armature windings – lap and wave windings – simplex and multiplex windings – use of laminated armature – E. M.F Equation.

Armature reaction – Cross magnetizing and de-magnetizing AT/pole – compensating winding –commutation – reactance voltage – methods of improving commutation.

Methods of Excitation – separately excited and self-excited generators – build-up of E.M.F - critical field resistance and critical speed - causes for failure to self-excited and remedial measures. Load characteristics and applications of shunt, series and compound generators.

Unit - II D.C. Motors

Principle of operation – Back E.M.F. - Torque equation – characteristics and application of shunt, series and compound motors – Armature reaction and commutation.

Speed control of D.C. Motors - Armature voltage and field flux control methods.

Motor starters - 3 point and 4 point starters.

Unit - III Testing of D.C. Machines

Losses - Constant and Variable losses –Calculation of efficiency – condition for maximum efficiency - Methods of Testing – direct, indirect, and regenerative testing – Brake test – Swinburne's test – Hopkinson's test –Field's test - separation of stray losses in a D.C. motor.

Unit - IV Single Phase Transformers

Types - constructional details-minimization of hysteresis and eddy current losses- EMF equation - operation on no load and on load - phasor diagrams and Applications.

Equivalent circuit - losses and efficiency – regulation - All day efficiency - effect of variations of frequency & supply voltage on iron losses.

Unit - V Testing of Transformers and Poly-Phase Transformers

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

Open Circuit and Short Circuit tests - Sumpner's test - predetermination of efficiency and regulation-separation of losses test parallel operation with equal and unequal voltage ratios - auto transformers-equivalent circuit - comparison with two winding transformers.

TEXT BOOKS

1. P. S. Bimbhra, Electrical Machinery, 2011, Khanna Publishers.
2. I.J. Nagrath and D. P. Kothari, Electric Machines, 2010, McGraw Hill Education.

REFERENCE BOOKS

1. Prithwiraj Purkait, Indrayudh Bandyopadhyay, Electrical Machines, 2017, Oxford.
2. M. G. Say, Performance and Design of AC Machines, 2002, CBS Publishers.
3. A. E. Fitzgerald and C. Kingsley, Electric Machinery, 2013, McGraw Hill Education, New York.
4. A. E. Clayton and N. N. Hancock, Performance and design of DC machines, 2004, CBS Publishers.
5. J. B. Gupta, Theory and Performance Electrical Machines, 2015, Katsons Book Publisher.
6. S.K. Sahdev, Electrical Machines, 2017, Cambridge University Press.

B.Tech. II Year I Semester

Course Code	Course Title	L	T	P	Credits
EE303PC	ANALOG ELECTRONIC CIRCUITS	3	0	0	3

Prerequisites **Applied Physics, Electrical Circuit Analysis**

Course Description: This Course provides a comprehensive knowledge on characteristics of Diode, Transistor, FET, Operational Amplifier and implementation of various analog circuits like Multi-stage, Power, Feedback amplifiers and Oscillators

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

C303.1: Illustrate the characteristics of PN junction diode and its applications

C303.2: Analyze the construction, characteristics and small signal model of BJT and FET

C303.3: Build different types of multistage amplifiers, differential amplifiers and power amplifiers.

C303.4: Examine the characteristics of different Feedback Amplifiers.

C303.5: Design various sinusoidal oscillator circuits for given frequencies.

C303.6: Design simple analog circuits using Op-Amp.

Unit - I Diode and Bipolar Transistor Circuits

P-N junction diode, I-V characteristics of a diode; review of half-wave and full-wave rectifiers, clamping and clipping circuits. Input output characteristics of BJT in CB, CE, CC configurations, biasing circuits, Load line analysis, common-emitter, common-base and common collector amplifiers; Small signal equivalent circuits.

Unit - II FET Circuits

FET Structure and VI Characteristics, MOSFET structure and I-V characteristics. MOSFET as a switch. Small signal equivalent circuits - gain, input and output impedances, small-signal model and common-source, common-gate and common-drain amplifiers, trans conductance, high Frequency equivalent circuit.

Unit - III Multi-Stage and Power Amplifiers

Direct coupled and RC Coupled multi-stage amplifiers; Differential Amplifiers, Power amplifiers - Class A, Class B, Class C

Unit - IV Feedback Amplifiers and Oscillators

Feedback Amplifiers: Concepts of feedback – Classification of feedback amplifiers – General characteristics of Negative feedback amplifiers – Effect of Feedback on Amplifier characteristics –Voltage series, Voltage shunt, Current series and Current shunt Feedback configurations – Simple problems.

Oscillators: Condition for Oscillations, RC type Oscillators-RC phase shift and Wien-bridge Oscillators, LC type Oscillators –Generalized analysis of LC Oscillators, Hartley and Colpitts Oscillators.

Unit - V Operational Amplifiers

Ideal op-amp, Output offset voltage, input bias current, input offset current, slew rate, gain bandwidth product, Inverting and non-inverting amplifier, Differentiator, integrator, Square-wave and triangular- wave generators.

TEXT BOOKS

1. Jacob Millman, Christos C Halkias, Integrated Electronics, 2nd Edition, 2010, McGraw Hill Education,
2. Ramakanth A. Gayakwad, Op-Amps & Linear ICs, 2003, PHI.

REFERENCE BOOKS

1. Thomas L. Floyd, Electronic Devices Conventional and current version, 2015, Pearson.
2. J. Millman and A. Grabel, Microelectronics, 1988, McGraw Hill Education.
3. P. Horowitz and W. Hill, The Art of Electronics, 1989, Cambridge University Press.
4. P. R. Gray, R. G. Meyer and S. Lewis, Analysis and Design of Analog Integrated Circuits, 2001, John Wiley & Sons.

B.Tech. II Year I Semester

Course Code	Course Title	L	T	P	Credits
EE304PC	POWER SYSTEM - I	3	0	0	3

Prerequisites Electrical Circuit Analysis-I & II, Electrical Machines-I.

Course Description: This course is an introductory subject in the field of electric power systems, to understand the power generation through conventional and non-conventional sources. The emphasis of this course is laid on the Economics of power generation and load tariffs, this course also deals the Overhead line transmission performance analysis by calculating transmission line parameters, AC and DC Distribution system and Indoor, outdoor substations.

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

- **C304.1:** Categorize the sources of power generation.
- **C304.2:** Outline the economic aspects for electrical power generation and loads.
- **C304.3:** Compute transmission line parameters for different configurations.
- **C304.4:** Analyze the Performance of overhead transmission lines using equivalent circuit models.
- **C304.5:** Compute voltage drop in distribution systems based on various requirements & design features.
- **C304.6:** Differentiate the features of various substations

Unit - I Generation of Electric Power

Conventional Sources: Hydro station, Steam Power Plant, Nuclear Power Plant and Gas Turbine Plant, Combined cycle generation (Steam and Gas)

Non-Conventional Sources (Elementary Treatment) Solar Energy, Wind Energy, Fuel Cells, Ocean Energy, Tidal Energy, Wave Energy, and Cogeneration, energy conservation and storage.

Unit - II Economics of Power Generation

Introduction, definitions of connected load, maximum demand, demand factor, load factor, diversity factor, Load duration curve, number and size of generator units. Base load and peak load plants.

Cost of electrical energy-fixed cost, running cost, Revised tariff on charge to customer (Case study for grid integrated RES).

Unit - III Overhead Transmission Line Parameters

Over Head Transmission Lines: Line conductors, inductance and capacitance of single phase and three phase lines with symmetrical and unsymmetrical spacing, Composite conductor's transposition, bundled conductors, and effect of earth on capacitance, skin and proximity effects.

Unit - IV Substations

Air Insulated Substations (AIS): Indoor & Outdoor substations: Substations layout showing the location of all the substation equipment. Bus bar arrangements in the Sub-Stations: Simple arrangements like single bus bar, sectionalized single bus bar, main and transfer bus bar system with relevant diagrams.

Gas Insulated Substations (GIS): Advantages of Gas insulated substations, different types of gas insulated substations, single line diagram of gas insulated substations, bus bar, construction aspects of GIS, Installation and maintenance of GIS, Comparison of Air insulated substations and Gas insulated substations.

Unit - V DC And AC Distribution

D.C. Distribution: Classification of Distribution Systems. Requirements and Design features of Distribution Systems - Voltage Drop Calculations (Numerical Problems) in D.C Distributors for the following cases: Radial D.C Distributor fed one end and at the both the ends (equal/unequal Voltages) and Ring Main Distributor.

A.C. Distribution: Introduction, AC distribution, Comparison of DC vs. AC and Under-Ground vs. Over- Head Distribution Systems. Single phase, 3-phase, 3 phase 4 wire system, bus bar arrangement, Selection of site for substation. Voltage Drop Calculations (Numerical Problems) in A.C. Distributors for the following cases: Power Factors referred to receiving end with respect to load voltages.

TEXT BOOKS

1. C.L. Wadhwa, Electrical Power Systems, 5th Edition, New Age International, 2009.
2. V.K Mehta and Rohit Mehta, Principles of Power Systems, S. Chand & Company Ltd, New Delhi, 2004.
3. R. K. Rajput, Power System Engineering, 1st Edition, LAXMI Publications, 2006.

REFERENCE BOOKS

1. A. Chakrabarti, M.L. Soni, P.V. Gupta, U.S. Bhatnagar, A Text book on Power System Engineering, 2008, Dhanpat Rai Publishing Company (P) Ltd.
2. C.L. Wadhwa, Generation, Distribution and Utilization of Electrical Energy, 2nd Edition, 2009, New Age International.
2. M.V. Deshpande, Elements of Electrical Power Station Design, 3rd Edition, 1998, Wheeler Pub.
3. H.Cotton & H. Barber, The Transmission and Distribution of Electrical Energy, 3rd Edition, 1970.
4. W.D. Stevenson, Elements of Power System Analysis, 4th Edition, 1984, McGraw Hill.

B.Tech. II Year I Semester

Course Code	Course Title	L	T	P	Credits
EE305PC	ELECTROMAGNETIC FIELDS	3	0	0	3

Prerequisites Matrices and Calculus, Applied Physics, Numerical Methods and Complex Variables

Course Description: This course introduces the concepts of electric field and magnetic fields and their applications which will be utilized in the development of the theory for power transmission lines and electrical machines.

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

C305.1: Illustrate the concepts of electromagnetic field theory using fundamental laws

C305.2 Examine the influence of electric fields on conductors, insulators and dielectrics.

C305.3: Compute the Magnetostatic parameters using Biot Savart's and Ampere's circuital laws for different conductor configuration.

C305.4: Calculate Force, Torque and inductance in magnetic fields for electrical engineering applications.

C305.5: Interpret the concepts of Maxwell's equations from electromagnetic fields.

C305.6: Apply Maxwell's equation relating to transmission lines and uniform plane wave propagation.

Unit - I Static Electric Field

Rectangular, Cylindrical, Spherical Coordinate Systems-Transformations, Gradient and Laplacian of a Scalar field, Divergence and Curl of a Vector Field.

Coulomb's law, Electric field intensity, Electrical field due to point charges. Line, Surface and Volume charge distributions. Gauss law and its applications. Absolute Electric potential, potential difference, Calculation of potential differences for different configurations. Electric dipole, Electrostatic Energy and Energy density

Unit - II Conductors, Dielectrics and Capacitance

Current and current density, Ohms Law in Point forms, Continuity equation, Boundary conditions of conductors and dielectric materials. Capacitance, Capacitance of a Spherical Conductor and Co-axial or Cylindrical Cable, Poisson's equation, Laplace's equation, Solution of Laplace and Poisson's equation.

Unit - III Static Magnetic Fields and Magnetic Forces

Biot-Savart Law, Ampere Law, Magnetic flux and magnetic flux density, Scalar and Vector Magnetic potentials. Steady magnetic fields produced by current carrying conductors.

Force on a moving charge, Force on a differential current element, Force between differential current elements, Magnetic boundary conditions, Magnetic circuits, Self-inductances and mutual inductances.

Unit - IV Time Varying Fields and Maxwell's Equations

Faraday's law for Electromagnetic induction, Displacement current, Point form of Maxwell's equation, Integral form of Maxwell's equations, Motional Electromotive forces.

Unit - V Electromagnetic Waves

Derivation of Wave Equation, Uniform Plane Waves, Maxwell's equation in Phasor form, Wave equation in Phasor form, Plane wave in free space and in a homogenous material. Wave equation for a conducting medium, Plane waves in lossy dielectrics, Propagation in good conductors. Poynting theorem.

TEXT BOOKS

1. M.N.O. Sadiku, Elements of Electromagnetics, 2014, Oxford University Publication.
2. W. Hayt, Engineering Electromagnetics, 2012, McGraw Hill Education.

REFERENCE BOOKS

1. A. Pramanik, Electromagnetism-Problems with solution, 2012, Prentice Hall India.
2. G. W. Carter, The Electromagnetic field in its engineering aspects, 1954, Longmans.
3. W. J. Duffin, Electricity and Magnetism, 1980, McGraw Hill Publication.
4. W. J. Duffin, Advanced Electricity and Magnetism, 1968, McGraw Hill.
5. A. Pramanik, Electromagnetism - Theory and applications, 2009, PHI Learning Pvt. Ltd, New Delhi.

B.Tech. II Year I Semester

Course Code	Course Title	L	T	P	Credits
EE306PC	**ELECTRICAL MACHINES LABORATORY-I**	0	0	2	1

Prerequisites Electrical Circuit Analysis-I & Electrical Circuit Analysis-II

Course Description: Electrical Machines Laboratory-I course is to provide the practical exposure on performance of various electrical machines like DC Generators, DC Motors and Transformers. This course will also help the students to gain the skill set in order to select the machine for a specific application.

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

C306.1: Examine the performance characteristics of DC generators

C306.2: Compute the losses and efficiency of DC machines.

C306.3: Outline the performance curves of DC motors.

C306.4: Analyse the Performance of Single-Phase Transformer and Poly-Phase Transformer Connections.

Part-A: The following experiments are required to be conducted compulsory experiments:

1. Magnetization characteristics of DC shunt generator (Determination of critical field resistance and critical speed)
2. Load test on DC shunt generator (Determination of characteristics)
3. Load test on DC series generator (Determination of characteristics)
4. Hopkinson's test on DC shunt machines (Predetermination of efficiency)
5. Swinburne's test and speed control of DC shunt motor (Predetermination of efficiencies)
6. Brake test on DC compound motor (Determination of performance curves)
7. OC and SC Test on Single Phase Transformer
8. Three Phase Transformer: Verification of Relationship between Voltages and Currents (Star-Delta, Delta-Delta, Delta-star, Star-Star)

Part-B: In addition to the above eight experiments, at least any two of the experiments from the following list are required to be conducted:

1. Brake test on DC shunt motor (Determination of performance curves)
2. Load test on DC compound generator (Determination of characteristics.
3. Fields test on DC series machines (Determination of efficiency)
4. Retardation test on DC shunt motor (Determination of losses at rated speed)
5. Separation of losses in DC shunt motor.
6. Measurement of Voltage, Current and Real Power in primary and Secondary Circuits of a Single-Phase Transformer
7. Load Test on Single Phase Transformer (Calculate Efficiency and Regulation)

B.Tech. II Year I Semester

Course Code	Course Title	L	T	P	Credits
EE307PC	ANALOG ELECTRONIC CIRCUITS LABORATORY	0	0	2	1

Prerequisites Applied Physics, Electrical Circuit Analysis

Courses Description: This course provides practical knowledge on characteristics and applications of Diode, BJT, FET and Op-Amp. It also provides design and analysis of various amplifiers and Oscillators.

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

C307.1: Analyse the characteristics of PN junction diode and rectifier circuits.

C307.2: Verify the characteristics of different configurations of BJT and JFET.

C307.3: Design Various analog application circuits using Op-Amp

C307.4: Analyse positive & negative Feedback amplifiers and power amplifiers.

List of Experiments / Programs

1. Draw the VI Characteristics of given PN Junction diode. Determine the Static and Dynamic resistance of the Diode.
2. Determine the Ripple factor, %Regulation PIV and TUF of the given Rectifier with & without filter.
3. Obtain the I/O Characteristics of CE configurations of BJT. Calculate h-parameters from the Characteristics.
4. Obtain the I/O Characteristics of CB configurations of BJT. Calculate h-parameters from the Characteristics.
5. Obtain the I/O Characteristics of CC configurations of BJT. Calculate h-parameters from the Characteristics.
6. Obtain the Drain and Transfer characteristics of CD, CS configuration of JFET. Calculate g_m, r_d from the Characteristics.
7. Inverting and Non-inverting Amplifiers using Op Amps
8. Adder and Subtractor using Op Amp
9. Integrator Circuit using IC 741.
10. Differentiator circuit using Op Amp.
11. Current Shunt Feedback amplifier
12. Design an RC phase shift oscillator circuit and derive the gain condition for oscillations practically for given frequency.
13. Design a Colpitts oscillator circuit for the given frequency and draw the output waveform.
14. Design transformer coupled class A power amplifier and draw the input and output waveforms, find its efficiency.

B.Tech. II Year I Semester

Course Code	Course Title	L	T	P	Credits
EE308PC	ELECTRICAL SIMULATION TOOLS LABORATORY	0	0	2	1

Prerequisites Electrical Circuit Analysis –I and II, Electrical Machines-I

Course Description: This lab deals with the implementation of different electrical/electronic circuits using basic block sets of different simulation platforms as well as coding. It gives the basic knowledge about the various software tools available and helps the students in carrying out their project works.

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

C308.1: Gain knowledge of software packages to simulate electrical and electronics systems using block sets of various simulation platforms.

C308.2: Gain knowledge of software packages to simulate electrical and electronics systems using programming/coding.

C308.3: Model different electrical and electronic systems and analyze the results.

C308.4: Articulate importance of software packages used for simulation in laboratory experimentation by analyzing the simulation results.

List of Experiments / Programs

Part-A: *The following experiments are required to be conducted as compulsory experiments:*

1. Introduction to basic block sets of simulation platforms. Basic matrix operations, generation of standard test signals.
2. Obtain the total time response of series RL and RC circuits by solving differential equations with DC source.
3. Analyze the step response of second order series RLC circuit for various damping factors.
4. Verification of different network theorems with dependent and independent sources using suitable simulation tools.
5. Verification of performance characteristics of diode and BJT using suitable simulation tools.
6. Analysis of series and parallel resonance circuits using suitable simulation tools.
7. Obtaining the response of electrical network for different standard test signals using suitable simulation tools.
8. Modeling and analysis of low pass and high pass filters using suitable simulation tools.

Part-B*:* *In addition to the above experiments, at least any two of the following experiments are required to be conducted.*

9. Performance analysis of DC motor using suitable simulation tools.
10. Modeling and analysis of equivalent circuit of transformer using suitable simulation tools.

11. Analysis of single-phase bridge rectifier with and without filter using suitable simulation tools.
12. Modeling and verification of voltage regulator using suitable simulation tools.
13. Modeling of transmission line using simulation tools.
14. Performance analysis of solar PV model using suitable simulation tools.

Note: Minimum of 10 Experiments are to be performed

B.Tech. II Year I Semester

Course Code	Course Title	L	T	P	Credits
*MC311	ENVIRONMENTAL SCIENCE	3	0	0	0

Prerequisites Nil

Course Description: This course enables the students engage with the scientific principles, concepts, and methodologies required to understand the interrelationships of the natural world. The course requires that students identify and analyze natural and human-made environmental problems, evaluate the relative risks associated with these problems. It provides the scope to examine alternative solutions for resolving or preventing them. It is essentially a multidisciplinary approach that brings out an appreciation of our natural world and human impact on its existence and integrity. Its components include Biology, Geology, Chemistry, Physics, Engineering, Sociology, Health, Anthropology, Economics, Statistics, Computers and Philosophy.

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

- **C311.1:** Analyze the important components of environment.
- **C311.2:** Illustrate the major environmental effects of exploiting natural resources.
- **C311.3:** Utilize environmental laws for the protection of forest and wildlife.
- **C311.4:** Categorize different types of pollutions and their control measures and discover effective methods of waste management.
- **C311.5:** Identify global environmental problems and come out with best possible solutions.
- **C311.6:** Illustrate green environmental issues.

Unit - I ECOSYSTEMS

Ecosystems: Definition, Scope, and Importance of ecosystem. Classification, structure, and function of an ecosystem, Food chains, food webs, and ecological pyramids. Flow of energy, Biogeochemical cycles, Bioaccumulation, Biomagnifications, ecosystem value, services and carrying capacity, Field visits

Unit - II Natural Resources: Classification of Resources

Natural Resources: Classification of Resources: Living and Non-Living resources, **water resources:** use and over utilization of surface and ground water, floods and droughts, Dams: benefitsand problems.

Mineral resources: use and exploitation, environmental effects of extracting and using mineral resources

Land resources: Forest resources

Energy resources: growing energy needs, renewable and non-renewable energy sources, use of alternate energy source, case studies

Unit - III Biodiversity and Biotic Resources

Biodiversity and Biotic Resources: Introduction, Definition, genetic, species and ecosystem diversity.Value of biodiversity; consumptive use, productive use, social, ethical, aesthetic and optional values. India as a mega diversity nation, Hot spots of biodiversity. Field visit.

Threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts; conservation of biodiversity: In-Situ and Ex-situconservation.

Unit - IV Environmental Pollution and Control Technologies:

Environmental Pollution: Classification of pollution,

Air Pollution: Primary and secondary pollutants, Automobile and Industrial pollution, Ambientair quality standards.

Water pollution: Sources and types of pollution, drinking water quality standards.

Soil Pollution: Sources and types, Impacts of modern agriculture, degradation of soil.

Noise Pollution: Sources and Health hazards, standards.

Solid waste: Municipal Solid Waste management, composition and characteristics of e-Waste and its management.

Pollution control technologies:

Wastewater Treatment methods: Primary, secondary and Tertiary.

International conventions / Protocols: Earth summit, Kyoto protocol, and Montréal Protocol.

Green Environmental Issues: Clean development mechanism, carbon foot printing, carbon credits, carbon sequestration and Polluter pay principle

Unit - V Environmental Policy, Legislation & EIA

Environmental Policy, Legislation & EIA: Environmental Protection act, Legal aspects Air Act- 1981,Water Act, Forest Act, Wild life Act, Municipal solid waste management and handling rules, biomedical waste management and handling rules, hazardous waste management and handling rules. EIA: EIA structure, methods of baseline data acquisition. Concepts of Environmental Management Plan (EMP).

Towards Sustainable Future: Concept of Sustainable Development Goals, Population and itsexplosion, Crazy Consumerism, Environmental Education, Urban Sprawl, Human health, Environmental Ethics, Concept of Green Building, Ecological Foot Print, Life Cycle assessment (LCA),Low carbon life style.

TEXT BOOKS

1. Erach Bharucha, Textbook of Environmental Studies for Undergraduate Courses, 1st Edition, 2005, Universities press.
2. Anubha Kaushik, C.P. Kaushik, Perspectives in Environmental Studies.,4th Edition, 2014, New age international publishers.
3. S. Deswal and A. Deswal, A basic course in environmental studies, 2nd Edition, 2004, Dhanapathirai & Co.
4. Benny joseph, Environmental studies, 3rd Edition, 2017, McGraw Hill Education (India) Private Limited.

REFERENCE BOOKS

1. Daniel B. Botkin and Edwards A. Keller, Environmental science, 8th Edition, 2010, Wiley India (P) Ltd.
2. Richard T. Wright, Environmental Science: towards a sustainable future, 4th Edition, 2008, PHL Learning Private Ltd.
3. P. D. Sharma, Ecology and Environment, 5th Edition, 2009, Rastogi Publications.

B. Tech. II Year II Semester

Course code	Course Title	L	T	P	Credits
ME401ES	**SOLID MECHANICS AND HYDRAULIC MACHINES**	**3**	**1**	**0**	**4**

Prerequisites Nil

Course Description: To apply the concepts of forces, equilibrium, stress, strain, shear force, bending moment, and torsion to simple cases involving beams and shafts.

To learn the basics of fluid flow and how they apply to the movement of fluid through pipes and hydraulic machinery. In these areas, the student must be able to resolve application-related problems.

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

C401.1: To understand the concept of materials stress- strain behaviour

C401.2: Determine the shear stress distribution for various beam cross sections

C401.3: Discuss the concepts of fluid properties, various types of flows and law of conservation of mass.

C401.4: Evaluate the various applications of Bernoulli equation and law of conservation of momentum.

C401.5: Analyze the concepts of major and minor losses in a conduit flow.

C401.6: Interpret the working proportions, design and efficiencies of pumps & turbines in domestic and industrial field.

Unit - I Simple Stresses & Strains (6 L)

Elasticity and plasticity – Types of stresses & strains–Hooke's law– stress – strain diagram for mild steel – Working stress – Factor of safety – Lateral strain, Poisson's ratio & volumetric strain – Elastic moduli & the relationship between them – Bars of varying section – composite bars – Temperature stresses. Strain energy – Resilience – Gradual, sudden, impact and shock loading, Torsion and Bending Equation

Unit - II Shear Force and Bending Moment (7 L)

Definition of beam – Types of beams – Concept of shear force and bending moment – S.F and B.M diagrams for cantilever, simply supported and overhanging beams subjected to point loads, uniformly distributed load, uniformly varying loads and combination of these loads – Point of contra flexure – Relation between S.F., B.M and rate of loading at a section of a beam

Unit - III Fluid Property and Flow Characteristics (7 L)

Density - Specific weight- Specific Volume- Specific Gravity - Surface tension – Capillarity – Viscosity – Newton's law – Fluid pressure and pressure head - Fluid velocity – Uniform and steady flow – Reynolds number - Classification as laminar and turbulent flow –Continuity equation.

Unit - IV Flow Dynamics & Measurement In Pipe (7 L)

Euler's and Bernoulli's Equations – Manometer, Venturi meter and orifice meter - Statement of Darcy – Weisbach equation - Hydraulic gradient line and total energy line-

Pressure losses along the flow– Categorization into minor losses - Flow through circular pipes –Friction factor – Pipes in series and parallel -

Unit - V TURBINES AND PUMPS (7 L)

Introduction and Classification of Turbines – Pelton wheel- Franci's turbine - Kaplan Turbine - Specific Speed – Turbine characteristics Speed Governance –Classification– Centrifugal Pumps – Impeller Blade Profiles – Cavitation in pumps – Pump characteristics – Efficiency – Reciprocating Pumps – Classification.

TEXT BOOKS:

1. Barry J. Goodno and James M. Gere, "Mechanics of Materials" Ninth Edition, Cengage Learning, 2018.
2. S. S. Rattan, "Strength of Materials", Second Edition Tata McGraw Hill Education Pvt. Ltd, New Delhi, 2011.
3. Hydraulics, Fluid mechanics and Hydraulic Machinery - MODI and SETH, 21st Edition, standard Book House.
4. Fluid Mechanics and Hydraulic Machines by Er. R. K. Rajput, S. Chand, 2019.

REFERENCE BOOKS:

1. U. C. Jindal, "Strength of Materials", Pearson Education India,2012
2. Egor P. Popov, Toader A. Balan, "Engineering Mechanics of Solids", PHI Learning, 2010.
3. Strength of Materials by S. Ramamrutham, Dhanpat Rai Publishing company
4. Fluid Mechanics and Fluid Power Engineering by D.S. Kumar, S.K. Kataria & Sons, 2018
5. Fluid Mechanics and Machinery by D. Rama Durgaiah, New Age International publishers
6. Banga & Sharma, "Hydraulic machines" Khanna publications.
7. R. C. Hibbeler, "Fluid mechanics", Pearson India education services Pvt. Ltd

ONLINE RESOURCES

1. https://nptel.ac.in/courses/105105108
2. https://nptel.ac.in/courses/105103095

B. Tech. II Year II Semester

Course code	Course Title	L	T	P	Credits
EE402PC	**MEASUREMENTS AND INSTRUMENTATION**	**3**	**0**	**0**	**3**

Prerequisites Electrical Circuit Analysis-I & II.

Course Description: This course provides an in-depth understanding of various measuring instruments used in electrical engineering applications. The syllabus covers analog instruments, potentiometers, instrument transformers, measurement of power and energy, bridges, transducers, and an introduction to smart and digital metering technologies.

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

C402.1: Gain a comprehensive understanding of analog measuring instruments.

C402.2: Gain familiarity with smart and digital metering technologies

C402.3: Able to apply the principles of potentiometers and instrument transformers to measure unknown resistances

C402.4: Understand the principles and techniques for measuring power and energy

C402.5: Comprehend the principles of operation and characteristics of transducers

C402.6: Develop proficiency in using DC and AC bridges for measuring resistance, inductance, and capacitance

Unit - I Instrument Classification, Characteristics, & Measurement Techniques

Classification of instruments, static characteristics, errors, deflecting, control and damping torques – Ammeters and Voltmeters – PMMC, moving iron type instruments – expression for the deflecting torque and control torque – Errors and compensations, extension of range using shunts and series resistance, True rms meter, Digital Multi meter, clamp on meter, Digital Storage Oscilloscope.

Unit - II Potentiometers & Instrument Transformers

Principle and operation of D.C. Crompton's potentiometer – standardization – Measurement of unknown resistance, current, voltage. A.C. Potentiometers: polar and coordinate type's standardization – applications. CT and PT – Ratio and phase angle errors, Phasor measurement unit.

Unit - III Measurement of Power & Energy

Single phase dynamometer wattmeter, LPF and UPF, Double element and three element dynamometer wattmeter, expression for deflecting and control torques – Extension of range of wattmeter using instrument transformers – Measurement of active and reactive powers in balanced and unbalanced systems, Digital Energy Meter.

Single phase induction type energy meter – driving and braking torques – errors and compensations –testing by phantom loading using R.S.S. meter. Three phase energy meters, Introduction to net energy metering – Smart meter, Digital energy meter.

Unit - IV Transducers

Definition of transducers, Classification of transducers, Advantages of Electrical

transducers, Characteristics and choice of transducers; Principle operation of LVDT and capacitor transducers; LVDT Applications, Strain gauge and its principle of operation, gauge factor, Thermistors, Thermocouples, Piezo electric transducers, photovoltaic, photo conductive cells, and photo diodes.

Unit - V DC & AC Bridges

Method of measuring low, medium and high resistance – sensitivity of Wheat-stone's bridge – Carey Foster's bridge, Kelvin's double bridge for measuring low resistance, measurement of high resistance – loss of charge method.

Measurement of inductance- Maxwell's bridge, Hay's bridge, Anderson's bridge - Owen's bridge. Measurement of capacitance and loss angle –Desaunty's Bridge - Wien's bridge – Schering Bridge

TEXT BOOKS:

1. A. K. Sawhney, "Electrical & Electronic Measurement & Instruments", Dhanpat Rai & Co. Publications,2005.
2. Dr. Rajendra Prasad, "Electrical Measurements & Measuring Instruments", Khanna Publishers, 1989.
3. P. Purkait, B.Biswas, S. Das, C. Koley, "Electrical and Electronics Measurements and Instrumentation", Mcgraw Hill Publishers.

REFERENCE BOOKS:

1. A. Pramanik, "Electromagnetism- Theory and applications", PHI Learning Pvt. Ltd, New Delhi, 2009.1. G. K. Banerjee, "Electrical and Electronic Measurements", PHI Learning Pvt. Ltd., 2nd Edition,2016.
2. R. K. Rajput, "Electrical & Electronic Measurement & Instrumentation", S. Chand and Company Ltd.,2007.
3. S. C. Bhargava, "Electrical Measuring Instruments and Measurements", BS Publications, 2012.

B. Tech. II Year II Semester

Course Code	Course Title	L	T	P	Credits
EE403PC	ELECTRICAL MACHINES–II	3	0	0	3

Prerequisites Electrical Circuit Analysis-I, Electrical Circuit Analysis-II & Electrical Machines-I

Course Description: Electrical Machines are the heart of every system and the electrical power sector is the need of society and nation. The rotating electrical machines play a vital role for the society and overall development of the country by providing hassle free operations with low maintenance. This particular subject deals with the theory, practical and performance analysis of various electrical machines with different loading conditions.

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

C403.1: Illustrate the construction and working principle of Induction & Synchronous Machines.

C403.2: Evaluate the voltage regulation of Alternators using different methods.

C403.3: Evaluate the performance of synchronous generators for parallel operation and load sharing.

C403.4: Assess the performance and speed control of a poly phase induction motor.

C403.5: Illustrate different starting methods of Induction & Synchronous motors.

C403.6: Assess the single-phase machines for different applications.

Unit - I

Synchronous Machines: Production of a rotating magnetic field-Constructional Features of round rotor and salient pole machines – Armature windings – Integral slot and fractional slot windings; Distributed and concentrated windings – distribution, pitch and winding factors – E.M.F Equation. Harmonics in generated e.m.f. – suppression of harmonics – armature reaction - leakage reactance – synchronous reactance and impedance – experimental determination - phasor diagram – load characteristics.

Regulation by synchronous impedance method, M.M.F. method, Z.P.F. method and A.S.A. methods – salient pole alternators – two reaction analysis – experimental determination of X_d and X_q (Slip test) Phasor diagrams – Regulation of salient pole alternators.

Unit - II

Parallel Operation of Synchronous Machines: Synchronizing alternators with infinite bus bars – synchronizing power torque – parallel operation and load sharing -Effect of change of excitation and mechanical power input. Analysis of short circuit current wave form – determination of sub-transient, transient and steady state reactance's and Applications.

Synchronous Motors: Theory of operation – phasor diagram – Variation of current and power factor with excitation – synchronous condenser – Mathematical analysis for power developed. - Hunting and its suppression – Methods of starting – synchronous induction motor.

Unit - III

Poly-Phase Induction Machines: Constructional details of cage and wound rotor machines-principle of operation - induction generator-principle of operation (Qualitative treatment

only)-Slip & its Effect on Rotor parameters during operation- Power Flow Diagram of induction motor- Rotor power input, rotor copper loss and mechanical power developed and their inter relation.

Unit - IV

Characteristics Of Induction Machines: Torque equation-expressions for maximum torque and starting torque - Torque slip characteristic - equivalent circuit - phasor diagram - crawling and cogging, No-load Test and Blocked rotor test –Predetermination of performance-Methods of starting- starting current and Torque calculations, Applications.

Speed Control Methods: Change of voltage, change of frequency, voltage/frequency, injection of an EMF into rotor circuit (qualitative treatment only).

Unit - V

Single Phase Machines: Single phase induction motor – Constructional Features-Double revolving field theory – split-phase motors – AC series motor- Universal Motor-Shaded pole motor and Applications.

TEXT BOOKS

1. P. S. Bimbhra, “Electrical Machinery”, Khanna Publishers, 2011.
2. I.J. Nagrath and D. P. Kothari, “Electric Machines”, McGraw Hill Education, 2010.

REFERENCE BOOKS

1. Prithwiraj Purkait, Indrayudh Bandyopadhyay, “Electrical Machines”, Oxford, 2017.
2. M. G. Say, “Performance and design of AC machines”, CBS Publishers, 2002.
3. A. E. Fitzgerald and C. Kingsley, "Electric Machinery”, New York, McGraw Hill Education, 2013.
4. A. E. Clayton and N. N. Hancock, “Performance and design of DC machines”, CBS Publishers, 2004.
5. J.B. Gupta, “Theory and Performance Electrical Machines”, Katsons Book Publisher, 2015.
6. S.K. Sahdev, “Electrical Machines”, Cambridge University Press, 2017.

B.Tech. II Year II Semester

Course Code	Course Title	L	T	P	Credits
EE404PC	**DIGITAL ELECTRONICS**	3	0	0	3

Prerequisites Analog Electronic Circuits

Course Description: In this course common forms of number representation in logic circuits, design of digital circuits, concepts of combinational logic circuits and sequential circuits will be studied.

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

- **C404.1:** Apply the concepts of number systems, and codes in digital system design
- **C404.2:** Minimize Boolean expressions using various techniques
- **C404.3:** Realize combinational logic circuits for given specifications
- **C404.4:** Design Shift Registers and Counters using flip-flops
- **C404.5:** Compare various semiconductor memories
- **C404.6:** Implement logic functions using PLDs

Unit - I Fundamentals of Digital Systems

Number systems-binary, Signed binary, Octal hexadecimal number, Binary arithmetic, One's and Two's complements arithmetic. Digital signals, Digital circuits, AND, OR, NOT, NAND, NOR and Exclusive-OR operations, Boolean algebra, Examples of IC gates.

Unit - II Combinational Circuits-I

Standard representation for logic functions, K-map representation and simplification of logic functions using K- map, Minimization of logical functions, Don't care conditions, Q-M method of function realization.

Unit - III Combinational Circuits-II

Adders, Subtractors, Carry look ahead adder, Multiplexer, De-Multiplexer, Digital comparator, Parity checker/generator, Code converters, Priority encoders, Decoders/Drivers for display devices.

Unit - IV Sequential Circuits

Introduction to flip-flops, SR, JK, T and D type's flip-flops, Shift registers, Conversion of flip-flops, Ring counter, Ripple (Asynchronous) counters, Synchronous counters, FSM – Mealy and Moore models.

Unit - V Semiconductor Memories and Programmable Logic Devices

Memory organization and operation, expanding memory size, classification and characteristics of memories, sequential memory, read-only memory (ROM), ROM types, Read and write memory (RAM) types, Programmable logic array, Programmable array logic, Field Programmable Gate Array (FPGA).

TEXT BOOKS

1. A. Anand Kumar, "Fundamentals of Digital Circuits", Prentice Hall India, 2016.
2. M. M. Mano, "Digital logic and Computer design", Pearson Education India, 2016.

REFERENCE BOOKS

1. R.S. Sedha, “A Textbook of Digital Electronics”, S.Chand, 2005
2. R. P. Jain, "Modern Digital Electronics", McGraw Hill Education, 2009.
3. Charles H.Roth – Fundamentals of LogicDesign,5thEd.,Cengage Learning,2004.
4. Morris Mano, Fredriac J. Hill, Gerald R. Peterson - Introduction to Switching Theory and Logic Design –3rd Ed., John Wiley &Sons Inc.

B. Tech. II Year II Semester

Course code	Course Title	L	T	P	Credits
EE405PC	**POWER SYSTEM-II**	**3**	**0**	**0**	**3**

Prerequisites Power System–I & Electro Magnetic Fields

Course Description: Power System II is a course designed to provide students with a deeper understanding of electrical power systems, focusing on the performance of transmission lines, voltage control, transient analysis of transmission lines and fault calculations. Building upon the foundational concepts covered in Power System 1, this course delves into more complex topics and practical applications essential for professionals in the field of electrical engineering.

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

C405.1: Assess the performance of transmission lines.

C405.2: Illustrate the voltage control and compensation of transmission lines.

C405.3: Asses the transient behavior of transmission lines.

C405.4: Illustrate the per unit representation of transmission lines.

C405.5: Evaluate the performance of power system for different faulty conditions.

C405.6: Evaluate the performance of different types of underground cables.

Unit - I Performance of transmission lines:

Representation of lines, short transmission lines, medium length lines, nominal T and PI-representations, long transmission lines. The equivalent circuit representation of a long line, A, B, C, D constants, Ferranti effect. Corona: Introduction, critical disruptive voltage, corona loss, Factors affecting corona loss and methods of reducing corona loss, Disadvantages of corona, interference between power and communication lines.

Unit - II Voltage control & compensation of transmission lines.

Introduction-Excitation control, automatic voltage regulators, tap Changing transformers, booster transformer, induction voltage regulator, series capacitors, shunt capacitors, shunt inductor, synchronous coil, synchronous capacitor and synchronous condenser and power factor improvement methods. Compensation of transmission lines: Introduction-Concepts of Load compensation, load ability characteristics of overhead lines, uncompensated transmission line, symmetrical line, radial line with asynchronous load, compensation of lines.

Unit - III Transient analysis of transmission lines & underground cables:

Travelling waves on transmission lines: Production of travelling waves, open circuited line, short-circuited line, line terminated through a resistance, line connected to a cable, reflection and refraction at T-junction line terminated through a capacitance, capacitor connection at a T-junction, Attenuation of travelling waves.

Underground cables**:** Construction, Classification of cables, Calculation of insulation resistance and capacitance of single core and three core cables, applications and losses.

Unit - IV Overhead line insulators & per unit representation:

Introduction, types of insulators, Potential distribution over a string of suspension insulators, Methods of equalizing the potential, testing of insulators, sags and tension calculations. Representation of electrical quantities in absolute and per unit system, single -line diagram, impedance and reactance diagrams, per unit quantities, changing the base of per unit quantities, advantages and dis-advantages of per unit system.

Unit - V Symmetrical components, sequence networks & fault calculations:

Need of symmetrical components, detail analysis of positive, negative and zero sequence components, average 3-phase power in terms of symmetrical components, sequence impedances and sequence networks. Analysis of short circuit faults: Single line to ground fault, line to line fault, double line to ground fault, three phase fault, three phase to ground fault, analysis of Open circuit faults, current limiting reactors, short circuit capacity of a bus.

TEXT BOOKS

1. C.L. Wadhwa, “Electrical Power Systems”, New Age International Pub. Co, Third Edition, 2001.
2. D.P. Kothari and I.J. Nagrath, “Modern Power System Analysis”, Tata McGraw Hill Pub. Co., New Delhi, Fourth edition, 2011.

REFERENCE BOOKS

1. A. Chakrabarti, M.L. Soni, P.V. Gupta, U.S. Bhatnagar, “A Text book on Power System Engineering”, Dhanpat Rai Publishing Company (P) Ltd, 2008.
2. John J. Grainger & W.D. Stevenson, “Power System Analysis”, McGraw Hill International,1994.
3. Hadi Saddat, “Power System Analysis”, Tata Mc Graw Hill Pub. Co. 2002.
4. W.D. Stevenson, “Elements of Power system Analysis”, McGraw Hill International Student Edition.

B.Tech. II Year II Semester

Course Code	Course Title	L	T	P	Credits
EE406PC	**DIGITAL ELECTRONICS LABORATORY**	0	0	2	1

Course Description: In this course design of digital circuits and number conversion systems, implementation of simple logical operations, combinational logic circuits and sequential logic circuits will be studied.

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

C406.1: Examine the performance characteristics of DC generators

C406.2: Compute the losses and efficiency of DC machines.

C406.3: Outline the performance curves of DC motors.

C406.4: Analyse the Performance of Single-Phase Transformer and Poly-Phase Transformer Connections.

List of Experiments

1. Realization of Boolean Expressions using Gates
2. Design and realization logic gates using universal gates
3. Generation of clock using NAND/NOR gates
4. Design a 4 – bit Adder / Subtractor
5. Design and realization a 4 – bit gray to Binary and Binary to Gray Converter
6. Design and realization of a 4-bit pseudo random sequence generator using logic gates.
7. Design and realization of an 8-bit parallel load and serial out shift register using flip-flops.
8. Design and realization Asynchronous and Synchronous counters using flip-flops
9. Design and realization 8x1 using 2x1 mux
10. Design and realization 2-bit comparator
11. Verification of truth tables and excitation tables
12. Realization of logic gates using DTL, TTL, ECL, etc.,

B.Tech. II Year II Semester

Course code	Course Title	L	T	P	Credits
EE407PC	**MEASUREMENTS AND INSTRUMENTATION LABORATORY**	**0**	**0**	**2**	**1**

Prerequisites Measurement & Instrumentation

Course Description: This laboratory course is designed to complement theoretical knowledge in measurements and instrumentation with practical skills in designing, building, and testing of measuring instruments. Students will gain hands-on experience with a variety of measuring devices and systems commonly used in applications such as bridges. Energy meter & wattmeter.

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

C407.1: Determine unknown electrical parameters using bridges

C407.2: Measure active and reactive power using various methods

C407.3: Calibrate various measuring instruments.

C407.4: Examine electrical parameters and characteristics of electrical instruments.

Part-A: The following experiments are required to be conducted compulsory experiments:

1. Calibration and Testing of single-phase energy Meter.
2. Calibration of dynamometer power factor meter.
3. Crompton D.C. Potentiometer – Calibration of PMMC ammeter and PMMC voltmeter.
4. Kelvin's double Bridge – Measurement of resistance – Determination of Tolerance.
5. Dielectric oil testing using H.T. testing Kit.
6. Schering Bridge & Anderson Bridge.
7. Measurement of 3 - Phase reactive power with single-phase wattmeter.
8. Measurement of displacement with the help of LVDT

Part-B: In addition to the above eight experiments, at least any two of the experiments from the following list are required to be conducted:

1. Calibration LPF wattmeter – by Phantom testing.
2. Measurement of 3-phase power with single watt meter and two CTs.
3. C.T. testing using mutual Inductor – Measurement of % ratio error and phase angle of given CT by Null method.
4. PT testing by comparison – V. G. as Null detector – Measurement of % ratio error and phase angle of the given PT
5. Resistance strain gauge – strain measurements and Calibration.
6. Transformer turns ratio measurement using AC bridges.
7. Measurement of % ratio error and phase angle of given CT by comparison.
8. Measurement of parameters of a choke coil using 3 voltmeter and ammeter method.

9. Measurement capacitance by Wien series bridge (Virtual lab experiment).
10. To measure voltage and current in a resistive circuit using a digital meter and a Digital Storage Oscilloscope (DSO), and to compare the measurements obtained from both instruments.

REFERENCE BOOKS:

1. G.K.Banerjee, "Electrical and Electronic Measurements", PHI Learning Pvt. Ltd., 2nd Edition,2016.
2. R. K. Rajput, "Electrical & Electronic Measurement & Instrumentation", S.Chand and Company Ltd.,2007.
3. S. C. Bhargava, "Electrical Measuring Instruments and Measurements", BS Publications, 2012.
4. Buckingham and Price, "Electrical Measurements", Prentice – Hall, 1988.

B. Tech. II Year II Semester

Course Code	Course Title	L	T	P	Credits
EE408PC	**ELECTRICAL MACHINES LABORATORY-II**	0	0	2	1

Prerequisites Electrical Machines-I & Electrical Machines-II

Course Description: Electrical Machines Laboratory-II course is to provide the practical exposure on performance of various electrical machines like Induction Machines and Synchronous Machines. This course will also help the students to gain the skillset in order to select the machine for a specific application.

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

C408.1: Analyze the performance of a single-phase transformer.

C408.2: Analyze the suitability of AC machines and Transformers for real word applications.

C408.3: Examine the performance of Induction motor at different loading conditions.

C408.4: Appraise the performance of synchronous machines by using different methods.

The following experiments are required to be conducted as compulsory experiments:

1. Sumpner's test on a pair of single-phase transformers.
2. No-load & Blocked rotor tests on three phase Induction motor.
3. Regulation of a three–phase alternator by synchronous impedance, m.m.f, Z.P.F. and A.S.A methods.
4. 'V' and 'Inverted V' curves of a three-phase synchronous motor.
5. Equivalent Circuit of a single-phase induction motor.
6. Determination of X_d and X_q of a salient pole synchronous machine.
7. Load test on three phase Induction Motor.
8. Parallel operation of Single-phase Transformers.

In addition to the above experiments, at least any two of the following experiments are required to be conducted from the following list:

1. Separation of core losses of a single-phase transformer.
2. Determine efficiency and regulation of a 3-ϕ alternator with direct load test.
3. Heat run test on a bank of 3 Nos. of single-phase Delta connected transformers.
4. Measurement of sequence impedance of a three-phase alternator.
5. Vector grouping of Three Transformer.
6. Scott Connection of transformer.

TEXT BOOKS

1. P. S. Bimbhra, "Electrical Machinery", Khanna Publishers, 2011.
2. I.J. Nagrath and D. P. Kothari, "Electric Machines", McGraw Hill Education, 2010.

REFERENCE BOOKS

1. Prithwiraj Purkait, Indrayudh Bandyopadhyay, "Electrical Machines", Oxford, 2017.

2. M. G. Say, “Performance and design of AC machines”, CBS Publishers, 2002.
3. A. E. Fitzgerald and C. Kingsley, "Electric Machinery”, New York, McGraw Hill Education, 2013.
4. A. E. Clayton and N. N. Hancock, “Performance and design of DC machines”, CBS Publishers, 2004.
5. J.B. Gupta, “Theory and Performance Electrical Machines”, Katsons Book Publisher, 2015.
6. S.K. Sahdev, “Electrical Machines”, Cambridge University Press, 2017.

B.Tech. II Year II Semester

Course Code	Course Title	L	T	P	Credits
*** MC410**	**GENDER SENSITIZATION LAB**	**0**	**0**	**2**	**0**

Course Description: This course offers an introduction to Gender Studies, an interdisciplinary field that asks critical questions about the meanings of sex and gender in society. The primary goal of this course is to familiarize students with key issues, questions and debates in Gender Studies, both historical and contemporary. It draws on multiple disciplines – such as literature, history, economics, psychology, sociology, philosophy, political science, anthropology and media studies – to examine cultural assumptions about sex, gender, and sexuality.

This course integrates analysis of current events through student presentations, aiming to increase awareness of contemporary and historical experiences of women, and of the multiple ways that sex and gender interact with race, class, caste, nationality and other social identities. This course also seeks to build an understanding and initiate and strengthen Programmes combating gender-based violence and discrimination. The course also features several exercises and reflective activities designed to examine the concepts of gender, gender-based violence, sexuality, and rights. It will further explore the impact of gender-based violence on education, health and development.

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

C410.1 Students will have developed a better understanding of important issues related to gender in contemporary India.

C410.2 Students will be sensitized to basic dimensions of the biological, sociological, psychological and legal aspects of gender. This will be achieved through discussion of materials derived from research, facts, everyday life, literature and film.

C410.3 Students will attain a finer grasp of how gender discrimination works in our society and how to counter it.

C410.4 Students will acquire insight into the gendered division of labour and its relation to politics and economics.

Unit - I Understanding Gender

Introduction: Introduction to Gender, what is Gender, why should we study it. Socialization: Making Women, Making Men - Preparing for Womanhood. Growing up Male. First lessons in Caste: Different Masculinities.

Unit - II Gender Roles And Relations

Two or Many? -Struggles with Discrimination- Missing Women-Sex Selection and Its Consequences Declining Sex Ratio. Demographic Consequences - Gender Spectrum: Beyond the Binary.

Unit - III Gender And Labour

Division & Valuation of Labour - Housework: The Invisible Labor - “My Mother doesn’t Work.” “Share the Load.” - Work: Its Politics and Economics - Fact and Fiction. Unrecognized and Unaccounted work. Additional Reading: Wages and Conditions of Work.

Unit - IV Gender - Based Violence

Sexual Harassment: Say No! -Sexual Harassment, not Eve – teasing - Coping with Everyday Harassment- Further Reading: "Chupulu". Domestic Violence: Speaking Out Is Home a Safe Place? - When Women Unite [Film]. Rebuilding Lives. Thinking about Sexual Violence Blaming the Victim - "I Fought for my Life…." Additional Reading: The Caste Face of Violence.

Unit - V Gender And Coexistence

Gender Issues - Just Relationships: Being Together as Equals Mary Kom and Onler. Love and Acid just do not Mix. Love Letters. Mothers and Fathers. Rosa Parks The Brave Heart.

TEXT BOOKS

1. Suneetha, Uma Bhrugubanda, Duggirala Vasanta, Rama Melkote, Vasudha Nagaraj, Asma Rasheed, Gogu Shyamala, Deepa Sreenivas and Susie Tharu, Towards a World of Equals: A Bilingual Textbook on Gender, 2015, Telugu Academy, Hyderabad, Telangana.

REFERENCE BOOKS

1. Menon, Nivedita, Seeing like a Feminist, 2012, New Delhi: Zubaan-Penguin Books.
2. Abdulali Sohaila, I Fought For My Life…and Won, Available online at: http://www.thealternative.in/lifestyle/i-fought-for-my-lifeand-won-sohaila-abdulal/

E-TEXT BOOKS

1. Abdulali Sohaila, I Fought For My Life…and Won, Available online at: http://www.thealternative.in/lifestyle/i-fought-for-my-lifeand-won-sohaila-abdulal/

B.Tech. III Year I Semester

Course Code	Course Title	L	T	P	Credits
EE501PC	**POWER ELECTRONICS**	3	1	0	4

Prerequisites Analog Electronics, Digital Electronics

Course Description: This course introduces students to the principles and applications of power electronics, which is a specialized field within electrical engineering. Power electronics involves the study of electronic devices and circuits used for controlling and converting electrical power from one form to another.

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

C501.1 Analyze the characteristics and working of Power semi conductor devices.
C501.2 Assess the power electronic converters for AC-DC conversion.
C501.3 Evaluate control techniques and protection schemes for Power Electronic devices.
C501.4 Assess the Power electronic converters for AC-AC conversion.
C501.5 Determine performance parameters of DC-DC converters by applying control strategies.
C501.6 Illustrate various control techniques for thyristor and transistor-based inverters.

Unit - I Power Switching Devices

Concept of power electronics, scope and applications, types of power converters; Power semiconductor switches and their V-I characteristics - Power Diodes, Power BJT, SCR, Power MOSFET, Power IGBT; Thyristor ratings and protection, methods of SCR commutation,

Gate trigger circuits of SCR, Gate drive circuits for MOSFETs and IGBTs.

Unit - II AC-DC Converters

Principles of single-phase fully-controlled converter with R, RL, and RLE load, Principles of single-phase half-controlled converter with RL and RLE load, Principles of three-phase fully-controlled converter operation with RLE load, Effect of load and source inductances, Single phase and Three phase dual converters, Numerical Problems.

Unit - III DC - DC Converters

Introduction, elementary chopper with an active switch and diode, concepts of duty ratio, average inductor voltage, average capacitor current. Steady State Analysis of Non-Isolated DC-DC Converter- Buck, Boost, Buck-Boost- Power circuit and waveforms, duty ratio control of output voltage, Calculations of Inductor and Capacitor Values.

Unit - IV DC-AC Converters (Inverters)

Introduction, principle of operation, performance parameters, single phase Half bridge and Full Bridge voltage source inverters with R, RL loads, 3-phase bridge inverters – 120 - and 180 - degrees mode of operation, Voltage control of single-phase inverters –single pulse width modulation, multiple pulse width modulation, sinusoidal pulse width modulation.

Unit - V AC - AC Converters

Phase Controller (AC Voltage Controller)-Introduction, principle of operation of single-phase voltage controllers for R, R-L loads and its applications, Numerical Problems.

Cyclo-converter-Principle of operation of single phase cyclo-convertersMidpoint and Bridge

type (Step-Up and Step-Down operations) relevant waveforms, circulating current mode of operation, Advantages and disadvantages.

TEXT BOOKS

1. M. H. Rashid, "Power electronics: circuits, devices, and applications", Pearson Education India, 2009.
2. N. Mohan and T. M. Undeland, "Power Electronics: Converters, Applications and Design", John Wiley & Sons, 2007.

REFERENCE BOOKS

1. R. W. Erickson and D. Maksimovic, "Fundamentals of Power Electronics", Springer Science &Business Media, 2007.
2. L. Umanand, "Power Electronics: Essentials and Applications", Wiley India, 2009.
3. P.S.Bimbra, "Power Electronics" Khanna Publishers,4th Edition, 2008.
4. M.D Singh & K B Kanchandhani, Power Electronics, Tata McGraw-Hill Education, July 7, 2008.

B.Tech. III Year I Semester

Course Code	Course Title	L	T	P	Credits
EE502PC	**CONTROL SYSTEMS**	3	1	0	4

Prerequisites Electrical Circuit Analysis-I & Electrical Circuit Analysis-II, Matrix Algebra and Calculus, Applied and Multivariable Calculus, Numerical Methods and Complex Variables, Fundamental physical laws

Course Description: Control systems are a fundamental aspect of engineering that deal with regulating the behavior of dynamic systems to achieve desired outcomes. The primary objective of control systems is to maintain stability, optimize the system performance to achieve specified objectives. In this subject, students learn about the modeling of systems, analysis of their behavior in time and frequency domains and different stability techniques.

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

C502.1: Compute transfer function of a system by different techniques.

C502.2: Evaluate the time response of systems for standard input signals.

C502.3: Probe the stability of a system using time domain approach

C502.4: Probe the stability of a system using frequency domain approach

C502.5: Examine the performance of systems with compensators and controllers

C502.6: Construct state models for continuous & discrete time systems and Comment on controllability and observability of the system

Unit - I

Modelling of Physical Systems: Industrial and domestic Control examples. Mathematical modelling of physical systems: Mechanical and Electrical Systems, Concept of Control Systems Configurations: Open loop and Closed loop Systems, Introduction to types of Systems. Representation of Linear time-invariant Systems through Input-output Models: Transfer function, Block-diagram Techniques, Signal flow graph.

Concept of Feedback Control, Benefits of Feedback and Effects of feedback. Controller Components:

DC Servo motors, AC Servomotors, Synchros.

Unit - II

Time Domain Analysis: Time response of first order system for standard test inputs, Analysis of standard Second order systems with step input, Types of System, Error Analysis for Linear time Invariant Systems, Design specifications for second-order systems based on the time-response.

Concept of Stability. Routh-Hurwitz Criteria. Relative Stability analysis. Root-Locus technique. Construction of Root-loci.

Unit - III

Frequency Domain Analysis: Introduction to frequency response, Relationship between time and frequency response, Polar plots, Nyquist stability criterion, Relative stability using Nyquist criterion–gain and phase margin. Concept of Bode plots and construction. Closed-loop frequency response.

Unit - IV

Design of Classical Controllers and Compensators: Introduction, Stability, steady-state accuracy, transient accuracy, disturbance rejection, insensitivity and robustness of control systems.

Application of Proportional, Integral and Derivative Controllers, Root-loci method of feedback controller design. Design specifications in frequency-domain. Lead, Lag and Lag-Lead compensation in designs. Analog and Digital implementation of controllers.

Unit - V

State Variable Analysis and Design: Concept of State, State variables and State model. State State Representation, Transformation of State variables, Solution of state equations and Complete response of the Systems. Stability Analysis of Linear Systems. Concept of controllability and observability. Design of State feedback Controllers through Pole-placement.

TEXT BOOKS:

1. M. Gopal, “Control Systems: Principles and Design”, McGraw Hill Education, 1997.
2. B. C. Kuo, “Automatic Control System”, Prentice Hall, 1995.

REFERENCE BOOKS:

1. K. Ogata, “Modern Control Engineering”, Prentice Hall, 1991.
2. I. J. Nagrath and M. Gopal, “Control Systems Engineering”, New Age International, 2009.
3. S.Palani, “Control Systems Engineering”, Mc Graw Hill Education, 2010.

B.Tech. III Year I Semester

Course Code	Course Title	L	T	P	Credits
EE503PC	**MICROPROCESSORS AND MICROCONTROLLERS**	3	0	0	3

Prerequisites Digital Electronics

Course Description: This course describes about the operations of microprocessors and micro controllers, machine language programming, interfacing techniques, input output and memory systems.

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

C503.1: Differentiate between microprocessors and microcontrollers in terms of architecture and functionality.

C503.2: Summarize the addressing modes, instruction set and assembler directives of 8086 Microprocessor and 8051 Microcontroller.

C503.3: Develop programming skills in assembly language for 8086 microprocessor and 8051 microcontrollers.

C503.4: Interface peripheral devices and memory with 8086 using 8255, 8257 and 8259

C503.5: Implement basic hardware interfaces and connections with 8051 microcontrollers.

C503.6: Interface microprocessors and microcontrollers with external devices using different communication protocols.

Unit - I 8086 Microprocessor

8086Architecture-Pin diagram, Register Organization, Memory Segmentation, Programming Model, Modes of operation, Timing diagrams, Memory addresses, Physical Memory Organization, interrupts of8086.

Instruction Set and Assembly Language Programming Of 8086: Instruction formats, addressing modes, Instruction Set, Assembler Directives, Macros, and Simple Programs involving Logical, Branch and Call Instructions, Sorting, String Manipulations, Software Debugging tools, MDS.

Unit - II 8086 Interfacing

I/O Interface: 8255 PPI, Various modes of operations and interface of I/O devices to 8086, A/D, D/A Converter Interfacing.

Interfacing With Advanced Devices: 8086 System bus structure, Memory and I/O Interfacing with8086, Interfacing through various IC Peripheral Chips, 8257 (DMA Controller), 8259 (Interrupt Priority Control).

Unit - III Communication Interface

Serial Communication Standards, USART Interfacing RS-232, IEEE-488,20mA Current Loop, Prototyping and Troubleshooting,

Unit - IV 8051 Microcontrollers

Introduction To Micro Controllers: Overview of 8051 Micro Controller, Architecture, I/O ports and Memory Organization, addressing modes and Instruction set of 8051, Simple Programs using Stack Pointer, Assembly language programming of 8051Interrupts Communication: Interrupts - Timer/Counter and Serial Communication, Interrupt Priority in the 8051, Programming of 8051- Timers, Counters and Interrupts.

Unit - V Interfacing And Industrial Applications

Applications of Micro Controllers, interfacing 8051 to LED's, Keyboard Interfacing, Interfacing Seven Segment Display, ADC and DAC Interfacing, Stepper Motor Interfacing.

TEXT BOOKS

1. Advanced Microprocessors and Peripherals – A. K. Ray and K.M. Bhurchandani, MHE, 2nd Edition 2006.
2. The 8051 Microcontroller, Kenneth. J. Ayala, Cengage Learning, 3rd Ed.

REFERENCE BOOKS

1. ARM System Developers guide, Andrew N SLOSS, Dominic SYMES, Chris WRIGHT, Elsevier,2012
2. Microprocessors and Interfacing, D. V. Hall, MGH, 2nd Edition 2006.
3. Introduction to Embedded Systems, Shibu K.V, MHE, 2009
4. The 8051 Microcontrollers, Architecture and Programming and Applications -K. Uma Rao, Andhe Pallavi, Pearson, 2009.

B.Tech. III Year I Semester

Course Code	Course Title	L	T	P	Credits
EE504PC	**POWER SYSTEM PROTECTION**	3	0	0	3

Prerequisites Power Systems-I, Power Systems-II

Course Description: A Power System Protection course typically covers the principles, techniques, and devices used to safeguard electrical power systems from faults and abnormal operating conditions. This course is essential for electrical engineers, power system operators, and professionals involved in the design, operation, and maintenance of electrical power systems.

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

C504.1 Evaluate the construction and working of circuit breakers for real time applications.

C504.2 Distinguish the relays based on their operating principle along with their usage.

C504.3 Differentiate various over current and Distance protection schemes.

C504.4 Probe the protection schemes for generation and transmission systems during faults

C504.5 Categorize the over voltage protection schemes.

C504.6 Understand the basics of static and microprocessor based relays.

Unit - I Circuit Breakers

Circuit Breakers: Introduction, arcing in circuit breakers, arc interruption theories, re-striking and recovery voltage, resistance switching, current chopping, interruption of capacitive current, oil circuit breaker, air blast circuit breakers, SF6 circuit breaker, operating mechanism, selection of circuit breakers, high voltage DC breakers, ratings of circuit breakers, testing of circuit breakers.

Unit - II Earthing and Protective Relays

Introduction, Need for power system protection, effects of faults, evolution of protective relays, zones of protection, primary and backup protection, essential qualities of protection. Neutral Grounding: Grounded and Ungrounded Neutral Systems. - Effects of Ungrounded Neutral on system performance. Methods of Neutral Grounding: Solid, Resistance, Reactance - Arcing Grounds. Classification of protective relays and schemes, current transformers, potential transformers. Electromagnetic relays and thermal relays.

Unit - III Over-Current Protection and Distance Protection

Over-Current Protection: Time-current characteristics, current setting, over current protective schemes, directional relay, protection of parallel feeders, protection of ring mains, Phase fault and earth fault protection, Combined earth fault and phase fault protective scheme, Directional earth fault relay.

Distance Protection: Impedance relay, reactance relay, MHO relay, input quantities for various types of distance relays, Effect of arc resistance, Effect of power swings, effect of line length and source impedance on the performance of distance relays, selection of distance relays, MHO relay with blinders, Reduction of measuring units, switched distance schemes, auto re-closing.

Unit - IV Protection against Over Voltages and AC Machines & Bus Bar Protection

Over voltages in power systems: Generation of over voltages in power systems, protection against lightning over voltages, valve type and zinc oxide lighting arresters.

Protection of Generators, Protection of transformers, Bus zone protection, frames leakage protection.

Unit - V Static and Microprocessor Based Relays

Static Relays: Amplitude and Phase comparators, Duality between AC and PC, Static amplitude comparator, integrating and instantaneous comparators, static phase comparators, coincidence type of phase comparator, static over current relays, static directional relay, static differential relay, static distance relays, Multi input comparators, concept of Quadrilateral and Elliptical relay characteristics.

Microprocessor Based Relays: Advantages, over current relays, directional relays, distance relays.

TEXT BOOKS

1. Badri Ram and D.N. Vishwakarma, Power System Protection and Switchgear, TMH 2001.
2. U. A. Bakshi, M. V. Bakshi: Switchgear and Protection, Technical Publications, 2009.

REFERENCE BOOKS

1. C. Russel Mason – "The art and science of protective relaying, Wiley Eastern, 1995
2. L. P. Singh "Protective relaying from Electromechanical to Microprocessors", New Age International.
3. Sunil S Rao, ―Switchgear and Protection, Khanna Publishers, 1st Edition, 2013
4. VK Mehta, Principles of power systems, S Chand Publications, 4th Edition, 2009.

B.Tech. III Year I Semester

Course Code	Course Title	L	T	P	Credits
EE505PC	**POWER ELECTRONICS LABORATORY**	0	0	2	1

Prerequisites Power Electronics

Course Description: This laboratory course is designed to complement theoretical knowledge in power electronics with practical skills in designing, building, and testing power electronic circuits. Students will gain hands-on experience with a variety of power electronic devices and systems commonly used in applications such as power supplies, motor drives, and renewable energy systems.

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

C505.1 Examine the characteristics of SCR, MOSFET and IGBT.

C505.2 Analyze different techniques to Turn-on and Turn-off an SCR.

C505.3 Analyze power electronic converters by varying gate pulses.

C505.4 Design Power Electronic converters using simulation tools.

Part-A: The following experiments are required to be conducted compulsory experiments:

1. Study of Characteristics of SCR, MOSFET & IGBT
2. Gate firing circuits for SCR's
3. Single-Phase AC Voltage Controller with R and RL loads
4. Single-Phase half controlled, fully controlled bridge converter with R and RL loads
5. Forced commutation circuits (Class A, Class B, Class C, Class D & Class E)
6. Single-Phase Cyclo-converter with R and RL loads
7. (a)Simulation of single-phase Half wave converter using R and RL loads
   (b)Simulation of single-phase full converter using R, RL and RLE loads
   (c)Simulation of single-phase Semi converter using R, RL and RLE loads
8. Single-Phase IGBT based Bridge inverter drive for Induction Motor

Part-B: In addition to the above eight experiments, at least any two of the experiments from the following list are required to be conducted:

1. Three-Phase half-controlled bridge converter with R-load
2. Single Phase dual converter with RL loads
3. Single-Phase series & parallel inverter with R and RL loads
4. Simulation of Buck chopper
5. Simulation of single-phase Inverter with PWM control
6. Simulation of three phase fully controlled converter with R and RL loads, with and without freewheeling diode. Observation of waveforms for Continuous and Discontinuous modes of operation.
7. Study of PWM techniques
8. (a)Simulation of Single-phase AC voltage controller using R and RL loads
   (b)Simulation of Single phase Cyclo-converter with R and RL-loads

B. Tech. III Year I Sem

Course Code	Course Title	L	T	P	Credits
EE506PC	**CONTROL SYSTEMS LABORATORY**	0	0	2	2

Lab Description: Understand system representations like transfer function and state space, and assess system dynamic response, evaluate system performance using both time and frequency domain analyses, identifying methods to enhance performance, and Design controllers and compensators to improve system performance based on the assessments from time and frequency domain analyses.

Course Outcomes: After completing this lab, the student must be able to

C506.1: Calculate the transfer function and observe the effect of feedback on the system.

C506.2: Analyse the response of systems in frequency & time domain.

C506.3: Examine the effect of controllers & Compensators on the system.

C506.4: Design the state space model of a linear system using simulation.

PART-A

The following experiments are required to be conducted compulsory experiments:

1. Characteristics of Synchro's
2. Effect of feedback on DC servo motor
3. Characteristics of AC servo motor
4. Time response of Second order system
5. Programmable logic controller – Study and verification of truth tables of logic gates and simple Boolean expressions
6. Examine the speed control in MATLAB/Simulink with PID Controller by finding Physical Transfer function of DC motor
7. Stability analysis (Bode, Root Locus, Nyquist) of Linear Time Invariant system using suitable software
8. State space model for classical transfer function using suitable software -Verification.

PART-B

In addition to the above eight experiments, at least any two of the experiments from the following list are required to be conducted

1. Effect of P, PD, PI, PID Controller on a second order systems
2. Temperature controller using PID
3. Transfer function of DC generator
4. Simulation of P, PI, PID Controller.
5. Linear system analysis (Time domain analysis, Error analysis) using suitable software
6. Design of Lead-Lag compensator for the given system and with specification using suitable software

Note: Minimum of 10 Experiments are to be performed

B.Tech. III Year I Semester

Course Code	Course Title	L	T	P	Credits
EE507PC	**MICROPROCESSORS AND MICROCONTROLLERS LABORATORY**	0	0	2	1

Course Description: In this course operations and programming of microprocessors and microcontrollers will be studied.

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

C507.1: Develop 8086 assembly language programs using macro assembler.

C507.2: Interface peripheral devices to 8086 processor using serial and parallel communication.

C507.3: Write 8051 assembly language programs for simple arithmetic and logical operations and verify using Keil IDE.

C507.4: Interface various input/output devices to 8051 microcontroller using development kit.

The following programs/experiments are to be written for assembler and to be executed the same with 8086 and 8051 kits.

List of Experiments:

1. Programs for 16-bit arithmetic operations 8086(using various addressing modes)
2. Programs for sorting an array for 8086.
3. Programs for searching for a number of characters in a string for 8086.
4. Programs for string manipulation for 8086.
5. Programs for digital clock design using 8086.
6. Interfacing ADC and DAC to 8086.
7. Parallel communication between two microprocessor kits using 8255.
8. Serial communication between two microprocessor kits using 8251.
9. Interfacing to 8086 and programming to control stepper motor.
10. Programming using arithmetic, logical and bit manipulation instructions of 8051.
11. Program and verify Timer/Counter in 8051.
12. Program and verify interrupt handling in 8051.
13. UART operation in 8051.
14. Communication between 8051 kit and PC
15. Interfacing LCD to 8051
16. Interfacing Matrix/Keyboard to 8051
17. Data transfer from peripheral to memory through DMA controller 8237/8257

B. Tech. III Year I Semester

Course Code	Course Title	L	T	P	Credits
***MC508**	**INTELLECTUAL PROPERTY RIGHTS**	3	0	0	0

Pre - Requisite Nil

Course Description: To provide the students with the conceptual framework and the theories underlying Organizational Behaviour.

Course Outcomes

C508.1: Understand the fundamental aspects of Intellectual property Rights who are going to play major role in development and management of innovative projects in industries.

C508.2: Examine Trademarks, Acquisition of Trade Mark Rights and its registration processes.

C508.3: Evaluate various aspects relating to copyrights and its procedure for registration processes.

C508.4: Evaluate with the Trade Secret Law, protection for submission, Unfair Competition.

C508.5: Evaluate on the International Developments in Intellectual Property Rights.

C508.6: Interpret about current trends in IPR and the steps taken by the Government of India in fostering IPR.

Unit - I Introduction to Intellectual property (8 Hours)

Introduction, types of intellectual property, international organizations, agencies and treaties, importance of intellectual property rights.

Unit - II Trade Marks (10 Hours)

Purpose and function of trademarks, acquisition of trade mark rights, protectable matter, selecting, and evaluating trade mark, trade mark registration processes.

Unit - III Law of copy rights (10 Hours)

Fundamental of copy right law, originality of material, rights of reproduction, rights to perform the work publicly, copy right ownership issues, copy right registration, notice of copy right, international copy right law. Law of patents: Foundation of patent law, patent searching process, ownership rights and transfer

Unit - IV Trade Secrets (10 Hours)

Trade secrete law, determination of trade secrete status, liability for misappropriations of trade secrets, protection for submission, trade secrete litigation. Unfair competition: Misappropriation right of publicity, false advertising.

Unit - V New development of intellectual property (10 Hours)

New developments in trade mark law; copy right law, patent law, intellectual property audits. International overview on intellectual property, international – trade mark law, copy right law, international patent law, and international development in trade secrets law.

TEXT BOOKS:

1. Intellectual property right, Deborah. E. Bouchoux, Cengage learning.
2. Intellectual property right – Unleashing the knowledge economy, prabuddha ganguli, Tata McGraw Hill Publishing company ltd.

B.Tech. III Year I Semester

Course Code	Course Title	L	T	P	Credits
EE511PE	PROGRAMMABLE LOGIC CONTROLLER (Professional Elective-I)	3	0	0	0

Prerequisites Basic understanding of electrical circuits and industrial automation concepts.

Course Description: The objective of this course is to introduce students to the fundamentals of Programmable Logic Controllers (PLCs) and their role in industrial automation. By the end of the course, students will gain a comprehensive understanding of PLC hardware, programming languages, and applications in various industrial sectors.

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

C511.1: Understand the significance of Programmable Logic Controllers (PLCs) in industrial automation and their role in enhancing efficiency and productivity in modern manufacturing processes

C511.2: Identify different types of PLCs and comprehend the basic architecture of a PLC system, including the CPU, I/O modules, and communication interfaces.

C511.3: Gain knowledge of the various modules of a PLC and their functions within the control system

C511.4: Familiarize with programming standards used for PLC programming.

C511.5: Understand basics of ladder programming and understand the instructions set of PLCs

C511.6: Explore the implementation of PLC in real-world industrial applications

Unit - I Introduction to Programmable Logic Controllers (PLCS)

Introduction, Importance of PLC, Type of PLC's and basic architecture of CPU, Different modules of PLC, Programming standards, software tools for PLC Programming, IEC standards for Programming language of PLC, Ladder programming, Instructions set of PLC.

Unit - II PLC Hardware and Architecture

PLC hardware components and their functions, including CPU types, I/O modules, communication interfaces, etc. Classification of PLCs based on architecture: Compact PLCs, Modular PLCs, Rack-mounted PLCs, etc.

Unit - III Introduction to PLC Programming Software

Basic programming concepts: Boolean logic, timers, counters, arithmetic operations, comparison instructions, etc. Programming of PLC using structured text, Instruction list, Function block diagram, Sequential Flow chart.

Unit - IV PLC Functions

PLC intermediate functions: Arithmetic functions, number comparison functions, Skip and MCR functions, data move systems. PLC Advanced intermediate functions: Utilizing digital bits, sequencer functions, matrix functions.

Unit - V Real-World Applications of PLCs in Various Industries

Real-world applications of PLCs in various industries (manufacturing, automotive, food processing, etc.). Case studies of successful PLC implementations and their impact on industrial automation

TEXT BOOKS:

1. Frank D. Petruzella, Programmable logic controller, Tata-McGraw Hill publication
2. John W. Webb and Ronald A. Reis, Programmable Logic Controllers: Principles and Applications, PHI Publication

REFERENCE BOOKS:

1. John R. Hackworth and Frederick D. Hackworth Jr., Programmable Logic Controllers Programming methods and application, Pearson Publication.
2. G. Dunning, Introduction to Programmable Logic Controllers, Cengage Learning

B.Tech. III Year I Semester

Course Code	Course Title	L	T	P	Credits
EE512PE	**AI TECHNIQUES IN ELECTRICAL ENGINEERING (Professional Elective –I)**	3	0	0	3

Prerequisites Power Systems Operation and Control

Course Description: This course provides a full understanding of the concepts of neural networks, artificial intelligence, and fuzzy logic control, it is essential to design and implement fuzzy control systems. Moreover, examining soft computing techniques such as artificial neural networks and genetic algorithms is critical for developing advanced control design methodologies.

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

C512.1: Interpret biological neurons to a mathematical model, learning rules, and ANN Architectures.
C512.2: Elucidate multi-layer perceptron models, Associate memory, and Hopfield networks.
C512.3: Appraise fuzzy logic theory with respect to Classical set theory
C512.4: Analyze genetic algorithms, operations, and genetic mutations.
C512.5: Elucidate ANN models, and fuzzy logic control for applications in electrical engineering.
C512.6: Elucidate genetic algorithms for applications in electrical engineering

Unit - I Artificial Neural Networks

Introduction, Characteristics of ANN, Types of Neuron Activation Functions, ANN Architectures, Learning process -Error correction learning – Hebbian learning – Competitive learning – Boltzmann learning – Supervised learning – Unsupervised learning, Applications of AI.

Unit - II ANN Paradigms

Multi-layer perceptron using Backpropagation Algorithm (BPA), Self - Organizing Map (SOM), Radial Basis Function Network-Functional Link Network (FLN), Hopfield Network.

Unit - III Fuzzy logic

Introduction - Fuzzy versus crisp, Fuzzy Sets-Membership function - Basic Fuzzy set operations, Properties of Fuzzy sets - Fuzzy Cartesian Product, Operations on Fuzzy relations - Fuzzy logic - Fuzzy Quantifiers, Fuzzy Inference-Fuzzy Rule-based system, De-fuzzification methods, Applications of fuzzy controls for grid inverter to improve the power quality issues.

Unit - IV Genetic Algorithms

Introduction-Encoding –Fitness Function-Reproduction operators, Genetic Modeling - Genetic Operators-Cross over-Single site cross over, two points cross over-Multi point cross over Uniform cross over, Matrix cross over-Cross over Rate-Inversion & Deletion, Mutation operator -Mutation –Mutation Rate-Bit-wise operators, Generational cycle-convergence of Genetic Algorithm, Applications of GA in Optimal utilization of Renewable Energy.

Unit - V Applications of AI Techniques in Electrical Engineering:

Applications Of AI Techniques: Prediction of renewable energy (Solar and wind), cost prediction of RES, Load flow studies, Economic load dispatch, Energy Management using AI techniques, Speed control of DC and AC Motors using AI methods. Grid GPT/AI Powered Grid.

TEXT BOOKS

1. S. Rajasekaran and G.A.V. Pai Neural Networks, Fuzzy Logic & Genetic Algorithms, PHI, New Delhi, 2003.
2. Rober J. Schalkoff, Artificial Neural Networks, Tata McGraw Hill Edition, 2011.

REFERENCE BOOKS

1. Success stories of Energy Conservation by BEE, New Delhi (www.bee-india.org) P. D. Wasserman; Neural Computing Theory & Practice, Van Nostrand Reinhold, New York,1989.
2. Bart Kosko; Neural Network & Fuzzy System, Prentice Hall, 1992
3. D. E. Goldberg, Genetic Algorithms, Addison-Wesley 1999.

B.Tech. III Year I Semester

Course Code	Course Title	L	T	P	Credits
EE513PE	SPECIAL MACHINES (Professional Elective-I)	3	0	0	3

Prerequisites Electrical Machines-I& Electrical Machines-II

Course Description: Electrical Machines are the heart of every system and the electrical power sector is the need of society and nation. This course gives an overview of Special Electrical Machines for control and industrial applications.

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

C513.1: Illustrate the construction and working principle of FHP motors.

C513.2: Assess the performance of different types of BLDC motors.

C513.3: Analyze the theory of operation and control of Switched Reluctance Motor and Synchronous Reluctance Motor.

C513.4: Illustrate the theory of operation and performance of PMSM.

C513.5: Understand the principle of operation and control strategies of Linear Motors.

C513.6: Identify appropriate machine for specific application.

Unit - I

Fractional Horse Power (FHP) Motors:

Commutator Motors-Repulsion type Motors-Stepper Motors-Printed Circuit Board Motors-Qualitative treatment only-Applications.

Unit - II

Permanent Magnet Brushless DC (BLDC) Motors: Types- Principle of operation-Magnetic circuit analysis EMF and Torque equations- Characteristics- Controller Design-Transfer function -Machine, Load and Inverter-Current and Speed Controller-Applications.

Unit - III

Switched Reluctance Motors (SRM): Constructional features – Rotary and Linear SRM - Principle of operation – Torque production – Steady state performance prediction- Analytical method –Power Converters and their controllers – Methods of Rotor position sensing – Sensor less operation – Characteristics and Closed loop control – Applications.

Synchronous Reluctance Motors (Synrel Motors OR SYRM):

Constructional features – Types – Axial and Radial flux motors – Operating principles – Variable Reluctance Motors – Voltage and Torque Equations - Phasor diagram - performance characteristics – Applications.

Unit - IV

Permanent Magnet Synchronous Motors (PMSM):

Principle of operation – Ideal PMSM – EMF and Torque equations – Armature MMF – Synchronous Reactance –Sine wave motor with practical windings - Phasor diagram – Torque/speed characteristics - Power controllers -Converter Volt-ampere requirements– Applications.

Unit - V

Linear Motors:

Linear Induction Motor (LIM): Construction features, Principle of operation, Thrust equation, Concept of Current sheet, Goodness factor, Equivalent circuit, Performance characteristics, Control strategies -Applications.

Linear Synchronous Motors (LSM): Construction features, Principle of operation, Thrust equation, Control strategies, Applications.

Linear Levitation Machines (LLM): Principle of operation, Attraction and repulsion types of LLM, Goodness factor and Levitation Stiffness-Applications.

TEXT BOOKS

1. Special Electrical Machines, K.Venkata Ratnam, University press, 2009, New Delhi.
2. Brushless Permanent Magnet and Reluctance Motor Drives, Clarenden press, T.J.E. Miller, 1989, Oxford.
3. Special Electrical Machines, E.G. Janardhanan, PHI learning private limited, 2014.
4. P. S. Bimbhra, “Electrical Machinery”, Khanna Publishers, 2011.
5. I.J. Nagrath and D. P. Kothari, “Electric Machines”, McGraw Hill Education, 2010.

REFERENCE BOOKS

1. Prithwiraj Purkait, Indrayudh Bandyopadhyay, “Electrical Machines”, Oxford, 2017.
2. M. G. Say, “Performance and design of AC machines”, CBS Publishers, 2002.
3. A. E. Fitzgerald and C. Kingsley, "Electric Machinery”, New York, McGraw Hill Education, 2013.
4. A. E. Clayton and N. N. Hancock, “Performance and design of DC machines”, CBS Publishers, 2004.
5. J.B. Gupta, “Theory and Performance Electrical Machines”, Katsons Book Publisher,2015.
6. S.K. Sahdev, “Electrical Machines”, Cambridge University Press,2017.

B.Tech. III Year I Semester

Course Code	Course Title	L	T	P	Credits
EE514PE	**SIGNALS AND SYSTEMS (Professional Elective-I)**	3	0	0	3

Prerequisites Mathematics

Course Description: The course presents and integrates the basic concepts for both continuous-time and discrete-time signals and systems and their analysis using various transformation techniques. Further it presents the sampling theorem and its types.

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

C514.1: Understand various signals and systems

C514.2: Analyze the spectral characteristics of continuous and discrete signals.

C514.3: Analyze the signal transmission through linear time invariant systems.

C514.4: Analyze Signals and Systems using Laplace and Z Transforms

C514.5: Illustrate the need of sampling theorem for analog to digital signal Conversion

C514.6: Explain the applications of signal and system theory

Unit - I Introduction to Signals and Systems

Signals and systems as seen in everyday life, and in various branches of engineering and science. Signal properties: periodicity, absolute integrability, determinism and stochastic character. Some special signals of importance: the unit step, the unit impulse, the sinusoid, the complex exponential, some special time-limited signals; continuous and discrete time signals, continuous and discrete amplitude signals. System properties: linearity: additivity and homogeneity, shift-invariance, causality, stability, reliability. Examples.

Unit - II Fourier Transforms

Fourier Analysis: Fourier series representation of periodic signals, Waveform Symmetries, Calculation of Fourier Coefficients. Fourier Transforms and its properties, convolution/multiplication and their effect in the frequency domain, magnitude and phase response, Fourier domain duality. Parseval's Theorem.

Unit - III Behaviour of Continuous and Discrete-Time LTI Systems

Impulse response and step response, convolution, input-output behaviour with aperiodic convergent inputs, cascade interconnections. Characterization of causality and stability of LTI systems. System representation through differential equations and difference equations. State-space Representation of systems. State-Space Analysis, Multi-input, multi-output representation. State Transition Matrix and its Role. Periodic inputs to an LTI system, the notion of a frequency response and its relation to the impulse response.

Unit - IV Laplace Transforms and Z-Transforms

Review of the Laplace Transform for continuous time signals and systems, system functions, poles and zeros of system functions and signals, Laplace domain analysis, solution to differential equations and system behavior. The z-Transform for discrete time signals and systems, system functions, poles and zeros of systems and sequences, z-domain analysis.

Unit - V Sampling and Reconstruction

The Sampling Theorem and its implications. Spectra of sampled signals. Reconstruction: ideal interpolator, zero-order hold, first-order hold. Aliasing and its effects. Relation between continuous and discrete time systems. Introduction to the applications of signal and system theory: modulation for communication, filtering, feedback control systems.

TEXT BOOKS

1. B.P. Lathi -Signals, Systems & Communications, BSP, 2013.
2. A.V. Oppenheim, A.S. Willsky and S.H. Nawabi -Signals and Systems, 2nd Ed., Prentice Hall

REFERENCE BOOKS

1. Simon Haykin and Van Veen, A. Rama Krishna Rao, -Signals and Systems, TMH, 2008.
2. Michel J. Robert - Fundamentals of Signals and Systems, MGH International Edition, 2008.
3. C. L. Philips, J. M. Parr and Eve A. Riskin -Signals, Systems and Transforms, 3rd Ed., PE, 2004.

B.Tech. III Year II Semester

Course Code	Course Title	L	T	P	Credits
SM601MS	**BUSINESS ECONOMICS AND FINANCIAL ANALYSIS**	3	0	0	3

Pre - Requisite

Course Description: The course contains various topics related to forms of Business and the impact of economic variables on the Business. It includes the Demand, Supply, Production, Cost, Market Structure and Pricing aspects in business. The students can study the firm's financial position by analyzing the Financial Statements of a Company which can be used in their engineering career development.

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

C601.1: Understand the Economic Concepts in business decision making process.

C601.2: miliarize with the cost concepts, market structures.

C601.3: Make use of break-even analysis, CVP Analysis, pricing strategies.

C601.4: Examine financial accounting and analyze various financial statements.

C601.5: Interpret various financial statements by applying different types of ratios.

C601.6: Examine the usefulness of Investment decisions of a company.

Unit - I INTRODUCTION TO BUSINESS AND ECONOMICS (10 Hours)

Business: Introduction to business, Structure of Business Firm, Types of Business Entities: Sole Proprietorship, Partnership, Limited Liability Company & Co-operatives, Sources of Capital for a Company: Conventional, Non-Conventional Sources of Finance. Theory of Firm.

Economics: Significance of Economics, Micro and Macro Economic Concepts, Concepts and Importance of National Income, Inflation, Money Supply and Inflation, Business Cycle, Features and Phases of Business Cycle. Nature and Scope of Business Economics, Role of Business Economist, Multidisciplinary nature of Business Economics.

Unit - II DEMAND AND SUPPLY ANALYSIS (9 Hours)

Demand: Demand Determinants, Law of Demand

Elasticity of Demand: Elasticity, Types of Elasticity, Measurement and Significance of Elasticity of Demand, Factors affecting Elasticity of Demand, Elasticity of Demand in decision making, Demand Forecasting: Characteristics of Good Demand Forecasting, Steps in Demand Forecasting, Methods of Demand Forecasting.

Supply Analysis: Determinants of Supply, Supply Function and Law of Supply.

Unit - III PRODUCTION, COST, MARKET STRUCTURES & PRICING (10 Hours)

Production Analysis: Factors of Production, Production Function, Production Function with one variable input, two variable inputs, Returns to Scale, Different Types of Production Functions.

Cost analysis: Types of Costs, Short run and Long run Cost Functions.

Market Structures: Nature of Competition, Perfect competition, Monopoly, Oligopoly, Monopolistic Competition: Features and Price Determination.

Pricing: Types of Pricing, Product Life Cycle based Pricing, Break Even Analysis, and Cost Volume Profit Analysis.

Unit - IV FINANCIAL ACCOUNTING (10 Hours)

Accounting concepts and Conventions, Accounting Equation, Double-Entry system of Accounting, Rules for maintaining Books of Accounts, Journal, Posting to Ledger, Preparation of Trial Balance, Elements of Financial Statements, Preparation of Final Accounts.

Unit - V FINANCIAL ANALYSIS THROUGH RATIOS (9 Hours)

Concept of Ratio Analysis, Importance, Liquidity Ratios, Turnover Ratios, Profitability Ratios, Proprietary Ratios, Solvency, Leverage Ratios – Analysis and Interpretation (simple problems).

TEXT BOOKS:

1. Geethika Ghosh, Piyali Gosh, Purba Roy Choudhury, Managerial Economics, 2e, Tata Mc Graw Hill Education Pvt. Ltd. 2012.
2. D. D. Chaturvedi, S. L. Gupta, Business Economics - Theory and Applications, International Book House Pvt. Ltd. 2013.
3. Dhanesh K Khatri, Financial Accounting, Tata Mc –Graw Hill, 2011.

REFERENCE BOOKS:

1. S. N. Maheshwari, Sunil K Maheshwari, Sharad K Maheshwari, Financial Accounting, 5e, Vikas Publications, 2013.
2. Paresh Shah, Financial Accounting for Management 2e, Oxford Press, 2015.
3. Managerial Economics: Theory and Applications, D.M. Mithani, Himalaya Publishing House, 2017.

B.Tech. III Year II Semester

Course Code	Course Title	L	T	P	Credits
EE602PC	DIGITAL SIGNAL PROCESSING	3	0	0	3

Prerequisites: Numerical methods and complex variables

Course Description: This course is to comprehend digital signal analysis and processing, covering key concepts such as signal representation, sampling, analog-to-digital conversion, efficient computation of the Discrete Fourier Transform (DFT) through the Fast Fourier Transform (FFT) algorithm, studying the design and structure of digital filters (IIR and FIR), emphasizing analysis and synthesis for specific specifications, as well as familiarization with multi-rate signal processing techniques and addressing finite word length effects for system robustness and accuracy.

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

C602.1: Determine the behavior of LTI systems by solving difference equation

C602.2: Analyze digital signals in frequency domain using DFS and DFT

C602.3: Compute DFT using FFT algorithms

C602.4: Design and implement IIR and FIR digital filters

C602.5: Understand the concepts of multi rate digital signal processing

C602.6: Analyze the effects of finite word length representation

Unit - I

Introduction to Digital Signal Processing: Block diagram, Advantages and applications, Discrete Time Signals & Sequences, Normalized Frequency, Linear Shift Invariant Systems, Linear Constant Coefficient Difference Equations, System Function, Solution of Difference Equations of Digital Filters using Z-transforms.

Unit - II

Discrete Fourier Series and Transform: DFS Representation of Periodic Sequences, Properties of Discrete Fourier Series, Discrete Fourier Transforms: Properties of DFT, Linear Convolution of Sequences using DFT, Computation of DFT: Over-Lap Add Method, Over-Lap Save Method.

Fast Fourier Transforms: Fast Fourier Transforms (FFT) - Radix-2 Decimation-in-Time and Decimation-in-Frequency FFT Algorithms, Inverse FFT.

Unit - III

IIR Digital Filters: Analog filter approximations – Butterworth and Chebyshev, Design of IIR Digital Filters from Analog Filters, Step and Impulse Invariant Techniques, Bilinear Transformation Method, Spectral Transformations. Realization of Digital Filters – Direct, Canonic, Cascade and Parallel Forms.

Unit - IV

FIR Digital Filters: Characteristics of FIR Digital Filters, Frequency Response. Design of FIR Filters: Fourier Method, Digital Filters using Window Techniques, Frequency Sampling Technique, Comparison of IIR & FIR filters. Realization of FIR Digital Filters – Direct, Cascade, Parallel and Linear phase forms.

Unit - V

Multirate Digital Signal Processing: Introduction, Down Sampling, Decimation, Up sampling, Interpolation, Sampling Rate Conversion.

Finite Word Length Effects: Limit cycles, Overflow Oscillations, Round-off Noise in IIR Digital Filters, Computational Output Round Off Noise, Methods to Prevent Overflow, Trade Off Between Round Off and Overflow Noise, Measurement of Coefficient Quantization Effects through Pole-Zero Movement, Dead Band Effects

TEXT BOOKS

1. Digital Signal Processing, Principles, Algorithms, and Applications, John G. Proakis, Dimitris G. Manolakis, Pearson Education / PHI, 2007.
2. Discrete Time Signal Processing, A. V. Oppenheim and R.W. Schaffer, PHI, 2009

REFERENCE BOOKS

1. Digital Signal Processing, S. Salivahanan, A. Vallavaraj and C. Gnanapriya, TMH, 2009.
2. Digital Signal Processing - A Practical approach, Emmanuel C. Ifeachor and Barrie W. Jervis, 2nd Edition, Pearson Education, 2009.
3. Digital Signal Processing – Fundamentals and Applications, Li Tan, Elsevier, 2008
4. Fundamentals of Digital Signal Processing using MATLAB, Robert J. Schilling, Sandra L. Harris, Thomson, 2007

B.Tech. III Year II Semester

Course Code	Course Title	L	T	P	Credits
EE603PC	**POWER SYSTEM OPERATION AND CONTROL**	3	0	0	3

Prerequisites Power System-I, Power System-II

Course Description: Power System Operation and Control is a course focusing on the dynamic behavior and control of modern electrical power systems. The course covers the principles, techniques, and methodologies employed in the operation, monitoring, and control of interconnected power grids. Emphasis is placed on understanding the dynamic behavior of power systems under various operating conditions, as well as the design and implementation of control strategies to ensure stability, reliability, and efficiency.

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

C603.1: Evaluate the performance of power system network using Load flow studies.

C603.2: Evaluate the procedure for optimal scheduling of thermal power plants.

C603.3: Gain knowledge of frequency control in single area and two area system.

C603.4: Familiarize with modeling of power system components.

C603.5: Explore the implementation of SCADA and EMS functions.

C603.6 Understand Transient and Steady state stability of Power System

Unit - I Load flow studies

Introduction, Bus classification -Nodal admittance matrix - Load flow equations - Iterative methods - Gauss and Gauss Seidel Methods, Newton-Raphson Method-Fast Decoupled Method-Merits and demerits of the above methods-System data for load flow study.

Unit - II Economic operation of power systems

Unit Commitment-Distribution of load between units within a plant-Transmission loss as a function of plant generation, Calculation of loss coefficients-Distribution of load between plants.

Unit - III Load- Frequency Control

Introduction, load frequency problem-Megawatt frequency (or P-f) control channel, MVAR voltages (or Q-V) control channel-Dynamic interaction between P-f and Q-V loops. Mathematical model of speed-governing system-Turbine models, division of power system into control areas, P-f control of single control area (the uncontrolled and controlled cases)-P-f control of two area systems (the uncontrolled cases and controlled cases).

Unit - IV Power system stability

The stability problem-Steady state stability, transient stability and Dynamic Stability-Swing equation. Equal area criterion of stability-Applications of Equal area criterion, Step by step solution of swing equation-Factors affecting transient stability, Methods to improve steady state and Transient stability, Introduction to voltage stability.

Unit - V SCADA and Energy Management System

Need of computer control of power systems. Concept of energy control center (or) load dispatch center and the functions - system monitoring - data acquisition and control. System hardware configuration – SCADA and EMS functions. Network topology – Importance of Load Forecasting and simple techniques of forecasting.

TEXT BOOKS

1. C. L. Wadhwa, Electrical Power Systems, 3rd Edn, New Age International Publishing Co., 2001.
2. D. P. Kothari and I. J. Nagrath, Modern Power System Analysis, 4th Edn, Tata McGraw Hill Education Private Limited 2011.

REFERENCE BOOKS

1. D. P. Kothari: Modern Power System Analysis-Tata Mc Graw Hill Pub. Co. 2003.
2. Hadi Sadat: Power System Analysis –Tata Mc Graw Hill Pub. Co. 2002.

B.Tech. III Year II Semester

Course Code	Course Title	L	T	P	Credits
EE604PC	**POWER SYSTEM LABORATORY**	0	0	2	1

Prerequisites Power System-I, Power System-II, Power System Protection, Power System operation and control, Electrical Machines.

Course Description: The Power System Lab course is designed to complement theoretical knowledge with practical skills in the field of electrical power systems. Through a series of laboratory experiments, students will gain hands-on experience with various components and systems commonly found in power generation, transmission, and distribution networks. The course will demonstrate the principles of power system operation including protection.

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

C604.1: Plot the characteristics of IDMT relay and Microprocessor based relay.

C604.2: Analyze the response differential relay.

C604.3: Evaluate the performance of power system network by simulation

C604.4: Examine the effect of compensation.

The following experiments are required to be conducted as compulsory experiments

Part-A

1. Characteristics of IDMT Over-Current Relay.
2. Differential protection of 1-Φ transformer.
3. Finding the sequence impedances of 3-Φ Transformer.
4. A, B, C, D constants of a Long Transmission line
5. Load Flow Analysis using Gauss Seidel (GS) Method using MATLAB.
6. Load Flow Analysis using Newton Raphson (NR) Method using MATLAB.
7. Load Flow Analysis using Fast Decoupled (FD) Method using MATLAB.
8. Simulation of load frequency dynamics for a single area and two area system using MATLAB

In addition to the above eight experiments, at least any two of the experiments from the following list are required to be conducted

1. Finding the sequence impedances of 3-Φ synchronous machine.
2. Characteristics of Micro Processor based Over Voltage/Under Voltage relay.
3. MATLAB program for optimal loading of generators with penalty factors.
4. Simulation of Compensated Line using MATLAB.
5. MATLAB program to solve Swing equation using point by point method.

TEXT BOOKS:

1. C.L. Wadhwa, Electrical Power Systems, 3rd Edition, New Age International Pub. Co., 2001.
2. Hadi Sadat: Power System Analysis –Tata Mc Graw Hill Pub. Co. 2002.

REFERENCE BOOKS:

1. D. P. Kothari: Modern Power System Analysis-Tata Mc Graw Hill Pub. Co. 2003

B.Tech. III Year II Semester

Course Code	Course Title	L	T	P	Credits
EE605HS	**ADVANCED ENGLISH COMMUNICATION SKILLS LABORATORY**	0	0	2	1

Prerequisites Nil

Course Objectives: The course should enable the students to:

1. Imbibe an impressive personality, etiquette, professional ethics & values, effective time management & goal setting.
2. Understand the elements of professional update & upgrade through industry exposure in a mini-live project. Understand confidence building strategies and thereby to make effective presentations through PPTs.
3. Learn what constitutes proper grooming and etiquette in a professional environment while acquiring the necessary skills to make a smooth transition from campus to corporate

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

C604.1: Apply personality development principles to enhance their career readiness.

C604.2: Understand professional etiquette and confidently partake in professional interactions.

C604.3: Execute English language competencies in various forms of academic and professional reading and writing.

C604.4: Differentiate the communication skills of group discussion, presentation, interviews and collaborative projects.

Exercise-I

Main Topics: Thinking Skills, Personality Development, self-confidence and assertiveness,

Flipped Sessions: Personal Sensitivity & Professional Sensibility (Reading & Discussion)

Writing Input: Writing to Express - Drafting & Delivering a Speech (Free Writing Exercise)

Exercise-II

Main Topics: Group Discussion: Dynamics of group discussion, intervention, summarizing, modulation of voice, body language, relevance, fluency and coherence.

Flipped Sessions: Importance of Professional Updating & Upgrading (Reading & Discussions)

Writing Input: Writing with Precision - Writing Abstracts

Exercise-III

Main Topics: Interview Skills – concept and process, pre-interview planning, opening strategies, answering strategies, mock interviews. Resume' writing – structure and presentation, planning, defining the career objective, projecting one's strengths and skills.

Flipped Sessions: Mock Interviews (Video Sessions & Practice)

Writing Input: Writing to Reflect - Resume Writing

Exercise-IV

Main Topic: Corporate Culture – Grooming and etiquette, communication media, academic ethics and integrity

Flipped Sessions: Corporate Culture, Etiquette & Grooming (Video Sessions & Practice through Role-play)

Writing Input: Writing to Define - Writing an effective SOP.

Exercise-V

Main Topic: Mini Project – General/Technical. Research, developing a questionnaire, data collection, analysis, written report and project seminar. Elements & Structure of effective presentation. Presentation tools – Body language, Eye-contact, Props & PPT.

Flipped Sessions: Effective Presentations (Video & Writing Sessions, Practice through Emulation)

Writing Input: Writing to Record - Writing minutes of meeting.

REFERENCE BOOKS:

1. Madhavi Apte, "**A Course in English communication**", Prentice-Hall of India, 2007
2. Dr. Shalini Verma, **"Body Language- Your Success Mantra**", S Chand, 2006
3. Ramesh, Gopalswamy, and Mahadevan Ramesh, "**The ACE of Soft Skills",** New Delhi: Pearson, 2010
4. Van Emden, Joan, and Lucinda Becker, "**Presentation Skills for Students**", New York: Palgrave Macmillan, 2004

* Flipped Class-room: Students explore the concept first and then trainer explains it, students work on their own.

Web sources:

1. https://www.goskills.com/Soft-Skills
2. https://www.trainerbubble.com
3. https://www.skillsconverged.com

B.Tech. III Year II Semester

Course Code	Course Title	L	T	P	Credits
EE606PC	**DIGITAL SIGNAL PROCESSING LABORATORY**	0	0	2	1

Course Description: This course is to validate diverse digital signal processing (DSP) algorithms through thorough simulation and subsequently implement them in hardware for real-world applications.

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

C606.1: Generate sinusoidal and noise waveforms using different approaches.

C606.2: Analyze Impulse and frequency response of various digital filters.

C606.3: Verify different algorithms of DSP through simulation.

C606.4: Implement various DSP algorithms in hardware.

List of Experiments:

1. Generation of Sinusoidal Waveform / Signal based on Recursive Difference Equations
2. Histogram of White Gaussian Noise and Uniformly Distributed Noise.
3. To find DFT / IDFT of given DT Signal
4. To find Frequency Response of a given System given in Transfer Function/ Differential equation form.
5. Obtain Fourier series coefficients by formula and using FFT and compare for half sine wave.
6. Implementation of FFT of given Sequence
7. Determination of Power Spectrum of a given Signal(s).
8. Real-Time Pitch Detection of Speech Signal Using FFT.
9. Implementation of LP FIR Filter for a given Sequence/Signal.
10. Implementation of HP IIR Filter for a given Sequence/Signal
11. To find the roundoff noise in IIR digital filters
12. Generation of DTMF Signals
13. Implementation of Decimation Process
14. Implementation of Interpolation Process
15. Implementation of I/D Sampling Rate Converters
16. Impulse Response of First order and Second Order Systems.

B.Tech. III Year II Semester

Course Code	Course Title	L	T	P	Credits
*MC608	**CONSTITUTION OF INDIA**	3	0	0	0

Pre - Requisite Nil

Course Description: The students will be able to understand the history of Indian Constitution, and to understand the premises informing the twin themes of liberty and freedom from a civil rights perspective. It is to address the role of socialism in India after the commencement of the Bolshevik Revolution and develops the spirit of nationalism.

Course Outcomes

C608.1: Discuss the growth of the demand for civil rights in India for the bulk of Indians before the arrival of Gandhi in Indian politics.

C608.2: Discuss the intellectual origins of the framework of argument that informed the conceptualization of social reforms leading to revolution in India.

C608.3: Discuss the circumstances surrounding the foundation of the Congress Socialist Party under the leadership of Jawaharlal Nehru and the eventual failure of the proposal of direct elections through adult suffrage in the Indian Constitution.

C608.4: Discuss the passage of the Hindu Code Bill of 1956.

C608.5: Understand the Parliamentary form of Government in India.

C608.6: Discuss the role and importance of Local Administration.

Unit - I History and Philosophy of the Indian Constitution (6 Hours)

History of Drafting Committee, Preamble and Salient Features of the Indian Constitution.

Unit - II Contours of Constitutional Rights & Duties (11 Hours)

Fundamental Rights: Right to Equality, Right to Freedom, Right against Exploitation, Right to Freedom of Religion, Cultural and Educational Rights, Right to Constitutional Remedies, Directive Principles of State Policy. Fundamental Duties.

Unit - III Organs of Governance (10 Hours)

Parliament, Composition, Qualifications and Disqualifications, Powers and Functions, Executive, President, Governor, Council of Ministers, Judiciary, Appointment and Transfer of Judges, Qualifications, Powers and Functions.

Unit - IV Local Administration (11 Hours)

District's Administration head: Role and Importance, Municipalities: Introduction, Mayor and role of Elected Representative, CEO of Municipal Corporation. Panchayat raj: Introduction, PRI: Zila Panchayat. Elected officials and their roles, CEO Zila Panchayat: Position and role. Block level: Organizational Hierarchy (Different departments), Village level: Role of Elected and Appointed officials, Importance of grass root democracy.

Unit - V Election Commission (10 Hours)

Election Commission: Role and Functioning. Chief Election Commissioner and Election Commissioners. State Election Commission: Role and Functioning. Institute and Bodies for the welfare of SC/ST/OBC and women.

Suggested Reading:

1. The Constitution of India, 1950 (Bare Act), Government Publication.
2. Mahendra Pal Singh, V.N.Shukla's Constitution of India, Eastern Book Company, 2017.
3. D.D. Basu, Introduction to the Constitution of India, Lexis Nexis, 2015.
4. J.N. Pandey, Constitutional Law of India, Central Law Agency, 2018.

B.Tech. III Year II Semester

Course Code	Course Title	L	T	P	Credits
EE611PE	**WIND AND SOLAR ENERGY SYSTEMS (Professional Elective-II)**	3	0	0	3

Prerequisites Renewable Energy Systems

Course Description: This course aims at bringing the technological developments and research trends in the field of non-conventional energy sources with emphasis on engineering and design aspects.

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

- **C611.1:** Distinguish between the sustainable energy sources and fossil energy sources with emphasis on Wind and Solar power generation systems.
- **C611.2:** Understand the basic physics of Wind and Solar power generation.
- **C611.3:** Analyze the Wind generator topology.
- **C611.4:** Differentiate the types of PV Panels and their characteristics.
- **C611.5:** Compute solar power generation by various technologies.
- **C611.6:** Analyze the power quality issues related to the grid integration of Solar and Wind energy systems.

Unit - I

Physics of Wind Power: History of wind power, Indian and Global statistics, Evaluation of Wind Intensity – Topography, Wind physics, Betz limit ratio, stall and pitch control, Wind speed statistics-probability distributions, and Wind power-cumulative distribution functions.

Unit - II

Wind Generator Topologies: Review of modern wind turbine technologies, Fixed and Variable speed wind turbine, Induction Generators, Doubly-Fed Induction Generators and their characteristics, Permanent Magnet Synchronous Generators, Power electronics converters. Generator configurations, Converter Control.

Unit - III

The Solar Resource: Introduction, solar radiation spectra, solar geometry, Earth Sun angles, observer Sun angles, solar day length, Estimation of solar energy availability.

Solar Photovoltaic: Technologies-Amorphous, mono-crystalline, polycrystalline; V-I characteristics of a PV cell, PV module, array, Power Electronic Converters for Solar Systems, Types of Maximum Power point Tracking (MPPT) algorithms, Converter Control strategies.

Unit - IV

Network Integration Issues: Overview of grid code technical requirements. Fault ride-through for wind farms - real and reactive power regulation, voltage and frequency operating limits, solar PV and wind farm behavior during grid disturbances. Power quality issues. Power system interconnection experiences in the world. Hybrid and isolated operations of solar PV and wind systems.

Unit - V

Solar Thermal Power Generation: Flat Plate collector, Concentrating collectors - Parabolic trough, Central receivers, Parabolic dish, Fresnel, Solar Pond, elementary analysis.

TEXT BOOKS

1. T. Ackermann, "Wind Power in Power Systems", John Wiley and Sons Ltd., 2005.
2. G. M. Masters, "Renewable and Efficient Electric Power Systems", John Wiley and Sons, 2004.

REFERENCE BOOKS

1. S. P. Sukhatme, "Solar Energy: Principles of Thermal Collection and Storage", McGraw Hill, 1984.
2. H. Siegfried and R. Waddington, "Grid integration of wind energy conversion systems" John Wiley and Sons Ltd., 2006.
3. G. N. Tiwari and M. K. Ghosal, "Renewable Energy Applications", Narosa Publications, 2004.
4. J. A. Duffie and W. A. Beckman, "Solar Engineering of Thermal Processes", John Wiley & Sons, 1991.

B.Tech. III Year II Semester

Course Code	Course Title	L	T	P	Credits
EE612PE	**IoT APPLICATIONS IN ELECTRICAL ENGINEERING**	3	0	0	3

(Professional Elective-II)

Prerequisites Basic Electronics and Electrical Engineering

Course Description: This course explores the integration of Internet of Things (IoT) in Electrical Engineering through this course. Dive into real-world applications where IoT revolutionizes power systems, smart grids, and energy management. Learn how IoT enables efficient monitoring, control, and optimization of electrical devices and systems. Gain insights into IoT-enabled sensors, actuators, and communication protocols tailored for electrical engineering contexts. Equip yourself with essential skills to innovate and tackle modern challenges in the electrified world.

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

C612.1: Understand to recent trends in few applications of IoT in Electrical engineering.

C612.2: Know about usage of various types of motionless sensors.

C6123: Know about usage of various types of motion detectors.

C612.4: Understand the concepts of MEMS.

C612.5: To get exposed to various applications of IoT in smart grid.

C612.6: To get exposed to future working environment with Energy internet.

Unit - I

Sensors: Definitions, Terminology, Classification, Temperature sensors, Thermo resistive, Resistance, temperature detectors, Silicon resistive thermistors, Semiconductor, Piezoelectric, Humidity and moisture sensors. Capacitive, Electrical conductivity, Thermal conductivity, time domain reflectometer, Pressure and Force sensors: Piezo resistive, Capacitive, force, strain and tactile sensors, Strain gauge, Piezoelectric.

Unit - II

Occupancy and Motion detectors: Capacitive occupancy, Inductive and magnetic, potentiometric - Position, displacement and level sensors, Potentiometric, Capacitive, Inductive, magnetic velocity and acceleration sensors, Capacitive, Piezoresistive, piezoelectric cables, Flow sensors, Electromagnetic, Acoustic sensors -Resistive microphones, Piezoelectric, Photo resistors.

Unit - III

MEMS: Basic concepts of MEMS design, Beam/diaphragm mechanics, electrostatic actuation and fabrication, Process design of MEMS based sensors and actuators, Touch sensor, Pressure sensor, RF MEMS switches, Electric and Magnetic field sensors.

Unit - IV

IoT for Smart grid: Driving factors, Generation level, Transmission level, Distribution

level, Applications, Metering and monitoring applications, Standardization and interoperability, Smart home and Building Energy Management.

Unit - V

Internet of Energy: Concept of Internet of Energy, Evaluation of IoE concept, Vision and motivation of IoE, Architecture, Energy routines, information sensing and processing issues, Energy internet as smart grid.

TEXT BOOKS

1. Jon S. Wilson, "Sensor Technology Hand book", Newnes Publisher, 2004
2. Tai Ran Hsu, "MEMS and Microsystems: Design and manufacture", 1st Edition, McGraw hill Education, 2017
3. Ersan Kabalci and Yasin Kabalci, "From Smart grid to Internet of Energy", 1st Edition, Academic Press, 2019.

REFERENCE BOOKS

1. Raj Kumar Buyya and Amir Vahid Dastjerdi, "Internet of Things: Principles and Paradigms", Kindle Edition, Morgan Kaufmann Publisher, 2016
2. Yen Kheng Tan and Mark Wong, "Energy Harvesting Systems for IoT Applications": Generation, Storage and Power Management, 1st Edition, CRC Press, 2019
3. RMD Sundaram Shriram, K. Vasudevan and Abhishek S. Nagarajan, "Internet of Things", Wiley, 2019.

B.Tech. III Year II Semester

Course Code	Course Title	L	T	P	Credits
EE613PE	**COMPUTER AIDED ELECTRICAL MACHINE DESIGN**	3	0	0	3

(Professional Elective-II)

Prerequisites Electrical Machines-I & Electrical Machines-II

Course Description: This subject is introduced with a vision that the students should get familiar with the Design aspects of the Electrical machines. This subject helps the design engineer to take care of all these aspects during the designing stage. The calculations of each parameter, along with good logical decisions will result in a good design.

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

C613.1: Analyze the Major considerations of Electrical Machine Design

C613.2: Analyze the electrical, magnetic and thermal factors which influence the design of an electrical machine

C613.3: Apply the basic principles of electrical machine to carry out the design of a Transformer

C613.4: Apply the basic principles of electrical machine to carry out the design of an Induction motor

C613.5: Apply the basic principles of electrical machine to carry out the design of a Synchronous machine

C613.6: Understand the computer Aided Techniques and the latest developments in modern machine design.

Unit - I Introduction

Major considerations in electrical machine design, electrical engineering materials, space factor, choice of specific electrical and magnetic loadings, thermal considerations, heat flow, temperature rise, rating of machines.

Unit - II Transformers

Sizing of a transformer, main dimensions, kVA output for single- and three-phase transformers, window space factor, overall dimensions, operating characteristics, regulation, no load current, temperature rise in transformers, design of cooling tank, methods for cooling of transformers.

Unit - III Induction Motors

Sizing of an induction motor, main dimensions, length of air gap, rules for selecting rotor slots of squirrel cage machines, design of rotor bars & slots, design of end rings, design of wound rotor, magnetic leakage calculations, leakage reactance of poly-phase machines, magnetizing current, short circuit current, circle diagram, operating characteristics

Unit - IV Synchronous Machines

Sizing of a synchronous machine, main dimensions, design of salient pole machines, short circuit ratio, shape of pole face, armature design, armature parameters, estimation of airgap length, design of rotor, design of damper winding, determination of full load field mmf, design of field winding, design of turbo alternators, rotor design.

Unit - V Computer Aided Design (CAD)

Design optimization methods, variables, constraints and objective function, problem formulation.

Introduction to FEM based machine design. Introduction to **c**omplex structures of modern machines-PMSMs, BLDCs, SRM and claw-pole machines.

TEXT BOOKS

1. A. K. Sawhney, "A Course in Electrical Machine Design", Dhanpat Rai and Sons, 1970.
2. M.G. Say, "Theory & Performance & Design of A.C. Machines", ELBS London.

REFERENCES

1. S. K. Sen, "Principles of Electrical Machine Design with computer programmes", Oxford and IBH Publishing, 2006.
2. K. L. Narang, "A Text Book of Electrical Engineering Drawings", Satya Prakashan, 1969.
3. A. Shanmugasundaram, G. Gangadharan and R. Palani, "Electrical Machine Design Data Book", New Age International, 1979.
4. M. V. Murthy, "Computer Aided Design of Electrical Machines", B.S. Publications, 2008.
5. Electrical machines and equipment design exercise examples using Ansoft's Maxwell 2D machine design package.

B.Tech. III Year II Semester

Course Code	Course Title	L	T	P	Credits
EE614PE	FUNDAMENTALS OF ELECTRIC & AUTONOMOUS VEHICLES (Professional Elective-II)	3	0	0	3

Prerequisites Electrical Circuits, Physics, Electronics Circuits, Micro Controllers.

Course Description: This course offers the fundamental knowledge on Electrical Vehicles, Dynamics of Electric Vehicles, Battery Management System, ADAS, Autonomous Electric Vehicles and Connected Vehicles.

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

C614.1: Understand the Concept of Electric Vehicles and terminology

C614.2: Compute the Vehicle dynamics for a given specification.

C614.3: Apply the concept of Battery Management system for safe and onboard charging operation

C614.4: Understand the concept of ADAS and Architecture of Autonomous vehicular technology

C614.5: Apply the ADAS testing process for Autonomous Electric Vehicles.

C614.6: Apply the concept of Connected vehicles for Autonomous vehicle applications.

Unit - I Introduction to EV System and Battery Technology

Introduction of EV: Historical Background, Benefits of using EV's, Overview of types of EV's & its challenges, Defining the component sizing (Battery Pack, Electrical Machine, Traction Inverter, DC-DC Convertor and Onboard Charger) Drive cycle Simulation of EV Components in MATLAB and Simulink (Battery cell, Power Electronics, Electrical Machine simulation)

Unit - II Electric Vehicle Dynamics

Electric Vehicle Dynamics & Tractive Forces, Modelling of Vehicle Dynamics, Longitudinal vehicle dynamics, Lateral Vehicle dynamics, Tractive Efforts, Rolling Resistance, Aerodynamic Drag, Component of Vehicle mass acting down the slope, Provide acceleration to vehicle, Gradability, Regenerative force, Simulation of Tractive efforts, Dynamic Equations, Constant Tractive force dynamics equation, Variable Tractive force dynamic equation, Driving Cycle and Range

Unit - III Battery Management System and on Board Charger

Basics of Lithium-ion cells, Battery Management System, Hardware, Software Function, Communication Protocol, Battery Thermal Management System, Function Safety associated with Battery Pack and BMS System, Battery charging system: On board charger and charging station

Unit - IV Autonomous Vehicle Essentials

Overview of ADAS and Autonomous vehicle Technology, SAE levels of ADAS/ AD Software Stack Architecture, Overview of ADAS Features LDW/ LCA /LKA, ACC, IHC, Blind Spot Detection, Forward Collision Warning, Automatic Emergency Braking, Introduction to Simulation for ADAS/ AD- Commons tools and Platform sensors, Map, Traffic, Introduction to ADAS Software Testing Process- Unit/ System/ Integration Testing.

Unit - V Connected Vehicle Fundamentals

Overview of Wireless Network for Connected Vehicles, Standards for Autonomous Vehicle Applications, Transmission & Receiver Systems, Radio Transmission Concepts for Automotive Application, Wireless Networking and Applications to Vehicle Autonomy, Basics of Computer Networking – the Internet of Thing, Wireless Networking Fundamentals & Overview to 2G to 5G Networks for Automotive Application.

TEXT BOOKS

1. Per Enge, Nick Enge and Stephen Zoepf, "Electric Vehicle Engineering (Electronics)" **McGraw Hill**, 2021.
2. Dr. Manish K Saini, Dr. Sunita Saini, Dr. Ram Paul, and Dr. Akanksha Aggarwal "The Role of AI in Battery Management of Electric Vehicles" **Xoffencer, 2024**
3. Amit Kumar Mondal (Editor), Lentin Joseph (Editor), **Autonomous Driving And Advanced Driver-Assistance Systems** (ADAS), Part of: Chapman & Hall/CRC Artificial Intelligence and Robotics Series (35 books), December 2021.

B.Tech. III Year II Semester

Course Code	Course Title	L	T	P	Credits
EE600OE	**RENEWABLE ENERGY SOURCES (Open Elective – I)**	3	0	0	3

Prerequisites None

Course Description: Renewable Energy Sources is a comprehensive course that provides students with an in-depth understanding of various renewable energy technologies, their principles of operation, integration into energy systems, and their role in addressing global energy challenges. The course encompasses theoretical foundations, practical applications, and current trends in renewable energy development.

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

CO600.1: To understand the renewable energy sources available at present.

CO600.2: To educate the wind energy operation and its types.

CO600.3: Able to understand the solar energy operation and its characteristics.

CO600.4: Understand the principles of Energy storage systems.

CO600.5: To understand the operation of fuel cell

CO600.6: To understand the renewable energy sources integration.

Unit – I Introduction

Renewable Sources of Energy-Grid-Supplied Electricity-Distributed Generation-Renewable Energy Economics-Calculation of Electricity Generation Costs -Modern Electronic Controls of Power Systems.

Fuel Cells: The Fuel Cell-Low and High Temperature Fuel Cells-Commercial and Manufacturing Issues Constructional Features of Proton Exchange-Membrane Fuel Cells – Reformers - Electrolyser Systems and Related Precautions-Advantages and Disadvantages of Fuel Cells-Fuel Cell Equivalent Circuit- Practical Determination of the Equivalent Model Parameters -Aspects of Hydrogen as Fuel

Unit – II Wind Power Plants:

Appropriate Location -Evaluation of Wind Intensity -Topography -Purpose of the Energy Generated - General Classification of Wind Turbines-Rotor Turbines-Multiple-Blade Turbines Drag Turbines -Lifting Turbines-Generators and Speed Control used in Wind Power Energy Analysis of Small Generating Systems.

Induction Generators Principles of Operation-Representation of Steady-State Operation-Power and Losses Generated-Self Excited Induction Generator-Magnetizing Curves and Self-Excitation - Interconnected and Stand-alone operation -Speed and Voltage Control -Economical Aspects

Unit -III Photovoltaic Power Plants

Solar Energy-Generation of Electricity by Photovoltaic Effect -Dependence of a PV Cell Characteristic on Temperature-Solar cell Output Characteristics-Equivalent Models and Parameters for Photovoltaic Panels-Photovoltaic Systems-Applications of Photovoltaic Solar Energy-Economical Analysis of Solar Energy.

Unit – IV 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.

Unit – V Integration of Alternative Sources of Energy

Grid Integration: Standalone systems, Concept of Micro-Grid and its components
Interconnection of Alternative Energy Sources with the Grid:
Interconnection Technologies - Standards and Codes for Interconnection-Interconnection Considerations - Interconnection Examples for Alternative Energy Sources.

TEXT BOOKS

1. Felix A. Farret, M. Godoy Simoes, "Integration of Alternative Sources of Energy", John Wiley & Sons, 2006.
2. Solanki: Renewable Energy Technologies: Practical Guide for Beginners, PHI Learning Pvt. Ltd., 2008.

REFERENCE BOOKS

1. D. Mukherjee: Fundamentals of Renewable Energy Systems, New Age International publishers,2007.
2. Remus Teodorescu, Marco Liserre, Pedro Rodríguez: Grid Converters for Photovoltaic and Wind Power Systems, John Wiley & Sons, 2011.
3. Gilbert M. Masters: Renewable and Efficient Electric Power Systems, John Wiley & Sons, 2004.

B.Tech. III Year II Semester

Course Code	Course Title	L	T	P	Credits
EE601OE	**GREEN ENERGY TECHNOLOGIES (Open Elective – I)**	3	0	0	3

Prerequisites Fundamentals of engineering

Course Description: The course provides a comprehensive examination of energy sources, their environmental implications, and their role in sustainable development. It covers a wide range of topics including the classification of energy sources, renewable energy technologies, environmental impacts of energy systems, and the economic dimensions of energy production and consumption.

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

CO601.1: Understand the interconnectedness between energy, environment, and sustainable development.

CO601.2: Evaluate various energy sources in terms of availability, sustainability, and environmental impact.

CO601.3: Analyze the principles and technologies associated with renewable energy sources including their conversion processes and potential applications.

CO601.4: Examine the environmental impacts of energy systems on environment and assess strategies for mitigating pollution and promoting eco-restoration.

CO601.5: Explore the economic dimensions of energy production and consumption, energy markets, energy efficiency, and energy security.

CO601.6: Critically evaluate policies, regulations, and initiatives aimed at promoting sustainable energy development and addressing environmental challenges

Unit – I Energy

Introduction to the nexus between energy, environment and sustainable development, Energy sources over view and classification, sun as the source of energy, fossil fuel reserves and resources - overview of global/ India's energy scenario. Energy consumption models – Specific Energy Consumption

Unit – II Sources of Green Energy

Solar Energy: Solar radiation - measurements and prediction. Indian's solar energy potential and challenges, solar energy conversion principles and technologies: Photosynthesis, Photovoltaic conversion and Photo thermal energy conversion.

Wind Energy: Atmospheric circulations, atmospheric boundary layers, classification, factors influencing wind, wind shear, turbulence, wind energy basics and power Content, wind speed monitoring, Betz limit, wind energy conversion system: classification, characteristics and applications.

Ocean Energy: Ocean energy resources-ocean energy conversion principles and technologies: ocean thermal, ocean wave & ocean tide.

Bio Energy: Resources and types.

Unit -III Other Energy Sources and Systems

Hydropower, Nuclear fission and fusion-Geothermal energy: Origin, types of geothermal energy sites, site selection, geothermal power plants; hydrogen energy, Magneto-hydro-dynamic (MHD) energy conversion – Radioisotope Thermoelectric Generator (RTG), Bio-solar cells, battery & super capacitor, energy transmission and conversions.

Unit – IV Ecology and Environment

Concept and theories of ecosystems, energy flow in major man-made ecosystems agricultural, industrial and urban ecosystems - sources of pollution from energy technologies and its impact on atmosphere- air, water, soil, and the environment, The environmental protection act: Effluent standards and ambient air quality, innovation and sustainability, eco-restoration: phytoremediation.

Unit – V Energy and Economy

Gross domestic product (GDP) and energy, energy market and society, energy efficiency, energy and economics, energy security, environmental sustainability index and global measure.

TEXT BOOKS

1. Energy and Environment Set: Mathematics of Decision Making, Loulou, Richard; Waaub, Jean- Philippe; Zaccour, Georges (Eds.), 2005.
2. Energy and the Environment, Ristinen, Robert A. Kraushaar, Jack J. AKraushaar, Jack P. Ristinen, Robert A., 2nd Edition, John Wiley, 2006.Jorge Nocedal Stephen J. Wright, “Numerical Optimization”, Springer, 2nd edition, 1999.

REFERENCE BOOKS:

1. Energy and the Challenge of Sustainability, World Energy assessment, UNDP, N York, 2000.
2. Solar Energy: principles of Thermal Collection and Storage, S.P. Sukhatme, Tata McGraw-Hill (1984).
3. D. Y. Goswami, F. Kreith and J. F. Kreider, Principles of Solar Engineering, Taylor and Francis, Philadelphia, 2000.
4. Wind Energy Conversion Systems, L.L. Freris, Prentice Hal 1990.
5. Geothermal Energy: From Theoretical Models to Exploration and Development by Ingrid Sober and Kurt Bucher, Springer, 2013.
6. Ocean Energy: Tide and Tidal Power by R. H. Charlier and Charles W. Finkl, Springer 2010.

B.Tech. III Year II Semester

Course Code	Course Title	L	T	P	Credits
EE602OE	**FUNDAMENTALS OF ELECTRIC VEHICLES**	3	0	0	3

(Open Elective – I)

Prerequisites Electrical Machines, Electronics Circuits, Power Electronics

Course Description: This course is designed to provide students with a comprehensive understanding of electronics and computation within the automotive domain. Through theoretical study, students will acquire the knowledge and skills necessary to excel in modern industry, academia, or research within the automotive sector. The course will focus on Automotive Electronics, covering topics such as electronic systems integration, embedded software development, and computational techniques relevant to automotive applications.

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

CO602.1: Understand the fundamentals of Electric Vehicles.

CO602.2: Design of batteries, EV motors and Power electronic controllers for EV systems.

CO602.3: Understanding of Electric Vehicle Architecture.

CO602.4: Design Charging Infrastructure of Electric vehicles.

CO602.5: Evaluate the Performance and Efficiency of Electric Vehicles.

CO602.6: Analyze the economics of EV market and EV data using Analytical tools.

Unit – I Introduction

Overview of Electric Vehicles (EVs), Comparison of IC Engine and EVs, Need for EV charging from Renewable sources, Energy flow in EVs, Introduction & types of batteries, EV Subsystems, Cost considerations,

Unit – II Vehicle Dynamics

Forces acting on vehicle, Aerodynamic drag, Rolling Resistance and Uphill Resistance, Power and Torque to accelerate.

Drive Cycle: Concept of Drive Cycle, Drive Cycles and Energy used per km. (Elementary treatment only)

Unit -III EV Batteries

Introduction to Battery Parameters, Batteries in Future, Li-Ion Battery Cells, SoH and SoC estimation and Self Discharge, Battery Pack Development, Computation of Effective cost of battery, Charging Batteries, Fundamentals of EV Battery Pack, BMS

Unit – IV EV Motors and Controllers

Fundamentals and Design, Understanding Flow of Electricity, Magnetism and Heat, Power and Efficiency, Torque Production, Speed and Back EMF, Understanding Three phase AC and DC to AC conversion systems, Understanding the thermal design of the motors.

Unit – V EV Charging

Introduction, Slow or Fast EV Chargers, Battery Swapping, Standardization and on-board Chargers, Public Chargers, Bulk Chargers/Swap Stations, Economics of Public Chargers in context and Tools for EV systems.

TEXT BOOKS

1. Electric Power train - Energy Systems, Power electronics and drives for Hybrid, electric and fuel cell vehicles by John G. Hayes and A. Goodarzi, Wiley Publication.
2. Mehrdad Ehsani, Yimi Gao, Sebastian E. Gay, Ali Emadi, Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design, CRC Press, 2004.
3. 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.

B.Tech. IV Year I Semester

Course Code	Course Title	L	T	P	Credits
SM701MS	FUNDAMENTALS OF MANAGEMENT FOR ENGINEERS	2	0	0	2

Prerequisites

Course Description: The course helps the students to understand the Management Concepts, applications of Concepts in Practical aspects of business and development of Managerial Skills for Engineers.

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

C701.1: Understand the concept of Management and its approaches.

C701.2: Study the process of planning and development of business strategies for problem solving and decision making.

C701.3: Understand the Principles of organization for better Human Resource Management.

C701.4: Develop leadership qualities and make familiarize with motivational theories in an organization.

C701.5: Study the controlling techniques in an organization.

C701.6: Study the control frequency and methods for effective control.

Unit - I Introduction to Management

Definition, Nature and Scope, Functions, Managerial Roles, Levels of Management, Managerial Skills, Challenges of Management, Evolution of Management- Classical Approach- Scientific and Administrative Management, The Behavioral approach, The Quantitative approach, The Systems Approach, Contingency Approach, IT Approach.

Unit - II Planning and Decision Making

General Framework for Planning-Planning Process, Types of Plans, Management by Objectives, Production Planning and Control. Decision making and Problem Solving - Programmed and Non-Programmed Decisions, Steps in Problem Solving and Decision Making, Bounded Rationality and Influences on Decision Making, Group Problem Solving and Decision Making, Creativity and Innovation in Managerial Work.

Unit - III Organization and HRM

Principles of Organization: Organizational Design & Organizational Structures; Departmentalization, Delegation; Empowerment, Centralization, Decentralization, Recentralization; Organizational Culture; Organizational Climate and Organizational Change.

Human Resource Management & Business Strategy: Job Satisfaction, Job Enrichment, Job Enlargement, Talent Management, Strategic Human Resource Planning; Recruitment and Selection, Training and Development, Performance Appraisal.

Unit - IV Leading and Motivation

Leadership, Power and Authority, Leadership Styles; Behavioral Leadership, Situational Leadership, Leadership Skills, Leader as Mentor and Coach, Leadership during adversity

and Crisis; Handling Employee and Customer Complaints, Team Leadership.

Motivation - Types of Motivation; Relationship between Motivation, Performance and Engagement, Content Motivational Theories-Needs Hierarchy Theory, Two Factor Theory, Theory X and Theory Y.

Unit - V Communication and Controlling

Communication-Types of Communication, Formal and Informal communication, Barriers to communication, Control, Types and Strategies for Control, Steps in Control Process, Budgetary and Non-Budgetary Controls. Characteristics of Effective Controls, Establishing control systems, Control frequency and Methods.

TEXT BOOKS

1. Management Essentials, Andrew DuBrin, 9e, Cengage Learning,2012.
2. Fundamentals of Management, Stephen P. Robbins, Pearson Education,2009.

REFERENCE BOOKS:

1. Essentials of Management, Koontz, Kleihrich, Tata Mc-GrawHill.
2. Introduction to Management, John R Schermerhorn, Jr., Wiley,10e,2010.
3. Industrial Engineering and Management: Including Production Management, T. R. Banga, S. C. Sharma, Khanna Publishers.

B.Tech. IV Year I Semester

Course Code	Course Title	L	T	P	Credits
EE702PC	POWER ELECTRONIC APPLICATIONS TO RENEWABLE ENERGY SYSTEMS	3	1	0	4

Prerequisites Power System-I, Electrical Machines-II, Power Electronics

Course Description: This course explores the integration of power electronics with renewable energy systems, focusing on solar photovoltaic (PV) and wind energy technologies. The subject deals with the Integration of the Renewable sources to the Grid and the control of power. The course covers power converters, inverter topologies, battery sizing, and grid-connected renewable energy solutions. Topics include maximum power point tracking (MPPT), wind turbine generator control, and hybrid solar-wind energy systems. By the end of the course, students will be proficient in designing and implementing power electronic solutions for efficient renewable energy utilization.

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

C702.1: Analyze the characteristics of a solar cell and Fuel cell.

C702.2: Design the Power Converters for Solar PV Systems.

C702.3: Explain different components of Wind Energy Conversion Systems.

C702.4: Model different generators for Wind Energy Conversion Systems.

C702.5: Design the Power Converters for Wind Energy Conversion Systems.

C702.6: Understand a hybrid renewable energy system and the issues & solutions while integrating these systems into grid.

Unit - I

Solar cell: Characteristics and their measurement, PV Module, PV array, Modelling of a PV unit, Partial shading of a solar cell and a module, Power conditioning unit, maximum power point tracker, Implementation of Perturb and Observe Method, Incremental Conductance Method, Battery charger/discharge controller.

Fuel Cell: Characteristics & modeling, Modeling& Control of DC-DC Converters for Fuel-cell based system.

Unit - II

Types of PV Systems: Grid-Connected Solar PV System, Stand-Alone Solar PV System.

Inverter Topology - Centralized Inverters, String Inverters, Multi-string Inverters, Module Integrated Inverter/Micro-inverters, Model of Inverter.

Unit - III

Introduction to wind: Characteristics, Wind Turbine, Fixed and Variable-Speed Wind Turbines, Components of WECS, Description of Components, Types of Wind Turbine Generators, Modelling and Economics of Wind Energy Conversion Systems.

Unit - IV

Linking Wind Turbines onto the Grid, Power Converter Topologies for Wind Turbine Generators, Maximum Power Point Tracking for Wind Energy Generation, Control of Power converters for WECS.

Unit - V

Hybrid Energy Systems: Need for Hybrid Energy Systems, Range and types of Hybrid systems, Hybrid Solar PV/Wind Energy System, Architecture of Solar-Wind Hybrid System and Grid connected issues.

TEXTBOOKS:

1. S. N. Bhadra, D. Kastha, S. Banerjee, "Wind Electrical Systems", Oxford University Press, 2005.
2. S. N. Bhadra, D. Kastha, & S. Banerjee "Wind Electrical Systems", Oxford University Press, 2009.
3. Rashid. M. H, "Power Electronics Hand book", Academic Press, 2001.

REFERENCE BOOKS:

1. Rai. G. D, "Non-conventional energy sources", Khanna Publishers, 1993.
2. Rai. G.D," Solar energy utilization", Khanna Publishes, 1993.
3. Gray, L. Johnson, "Wind energy system", Prentice Hall of India, 1995.
4. B. H. Khan "Non-conventional Energy sources", Mc Graw-hill, 2nd Edition, 2009

B.Tech. IV Year I Semester

Course Code	Course Title	L	T	P	Credits
EE703PC	**SIMULATION OF RENEWABLE ENERGY SYSTEMS LAB**	0	0	4	1

Prerequisites Power System-I, Power System-II, Power Electronics

Course Description: This laboratory course is designed to complement theoretical knowledge in power electronics with practical skills in designing, building, and testing power electronic circuits. Students will gain hands-on experience with a variety of power electronic devices and systems commonly used in applications such as power supplies, motor drives, and renewable energy systems.

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

C703.1: Model and analyze renewable energy sources (PV, fuel cells, wind) and their power conversion interfaces.

C703.2: Design and simulate various DC-DC and DC-AC power electronic converters for renewable energy and power quality improvement.

C703.3: Implement control strategies for power converters, including MPPT techniques, soft-switching, and reactive power compensation.

C703.4: Evaluate power quality issues in AC and DC systems and apply corrective techniques for improved performance.

Part-A: The following experiments are required to be conducted compulsory experiments:

1. Modelling of PV and Fuel Cell energy sources
2. Modelling of Wind turbine.
3. Control of DC-DC Converters for fuel cell-based DC standalone Systems.
4. Modelling and control of DC-AC inverter for grid-connected PV system.
5. Implementation of Maximum Power Point Tracking (MPPT) techniques for wind energy Generation.
6. Switched capacitor DC–DC high gain converters.
7. Design and simulation of Isolated DC-DC Converter- Fly back converter.
8. Design and modelling of High-frequency AC link DC-DC converter.

PART-B: In addition to the above eight experiments, at least any two of the experiments from the following list are required to be conducted.

9. Zero Voltage Switching (ZVS) and Zero Current Switching (ZCS) in DC-DC buck power converters.
10. Power factor correction (PFC) techniques in AC-DC conversion.
11. Power quality issues and mitigation in distribution grid.
12. Compensation techniques for reactive power, harmonics, and phase imbalance.

**Note: Perform the simulation of the above list of experiments with MATLAB/any Simulation software*

TEXTBOOKS:

1. S. N. Bhadra, D. Kastha, Banerjee, “Wind Electrical Systems”, Oxford University Press, 2005.
2. S. N. Bhadra, D. Kastha, & S. Banerjee “Wind Electrical Systems”, Oxford University Press, 2009.
3. Rashid. M. H, “Power Electronics Hand book”, Academic Press, 2001.

REFERENCE BOOKS:

1. Rai. G.D, “Non-conventional energy sources”, Khanna Publishers, 1993.
2. Rai. G.D,” Solar energy utilization”, Khanna Publishes, 1993.
3. Gray, L. Johnson, “Wind energy system”, Prentice Hall of India, 1995.
4. B. H. Khan "Non-conventional Energy sources", Mc Graw-hill, 2nd Edition, 2009

B.Tech. IV Year I Semester

Course Code	Course Title	L	T	P	Credits
EE711PE	INDUSTRIAL DRIVES AND CONTROL	3	0	0	3

(Professional Elective-III)

Prerequisites Electrical Machines-I, Electrical Machines-II, Power Electronics

Course Description: This course offers a comprehensive introduction to electric drives, emphasizing the fundamental principles governing the operation of both DC and AC motor drives. It provides an in-depth understanding of the dynamics and control of various drive mechanisms, with a particular focus on energy conversion in electric drive systems. The curriculum includes the application of power electronic converters for speed control in DC and induction motors.

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

- **C711.1:** Elucidate the necessity, advantages, applications and components of electrical drives.
- **C711.2:** Apply the concept of power converters for DC motor speed control and braking.
- **C711.3:** Analyze induction motor modeling and advanced control methods.
- **C711.4:** Evaluate synchronous motor modeling and control techniques.
- **C711.5:** Evaluate various Permanent Magnet Drives in configuration and control.
- **C711.6:** Evaluate SRM Drives in configuration and control.

Unit - I

Introduction to Electric Drives: Electrical Drives: Advantages of Electrical Drives. Parts of Electrical Drives, Choice of Electrical Drives, Status of DC and AC Drives. Applications of drives in Drones, Robotics, Electric Vehicles & HVAC.

Unit - II

DC Motor Drives: Speed control of DC motors using single phase fully controlled and half controlled rectifiers. Three phases fully controlled and half controlled converter fed DC motor drives. Chopper controlled DC drives.

Different types of braking: Dynamic, Regenerative and Plugging.

Unit - III

Induction Motor Drives: Different transformations and reference frame theory, modeling of induction machines, voltage fed inverter control-v/f control, vector control, direct torque and flux control (DTC)

Unit - IV

Synchronous Motor Drives: Modeling of synchronous machines, open loop v/f control, vector control, direct torque control, CSI fed synchronous motor drives.

Unit - V

Permanent Magnet Motor Drives: Introduction to various PM motors, BLDC and PMSM drive configuration, comparison, block diagrams, Speed and torque control in BLDC and PMSM.

Switched Reluctance Motor Drives: Evolution of switched reluctance motors; various topologies for SRM drives, comparison, closed loop speed and torque control of SRM.

Micro-controller-based Drive Applications.

TEXT BOOKS

1. G.K. Dubey: Fundamentals of Electric Drives – Narosa Publishers, Second edition, 2007.
2. Vedam Subramanyam: Electric Drives Concepts & Applications –Tata McGraw Hill Edn. Pvt. Ltd, Second edition 2011.

REFERENCE BOOKS

1. Nisit K. De and Prashanta K. Sen: Electric Drives, PHI., 2001.
2. V. Subrahmanyam: Thyristor Control of Electric Drives, Tata McGraw Hill Edn. Pvt. Ltd, 2010.
3. Werner Leonhard: Control of Electric Drives, Springer international edition 2001.
4. Nisit K. De and Swapan K. Dutta: Electric Machines and Electric Drives, PHI learning Pvt. Ltd 2011.

B.Tech. IV Year I Semester

Course Code	Course Title	L	T	P	Credits
EE712PE	ADVANCED EV AND AUTONOMOUS VEHICLE	3	0	0	3

(Professional Elective-III)

Prerequisites: Fundamentals of Electric & Autonomous Vehicles

Course Description: The course "Advanced EV and Autonomous Vehicle" covers connected and autonomous vehicle technologies, including ECUs, cyber-physical systems, remote sensing, and wireless networks. It explores ADAS, sensor technologies (radar, LiDAR, ultrasonic, night vision), AI-driven autonomy, legal and security challenges, and cloud-based driving platforms. Additionally, it examines connected car technology, V2V and V2I communication, wireless security, and in-vehicle display systems.

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

C712.1: Understand the concept and working of Connected Autonomous Electric vehicles.

C712.2: Classify the various Advance Driver Assistance Systems.

C712.3: Apply the various Sensor Technologies Advanced Electric vehicles.

C712.4: Apply the global standards for various charging technology.

C712.5: Understand the concept of connected car technology.

C712.6: Apply the communication protocol for the autonomous electric vehicles.

Unit - I Fundamentals of Connected and Autonomous Vehicle Technology

Connected and Autonomous Vehicle Technology Basic Control System Theory, Overview of ECU operation, Concept of Cyber-Physical Control Systems, Remote Sensing Technology, Wireless Networks and Autonomy.

Unit - II Advanced Driver Assistance Systems (ADAS) and Applications

Advanced Driver Assistance Systems Basics of Theory of Operation, Applications, Integration of ADAS Technology into Vehicle Electronics, System Examples, Role of Sensor Data Fusion, Present ADAS Technology Examples, Troubleshooting and Maintenance of ADAS, Non-Passenger Car Advanced Driver Assistance Systems and Autonomous Operation.

Unit - III Sensor Technologies for ADAS and Vehicle Autonomy

Sensor Technology for Advanced Driver Assistance Systems Basics of Radar Technology and Systems, Ultrasonic Sonar Systems, Lidar Sensor Technology and Systems, Camera Technology, Night Vision Technology, Other Sensors, Use of Sensor Data Fusion.

Unit - IV EV Charging Infrastructure

Types of charging stations (Level 1, 2, DC fast charging), global standards (SAE J1772, CCS, CHAdeMO), 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.

Unit - V Connected Car Technology and Vehicle Communication Systems

Definition and components of connected vehicles. Evolution of connected car technologies. Applications of connected cars like (Infotainment systems, telematics, navigation, and over-the-air (OTA) updates).

Vehicle communication Protocols: Introduction to in-vehicle networks, CAN (Controller Area Network), LIN (Local Interconnect Network), Flex Rayand Ethernet.

Communication layers: Physical layer, data link layer, and application layer in vehicular communication.

The role of ECUs (Electronic Control Units) in vehicle communication. Wireless security overview.

TEXT BOOKS

1. Hanky Sjafrie, Introduction to Self-Driving Vehicle Technology, Chapman and Hall/CRC .
2. Abdelaziz Bensrhair, Thierry Bapin, From AI to Autonomous and Connected Vehicles-Advanced Driver-Assistance Systems (ADAS', Wiley-ISTE.
3. Nyle Phillips, Autonomous Vehicles-Safety Deployment and Effect of Infrastructure, Nova Science Publishers, Inc.
4. Thor I. Fossen, Kristin Y. Pettersen, Henk Nijmeijer, Sensing and Control for Autonomous Vehicles-Applications to Land, Water and Air Vehicles, Springer.

REFERENCE BOOKS

1. Radovan Miucic, Connected Vehicles-Intelligent Transportation Systems, Springer
2. Autonomous Vehicle Technology Report, Wevolver.
3. Shaoshan Liu, Liyun Li, Jie Tang, Shuang Wu, Jean-Luc Gaudiot, Creating Autonomous Vehicle Systems, Morgan & Claypool Publishers.
4. George Dimitrakopoulos, Aggelos Tsakanikas, Elias Panagiotopoulos, "Autonomous Vehicles Technologies, Regulations, and Societal Impacts", Elsevier Publications, 2021.
5. Dietmar P.F. Möller, Roland E. Haas, Guide to Automotive Connectivity and Cybersecurity: Trends, Technologies, Springer Publications, 2019.

B.Tech. IV Year I Semester

Course Code	Course Title	L	T	P	Credits
EE713PE	ENERGY STORAGE SYSTEMS & MANAGEMENT	3	0	0	3

(Professional Elective-III)

Prerequisites Engineering Chemistry, Power System – I, Control Systems

Course Description: This course aims to introduce the importance and application of energy storage systems and to familiarize with different energy storage technologies. This course covers the necessary technical knowledge on the fundamental principles and application areas of proven technologies and materials for energy storage solutions, together with an overview of development trends in this engineering field.

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

C713.1: Understand the Role of Electrical Energy Storage (EES).

C713.2: Classify and Compare Energy Storage Systems.

C713.3: Explore Applications of Energy Storage.

C713.4: Understand Management and Control of EES.

C713.5: Apply Valuation Techniques for Energy Storage Optimization.

C713.6: Assess Market Potential and Future Trends.

Unit - I

Introduction to Energy Storage Systems: Role and importance of energy storage in modern energy systems, Classification of EES systems, Standards for EES, Technical comparison of EES technologies, Applications of EES.

Unit - II

Modeling of Energy Storage Systems: Charge/Discharge cycles and their impact, State of Charge (SOC) and State of Health (SOH) models, Battery degradation models and efficiency, Dynamic models of energy storage systems in power networks.

Unit - III

Battery Management Systems (BMS): BMS functions, Importance of SOC, SOH, and temperature control in BMS, BMS hardware and software components, Control algorithms for charge/discharge cycles, Applications.

Unit - IV

Small-Scale Energy Storage Management: Home energy management systems (HEMS), EV battery management and charging optimization.

Large-Scale Energy Storage Management: Grid energy storage for frequency regulation and peak shaving, Industrial energy storage and demand-side management, Virtual power plants (VPPs) and energy trading with storage.

Control Strategies & Optimization: AI and IoT in energy storage management, Smart grid and microgrid integration.

Unit - V

Energy Management in Electric Vehicles (EVs) and Future Trends: Battery management and optimization in EVs, EV integration into the grid (V2G, V2H), Role of smart charging systems for fleet management, Emerging Trends in Energy Storage.

TEXT BOOKS

1. Power System Energy Storage Technologies, 1st Edition by Paul Breeze, Academic Press.
2. Energy Storage: Systems and Components, by Alfred Rufer, CRC Press, 2017.

REFERENCE BOOKS

1. Energy Storage Fundamentals, Materials and Applications, by Huggins and Robert, Springer.
2. Battery Management Systems: Design by Modeling by Davide Andrea
3. Energy Storage for Power Systems by Francis F. Wu
4. Handbook of Energy Storage: Demand, Technologies, Integration, Sterner, M., Stadler, I., Springer, 2019.
5. Advanced Battery Management Technologies for Electric Vehicles by Rui Xiong, Jiandong Li
6. Classification of Energy Storage Systems in Future Grid - Scale Energy Storage Solutions, Arabkoohsar, A., Academic Press, 2023.

B.Tech. IV Year I Semester

Course Code	Course Title	L	T	P	Credits
EE714PE	**DSP CONTROLLER AND APPLICATIONS**	3	0	0	3

(Professional Elective-III)

Prerequisites C programming and Data Structures, Analog Electronics, Digital Electronics and Power Electronics

Course Description: This course provides a comprehensive understanding of DSP-based control systems using the TMS320F28379D microcontroller, covering architecture, programming, and peripheral integration. Students will learn to design and implement digital control strategies for power converters.

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

C714.1: Develop Assembly Language Programs for the Digital Signal Processors.

C714.2: Configure GPIO, Timers, and PWM Modules.

C714.3: Interface with ADC, DAC, and Communication Protocols.

C714.4: Analyze quantization effects and sampling delays.

C714.5: Analysis of Digital Control Strategies for DC-DC Converters.

C714.6: Implementation of PWM Techniques for 3-Ph VSI using DSP.

Unit - I DSP Architecture and Programming Fundamentals

Introduction to DSP-based control systems, advantages over other microcontrollers, TMS320F28379D architecture, CPU and floating-point unit (FPU), control law accelerator (CLA), memory mapping and peripheral integration, clock systems, programming using Code Composer Studio (CCS), sampling, quantization, digital filtering.

Unit - II GPIO, Timers, and PWM Configuration

GPIO configuration and pin multiplexing, timers and time event generation, interrupt mechanisms and prioritization, enhanced PWM (ePWM) and high-resolution PWM (HRPWM).

Unit - III ADC, DAC, and Communication Interfaces

ADC architecture and configuration, DAC Architecture and Communication, eQEP Architecture and configuration, communication protocols-UART, SPI, I2C; initialization and data transfer.

Unit - IV Feedback Control Systems and Sensor Integration

Feedback systems, quantization effects, sampling delays with mitigation techniques, digital PID controller design, compensators, frequency-domain analysis, computational delays, and integration of converters and sensors.

Unit - V Digital Control of Power Converters

Open loop and Closed-loop control of buck, boost converters, Sinusoidal PWM and Space Vector PWM control strategies for Single-phase and Three-phase inverters, V/f control of induction motors.

TEXT BOOKS

1. The DSP Handbook Algorithms, Applications and design techniques, Andrew Bateman, Iain Paterson-Stephens, Pearson Education.
2. Texas Instruments Inc, "Code Compare Studio white paper", www.ti.com, Texas Instruments Literature number SPRA.

REFERENCE BOOKS

1. Hamid A. Toliyat, Steven G.Campbell, "DSP- based Electromechanical Motion Control", CRC Press-2004.
2. Digital Signal Processing in Power Electronics Control Circuits (Power Systems) by Sozański, Springer (ISBN: 9781447173311).
3. https://www.ti.com/product/TMS320F28379D-Q1

B.Tech. IV Year I Semester

Course Code	Course Title	L	T	P	Credits
EE721PE	**HVDC TRANSMISSION**	3	0	0	3

(Professional Elective-IV)

Prerequisites Power System-I, Power System-II, Power System Protection, Power System Operation and Control, Power Electronics

Course Description: This course covers the fundamentals of HVDC systems, including their necessity, economic aspects, and comparison with AC transmission. Topics include converter analysis, system control, power flow analysis, fault protection, harmonics, and filtering techniques. Students will gain insights into modern HVDC trends, reactive power control, and system optimization for efficient and reliable power transmission.

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

C721.1: Compare HVDC and AC Transmission systems in all aspects.

C721.2: Evaluate Converter control characteristics for different control schemes.

C721.3: Discuss Reactive power control in HVDC system.

C721.4: Analyze Power Flow studies in AC/DC Systems.

C721.5: Elucidate converter faults and their protection schemes.

C721.6: Analyze AC and DC filters for different types of harmonics.

Unit - I

Basic Concepts Necessity of HVDC systems, Economics and Terminal equipment of HVDC Transmission systems, Types of HVDC Links, Apparatus required for HVDC Systems, Comparison of AC and DC Transmission, Application of DC Transmission System, Planning and Modern trends in D.C. Transmission.

Analysis of HVDC Converters: Choice of Converter Configuration, Analysis of Graetz circuit, Characteristics of 6 Pulse and 12 Pulse converters, Cases of two 3 phase converters in Y/Y mode – their performance.

Unit - II

Converter and HVDC System Control: Principle of DC Link Control, Converters Control Characteristics, firing angle control, Current and extinction angle control, Effect of source inductance on the system, Starting and stopping of DC link, Power Control.

Reactive Power Control in HVDC: Introduction, Reactive Power Requirements in steady state, sources of reactive power- Static VAR Compensators, Reactive power control during transients.

Unit - III

Power Flow Analysis in AC/DC Systems: Modeling of DC Links, DC Network, DC Converter, Controller Equations, Solution of DC load flow, P.U. System for DC quantities, solution of AC-DC Power flow-Simultaneous Method-Sequential method.

Unit - IV

Converter Faults and Protection: Converter faults, protection against over current and over voltage in converter station, surge arresters, smoothing reactors, DC breakers, Audible noise, space charge field, corona effects on DC lines, Radio interference.

Unit - V

Harmonics: Generation of Harmonics, Characteristics harmonics, calculation of AC Harmonics, Non-Characteristics harmonics, adverse effects of harmonics, Calculation of voltage and Current harmonics, Effect of Pulse number on harmonics.

Filters: Types of AC filters, Design of Single tuned filters –Design of High pass filters.

TEXT BOOKS

1. K. R. Padiyar, HVDC Power Transmission Systems: Technology and system Interactions, New Age International (P) Limited, and Publishers, 1990.
2. S K Kamakshaiah, V Kamaraj, HVDC Transmission, TMH Publishers, 2011.
3. Jos Arrillaga, HVDC Transmission, The institution of electrical engineers, IEE power & energy series 29, 2nd edition 1998.

REFERENCE BOOKS

1. S. Rao, EHVAC and HVDC Transmission Engineering and Practice, Khanna publications, 3rd Edition 1999.
2. E. W. Kimbark, Direct Current Transmission, John Wiley and Sons, volume 1, 1971.
3. E. Uhlmann, Power Transmission by Direct Current, B. S. Publications, 2009.

B.Tech. IV Year I Semester

Course Code	Course Title	L	T	P	Credits
EE722PE	EMBEDDED SYSTEMS APPLICATIONS	3	0	0	3

(Professional Elective-IV)

Prerequisites C programming and Data Structures, Digital Electronics, Microprocessors and Microcontrollers.

Course Description: This course provides foundational knowledge of embedded systems, covering their architecture, design methodologies, and real-time operating system (RTOS) concepts. Students will learn to write assembly and Embedded C code for interfacing devices. By the end, they will be able to develop simple embedded systems for real-time applications.

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

C722.1: Describe embedded system basics like hardware, memory, and interrupts.

C722.2: Apply Embedded C and MISRA C for safe coding.

C722.3: Analyze data movement and RTOS interrupt handling.

C722.4: Evaluate input-output interfaces like keyboards and displays.

C722.5: Utilize embedded software tools and debugging.

C722.6: Outline testing and software loading in embedded systems.

Unit - I Embedded Systems Basics:

Introduction to Embedded systems, Examples of embedded systems, Typical Hardware, Gates, Timing Diagrams, Memory, Microprocessors, Buses, Direct Memory Access, Interrupts, Microprocessor Architecture, and Interrupt Basics.

Unit - II Embedded C Programming:

Overview of the C standard library, Embedded System Oriented topics, MISRA C - Designing safer C Programs, Basics of event driven programming.

Unit - III Moving Data:

Introduction, Addressing Modes, External Data Moves, Code Memory Read Only Data Moves, Push and Pop Opcodes, Data Exchanges.

Basic Design Using a Real-Time Operating System: Message Queues, Mailboxes and Pipes, Timer Functions, Events, Memory Management, Interrupt Routines in an RTOS Environment.

Unit - IV Applications:

Introduction, Keyboards, Human Factor, Key Switch Factors, Keyboard Configurations, Displays, Seven-Segment Numeric Display, D/A and A/D Conversions, Pointing Devices - Mouse, Trackpad, Joystick, Haptic Feedback and Tactile Interfaces and Biometric Input Devices.

Unit - V Embedded Software Development Tools:

Host and Target machines, Linker/Locators for Embedded Software, Getting Embedded

Software into the Target System; Debugging Techniques: Testing on Host Machine, Using Laboratory Tools, an example system.

TEXT BOOKS

1. An Embedded Software Primer, David E. Simon, Pearson Education.
2. Embedded Microcomputer Systems Real Time Interfacing, Jonathan W.Valvano, Cengage Learning.

REFERENCE BOOKS

1. Micro Controllers, Ajay V Deshmukhi, TMH.
2. Embedded System Design, Frank Vahid, Tony Givargis, John Wiley.
3. Microcontrollers, Raj kamal, Pearson Education.

B.Tech. IV Year I Semester

Course Code	Course Title	L	T	P	Credits
EE723PE	**FLEXIBLE AC TRANSMISSION SYSTEMS**	3	0	0	3

(Professional Elective-IV)

Pre-requisites Power System-I, Power System-II, Power Electronics, PSOC

Course Description: This course provides a comprehensive understanding of Flexible AC Transmission Systems (FACTS) and their role in enhancing power system performance. It covers power flow in AC systems, stability considerations, and the significance of FACTS controllers. Students will explore voltage source converters, static shunt and series compensation techniques, and their applications using devices like STATCOM, SVC, TCSC, and SSSC. The course also delves into advanced multi-type FACTS controllers, including UPFC and GUPFC, for improved power flow management and system stability

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

C723.1: Understand necessity of various types of FACTS Devices in transmission system

C723.2: Analyze the operation and characteristics of Voltage Source Converters (VSC) in FACTS applications.

C723.3: Describe the principles and working mechanisms of shunt compensators in power systems.

C723.4: Explain the operation and functionality of STATCOM

C723.5: Describe the principles and functioning of series controllers in transmission networks.

C723.6: Understand the concepts and coordination of multi-type FACTS controllers for enhanced power system performance.

Unit - I FACTS Concepts

Transmission interconnections power flow in an AC system, loading capability limits, Dynamic stability considerations, importance of controllable parameters, basic types of FACTS controllers, and benefits from FACTS controllers. Real and reactive power control using FACTS devices.

Unit - II Voltage Source Converters

Single phase, three phase full wave bridge converters transformer connections for 12 pulse operation. Three level voltage source converter, pulse width modulation converter, basic concept of current source Converters, and comparison of current source converters with voltage source converters.

Unit - III Static Shunt Compensation:

Objectives of shunt compensation - Methods of controllable VAR generation –configuration and operating characteristics of Thyristor Controlled Reactor (TCR), Thyristor Switched Reactor (TSR) and Thyristor Switched Capacitor (TSC).
Static Synchronous Compensator (STATCOM) – operating principle – Comparison between STATCOM and Static var Compensator (SVC).

Unit - IV Static Series Compensators:

Objectives of Series Compensation – Gate Turn Off Thyristor-Controlled Series Capacitor (GCSC), Thyristor-Switched Series Capacitor (TSSC), Thyristor-Controlled Series Capacitor (TCSC) and Static Synchronous Series Compensator (SSSC) - Operation and Control.

Unit - V Multi Type FACTS Controllers:

The unified Flow Power Controller (UPFC) – Operation and control, Comparison with other FACTS devices, Generalized Unified Power Flow Controller (GUPFC) - Interline Power flow Controller (IPFC) - Dynamic power flow controller (DPFC), fault current limiter (FCL).

TEXT BOOKS

1. N.G. Hingorani and L. Guygi, "Understanding FACTS Devices", IEEE Press Publications 2000.
2. Yong- Hua Song, Allan Johns, "Flexible AC Transmission System", IEE Press 1999.

REFERENCE BOOKS

1. Kalyan K. Sen and Meylingsen, "Introduction to FACTS Controllers, John wiley & sons, Inc., Mohamed E. EI – Hawary Series editor, 2009.
2. K. R Padiyar, Motilal, FACTS controllers in power transmission and distribution UK Books of India 2007.

B.Tech. IV Year I Semester

Course Code	Course Title	L	T	P	Credits
EE724PE	**POWER SYSTEM STABILITY**	3	0	0	3

(Professional Elective-IV)

Prerequisites Power system – I, Power system -II, Power system operation and control

Course Description: This course covers power system stability, including small-signal, transient, and voltage stability. Students will learn synchronous machine modeling, numerical methods for stability analysis, and voltage collapse prevention. Stability enhancement techniques like power system stabilizers and dynamic braking are explored. The course equips students with analytical skills to ensure reliable power system operation.

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

C724.1: Explain the fundamental concepts of power system stability and its significance in the reliable operation of electrical power grids.

C724.2: Analyze transient stability phenomena and evaluate system performance during large disturbances

C724.3: Illustrate voltage stability issues and apply appropriate methods for voltage stability analysis.

C724.4: Explain small-signal stability analysis techniques to predict system oscillations and assess system stability using Eigenvalue analysis.

C724.5: Analyze stability enhancement techniques, including power system stabilizers (PSS).

C724.6: Applies numerical methods for stability assessment.

Unit - I Introduction to Power System Stability

Definition and significance of power system stability, Types of stability: transient, voltage, and small-signal stability, Classification of stability problems, Synchronous Machine Modeling - Synchronous machine models: classical and dynamic models, Excitation systems and governors, IEEE 1110-2019: Generator modeling for stability studies, including saturation effects (Reference Topic – Not for Assessment).

Unit - II Small-signal stability

State space representation, Physical Interpretation of small– signal stability, Eigen properties of the state matrix: Eigenvalues and eigenvectors, modal matrices. Small– signal stability analysis of a Single-Machine Infinite Bus (SMIB) Configuration, IEEE 421.5-2016: Excitation system modeling and power system stabilizers (Reference Topic – Not for Assessment).

Unit - III Transient stability

Review of numerical integration methods: modified Euler and Fourth Order Runge-Kutta methods, Numerical stability, Interfacing of Synchronous machine (classical machine) model to the transient stability algorithm (TSA) with partitioned – explicit approaches- Application of TSA to SMIB system, IEEE 3002.9-2021: Load flow and transient stability analysis (Reference Topic – Not for Assessment).

Unit - IV Voltage stability

Factors affecting voltage stability- Classification of Voltage Stability-Transmission system characteristics- Generator characteristics- Load characteristics- Characteristics of reactive power compensating Devices- Voltage collapse, IEEE P3380-2021: Stability considerations in data centers with AC power converters (Reference Topic – Not for Assessment).

Unit - V Enhancement of small-signal stability and transient stability

Power System Stabilizer –. Principle behind transient stability enhancement methods: high speed fault clearing regulated shunt compensation, dynamic braking, reactor switching, independent pole-operation of circuit breakers, single-pole switching, fast- valving, high-speed excitation systems, IEEE 693-2018: Seismic resilience and power system stability (Reference Topic – Not for Assessment).

TEXT BOOKS

1. P. Kundur – Power System Stability and Control, McGraw-Hill Education, 1994.
2. R.Ramnujam, "Power System Dynamics Analysis and Simulation", PHI Learning Private Limited, New Delhi, 2009.

REFERENCE BOOKS

1. T.V. Cutsem and C.Vournas, "Voltage Stability of Electric Power Systems", Kluwer publishers, 1998.
2. Peter W., Saucer, Pai M.A., "Power System Dynamics and Stability, Pearson Education (Singapore), 9th Edition, 2007.
3. EW. Kimbark., "Power System Stability", John Wiley & Sons Limited, New Jersey, 2013.
4. SB. Crary., "Power System Stability", John Wiley & Sons Limited, New Jersey, 1955.
5. K.N. Shubhanga, "Power System Analysis" Pearson, 2017.
6. K.R. Padiyar, "Power systems dynamics: Stability and control", BS Publications, 2008.

B.Tech. IV Year I Semester

Course Code	Course Title	L	T	P	Credits
EE700OE	UTILIZATION OF ELECTRICAL ENERGY	3	0	0	3

(Open Elective-II)

Prerequisites Basic Electrical Engineering

Course Description: This course covers the fundamentals of illumination, electric heating, welding, and electric drives, with a focus on their applications in electrical traction systems. Students will learn good lighting practices, heating methods, and welding techniques, along with calculations for heat generation in induction furnaces. The course also includes evaluating lighting requirements and analyzing speed-time curves for traction systems.

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

C700.1: Explain electric heating methods and compare their efficiency.

C700.2: Differentiate welding techniques and analyze electrolysis applications.

C700.3: Apply illumination laws to lighting design.

C700.4: Compare electric traction systems and speed-time curves.

C700.5: Classify electric drives and evaluate their performance.

C700.6: Demonstrate applications of heating, welding, lighting, traction, and drives.

Unit - I Electrical Heating

Various types of electric heating methods - resistance heating, induction heating and dielectric heating. Comparison, advantages and disadvantages.

Unit - II Electric Welding

Resistance welding and Arc welding, comparison between AC and DC welding. Electrolysis process: principle of electrolysis, electroplating, metal extraction and metal processing, electromagnetic stirs.

Unit - III Illumination

Terminology, Laws of illumination, coefficient of Utilization and depreciation, sources of light - LED lamps (inverter lamps, and solar street lighting); discharge lamps - mercury vapor lamps, sodium vapor lamps and neon lamps. Basic principles of light control.

Unit - IV Electric Traction

Systems of electric traction and track electrification - DC system, single phase and 3-phase low frequency and high frequency system, composite system, Kando system, comparison between AC and DC systems Mechanics of traction movement, speed – time curves for different services, trapezoidal and quadrilateral speed – time curves.

Unit - V Electric Drives

Types of Electric Drives, Types of Motors, Starting and Running Characteristics, Speed control, Types of industrial loads – continuous, intermittent and variable loads, Applications of Electric Drives.

TEXT BOOKS

1. H. Partab, Modern Electric Traction, Dhanpat Rai & Co, 2007.
2. E. Openshaw Taylor, Utilization of Electric Energy, Orient Longman, 2010.

REFERENCE BOOKS

1. H. Partab, Art & Science of Utilization of Electric Energy, Dhanpat Rai & Sons, 1998.
2. N.V. Suryanarayana, Utilization of Electrical power including Electric drives and Electric Traction, New Age Publishers, 1997.

B.Tech. IV Year I Semester

Course Code	Course Title	L	T	P	Credits
EE701OE	**ELECTRIC DRIVES AND CONTROL**	3	0	0	3

(Open Elective-II)

Prerequisites Basic Electrical Engineering

Course Description: This course provides a comprehensive introduction to electric drives, focusing on the principles of operation for DC and AC motor drives. Students will learn the dynamics and control of various drive mechanisms, emphasizing energy conversion in electric drives. The course covers the application of power electronic converters for controlling the speed of DC and induction motors. Students will gain practical knowledge in evaluating motors and power converters for specific applications. Upon completion, they will be equipped to develop closed-loop control strategies and implement energy conservation methods in electric drive systems.

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

- **C701.1:** Explain the necessity, advantages, and components of electrical drives.
- **C701.2:** Interpret torque equations and multi-quadrant drive operations.
- **C701.3:** Evaluate DC motor drives and their control strategies.
- **C701.4:** Elucidate induction motor speed control and braking methods.
- **C701.5:** Assess energy losses and conservation strategies in electric drives.
- **C701.6:** Implement energy-efficient drive systems for power quality improvement.

Unit - I Introduction to Electric Drives

Electrical Drives, Advantages of Electric drives, Parts of Electrical Drives, Power Modulators, Control unit, Choice of Electric Drives and Losses.

Unit - II Control of Electrical Drives

Fundamental torque equation, components of load torque, load characteristics, modified torque equation, speed-torque convention & multi-quadrant operation.

Speed control and drive classifications, closed loop control of drives.

Unit - III DC Motor Drives

Starting, Braking, Speed control of DC motors using single phase fully controlled rectifiers. Three phases fully controlled converter fed DC motor drives. Chopper controlled DC drives.

Unit - IV Induction Motor Drives

Speed control using pole changing, stator voltage control, AC voltage controllers. Variable frequency and variable voltage control from inverter. Different types of braking, dynamic, regenerative and plugging.

Unit - V Energy Conservation in Electric Drives

Losses in Electric drive systems, measurement of Energy conservation in Electric drives. Use of efficient converters, energy efficient operation of drives, Improvement of p.f., improvement of quality of supply.

TEXT BOOKS

1. G.K. Dubey, Fundamentals of Electric Drives –Narosa Publishers, Second edition, 2007.
2. Vedam Subramanyam, Electric Drives Concepts & Applications –Tata McGraw Hill Edn. Pvt. Ltd, Second edition 2011.

REFERENCE BOOKS

1. Nisit K. De and Prashanta K. Sen, Electric Drives, PHI., 2001.
2. V. Subrahmanyam, Thyristor Control of Electric Drives, Tata McGraw Hill Edn. Pvt. Ltd, 2010.
3. Werner Leonhard, Control of Electric Drives, Springer international edition 2001.
4. Nisit K. De and Swapan K. Dutta, Electric Machines and Electric Drives, PHI learning Pvt. Ltd 2011.

B.Tech. IV Year I Semester

Course Code	Course Title	L	T	P	Credits
EE702OE	PRINCIPLES OF POWER SYSTEMS	3	0	0	3

(Open Elective-II)

Prerequisites Basic Electrical Engineering

Course Description: The course "Principles of Power Systems" introduces fundamental concepts of power system structure, operation, and protection. It covers power generation, transmission, and distribution, including conventional and deregulated power distribution systems. Emphasis is placed on power system components, substation technologies (AIS & GIS), and protection schemes. Additionally, the course explores modern trends such as smart grids, renewable energy integration, advanced metering infrastructure (AMI), and the role of AI and machine learning in power systems.

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

C702.1: Describe power system structure and generation methods.
C702.2: Illustrate the classification of transmission lines and underground cables with their applications.
C702.3: Explain power distribution systems along with AIS & GIS technologies.
C702.4: Identify the types of power quality issues and their mitigation techniques.
C702.5: Explore smart grids, AMI, and challenges in renewable energy integration.
C702.6: Discuss the role of AI, machine learning, and BESS in modern power systems.

Unit - I Fundamentals of Power Systems

Single-line diagram with functions of power system components, principle of operation of power generation methods of thermal, hydro, solar, wind, biomass, and ocean energy.

Unit - II Transmission Lines and Underground Cables

Components of transmission lines, Classification of Transmission Lines (Based on Voltage Levels), Applications of Transmission Lines.

Components of transmission lines, Classification of Underground Cables (Based on Voltage Levels), Applications of Underground Cables.

Unit - III Distribution Systems

Classification of distribution systems-primary, secondary, AC and DC systems, Configurations of DC Distribution Systems-Radial, interconnected and Ring main configurations, Substation layout, Comparison of air-insulated substations (AIS) and gas-insulated substations (GIS).

Unit - IV Power Quality Issues

Introduction to power quality (PQ) and its importance in power systems, PQ issues-voltage sag, swell, harmonics, flicker, transients, their causes and effects on electrical equipment, Principles of mitigation techniques-voltage regulators, harmonic filters, and surge protectors.

Unit - V Modern Trends in Power Systems

Deregulated power systems, Challenges in renewable energy integration, Necessity of Battery Energy Storage Systems (BESS), Smart Grid architecture and Advanced Metering Infrastructure (AMI), Role of AI and Machine Learning in power systems.

TEXT BOOKS

1. Kothari, D. P., & Nagrath, I. J. Power system engineering (3rd ed.). McGraw Hill India, 2019.
2. Kothari, D. P., & Nagrath, I. J. Modern power system analysis (5th ed.). McGraw Hill India, 2022.
3. Dugan, R. C., McGranaghan, M. F., Santoso, S., & Beaty, H. W. Electrical power systems quality (3rd ed.). McGraw Hill, 2012.

REFERENCE BOOKS

1. Weedy, B. M., Cory, B. J., Jenkins, N., Ekanayake, J. B., & Strbac, G. Electric power systems (5th ed.). Wiley, 2012.
2. Saadat, H. Power system analysis (3rd ed.). PSA Publishing LLC, 2011.
3. Bollen, M. H. J. Understanding power quality problems: Voltage sags and interruptions (1st ed.). Wiley-IEEE Press, 1999.

B.Tech. IV Year II Semester

Course Code	Course Title	L	T	P	Credits
EE811PE	POWER QUALITY (Professional Elective-V)	3	0	0	3

Prerequisites Power Systems-II, Power System Protection

Course Description: Power Quality is a crucial aspect of modern electrical engineering that deals with maintaining a stable, clean, and efficient supply of electrical power. The course explores the causes, effects, and solutions to power quality problems such as voltage sags, harmonics, transients, flicker, and other disturbances that can disrupt the operation of electrical equipment. Students will learn to analyze and measure power quality, understand the standards and regulations governing power quality, and gain practical knowledge in mitigating power quality issues using various methods and technologies.

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

C811.1: Elucidate the power quality issues and the related terms.
C811.2: Analyze the causes and effects of voltage sags and interruptions in power systems.
C811.3: Analyze effects of harmonics and mitigation techniques.
C811.4: Assess the effect of DG in power quality problems and know power quality monitoring.
C811.5: Understand the EMC standards in mitigation of power quality issues.
C811.6: Suggest various converter topologies to mitigate power quality issues.

Unit - I Introduction

Introduction: Introduction of the Power Quality (PQ) problem, Terms used in PQ: Voltage, Sag, Swell, Surges, Harmonics, over voltages, spikes, Voltage fluctuations, Transients, Interruption, overview of power quality phenomenon, Remedies to improve power quality, power quality monitoring: Digital Fault Recorder (DFR), Smart Relays, Voltage Recorders etc.

Unit - II Voltage sags and Interruptions

Sources of sags and interruptions, estimating voltage sag performance-area of vulnerability, equipment sensitivity to voltage sags, transmission system and utility distribution system, sag performance evaluation, fundamental principles of protection, solutions at the end user level, Ferro resonant transformers, magnetic synthesizers, standby UPS, hybrid UPS and superconducting magnetic energy storage (SMES) devices.

Unit - III Fundamentals of Harmonics

Harmonic Distortion, Voltage versus current distortion, Harmonics versus Transients, Power system Qualities under Non sinusoidal Conditions, Harmonic Indices, Harmonic Sources from Commercial Loads and Industrial Loads. effects of harmonic distortion-impact on capacitors, transformers, motors and telecommunications, inter harmonics, harmonic current mitigation

Unit - IV Distributed Generation and Power Quality

Distributed Generation and Power Quality: Resurgence of DG, DG technologies, interface to the utility system, power quality issues.

Power Quality and EMC Standards: Introduction to standardization, IEC Electromagnetic compatibility standards, European voltage characteristics standards, PQ surveys.

Unit - V Power Quality Enhancement using Custom Power Devices

Introduction to Custom Power Devices - Network Reconfigure types - Solid State Current Limiter (SSCL) - Solid State Breaker (SSB) - Solid State Transfer Switch (SSTS)- Compensating Type: DSTATCOM, Dynamic Voltage Restorer (DVR), Unified Power Quality Conditioner (UPQC) - Principle of Operation Only.

TEXT BOOKS

1. Roger C. Dugan, Mark F. Mc Granaghan, Surya Santoso, H. Wayne Beaty, *"Electrical Power Systems Quality"*, Tata McGraw Hill Education Private Ltd, 3rd Edition 2012.
2. C. Sankaran, "Power Quality", CRC Press 2001.

REFERENCE BOOKS

1. Math H J Bollen, "Understanding Power Quality Problems", IEEE Press, 2000.
2. R. Sastry Vedam and Mulukutla S. Sarma, "Power Quality VAR Compensation in Power Systems", CRC Press, 2008.
3. J. Arrillaga, N.R. Watson, "Power System Harmonics", John Wiley and Sons

B.Tech. IV Year II Semester

Course Code	Course Title	L	T	P	Credits
EE812PE	SOLAR POWER BATTERIES	3	0	0	3

(Professional Elective-V)

Prerequisites Renewable Energy Sources, Energy Storage Systems

Course Description: This course covers the fundamentals of solar power storage, focusing on battery technologies, design, and performance. Topics include battery chemistry, charging parameters, system integration, degradation mechanisms, selection criteria, cost analysis, and environmental impacts. Students will gain insights into optimizing solar batteries for grid-tied and off-grid applications, ensuring efficiency, reliability, and sustainability in solar energy storage systems.

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

C812.1: Understand Battery Operating Principles.

C812.2: Design and Implement Solar Battery Systems.

C812.3: Analyze AC and DC Coupled Storage.

C812.4: Evaluate Battery Performance and Degradation.

C812.5: Assess Economic and Environmental Impacts.

C812.6: Compare Grid Tie and Off-Grid Systems.

Unit - I Solar PV and Battery Storage Basics

Introduction to solar PV systems, basics of Storage for solar PV systems, Storage for solar PV systems: the batteries, Introduction to Solar Power Batteries, terminology associated, understanding Solar Battery Specifications, working principle, Series Vs. Parallel, Charging parameters, cycle life, Temperature effects, Battery Design and Construction, Important components in battery construction.

Unit - II Classification of Batteries

Primary and Secondary batteries, Classification of Secondary batteries, i.e Lead-Acid, Lead-Antimony, Lead-Calcium, Lead-Acid Battery Chemistry, Nickel-Cadmium, Lithium-ion, Sodium-ion, Zinc-Air, Dual-ion, Magnesium-ion Batteries and their types.

Unit - III Solar Battery System: Design and Performance

AC Coupled Storage vs. DC Coupled Storage, working of Solar Batteries with a Solar Power System and Hybrid Inverter, Main Degradation mechanisms of Solar Batteries, Battery Strengths and Weaknesses, Battery System Design and Selection Criteria, Life Expectancy, Battery standards, Safety precautions.

Unit - IV Solar Battery Economics and Applications

Solar Battery Costs, ROI calculations for batteries, Declining Cost, factors contribute to the performance of solar battery, selection of suitable batteries based on the application, Grid Tie vs. Off-Grid Solar Battery System, Benefits and disadvantages of using solar batteries

Unit - V Sustainability and future trends in solar Battery Storage

The environmental impacts of batteries: Introduction, Service life of the components, Energy

requirements for production and transport of the PV-battery system components, Contributing components, Influence of different user conditions, Uncertainties, Future research, Energy return factor, The overall battery efficiency, Different efficiency measures and battery design, The Future of Solar Battery Storage.

TEXT BOOKS

1. S. Sumathi and L. Ashok Kumar, Solar PV and Wind Energy Conversion Systems: An Introduction to Theory, Modeling with MATLAB/SIMULINK, and the Role of Soft Computing Techniques, Springer 2011.
2. H.A. Kiehne, "Battery Technology Handbook" by Publisher: CRC Press 2003
3. Ming-Fa Lin, Wen-Dung Hsu and Jow-Lay Huang “Lithium-Ion Batteries and Solar Cells” Publisher: CRC Press Taylor & Francis Group.

REFERENCE BOOKS

1. Cristina Archer and S. Lovejoy, Battery Technology for Electric Vehicles: Public Science and Private Innovation, Springer 2015.
2. Soteris A. Kalogirou, "Solar Energy Engineering: Processes and Systems" by, Academic Press, Year: 2009

B.Tech. IV Year II Semester

Course Code	Course Title	L	T	P	Credits
EE813PE	**HIGH VOLTAGE ENGINEERING (Professional Elective-V)**	3	0	0	3

Prerequisites Power Systems – I, Electro Magnetic Fields

Course Description: Electrical power transmission network is trending towards higher and higher voltages. Under such a scenario, the conceptual understanding related to insulation, testing the HV devices is must for every electrical engineer. High Voltage Engineering deals with HV test generating devices, measurement devices, over voltages including lightning and non-destructive testing as well.

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

- **C813.1:** Examine breakdown mechanisms in different states of matter.
- **C813.2:** Analyze the circuits used to generate high voltages and Currents.
- **C813.3:** Analyze the circuits used to measure high voltages and currents.
- **C813.4:** Understand the Lightning Phenomena and Insulation gradation for different electrical power apparatus and coordination in insulation systems.
- **C813.5:** Understand IS, IEC standards required for testing of high voltage apparatus.
- **C813.6:** Illustrate the procedures for testing of apparatus at high voltages

Unit - I

Breakdown In Gases: Ionization processes and de-ionization processes, Types of Discharge, Gases as insulating materials, Breakdown in Uniform gap, non-uniform gaps, Townsend's theory, Streamer mechanism, Corona discharge

Breakdown In Liquid and Solid Insulating Materials: Breakdown in pure and commercial liquids, Solid dielectrics and composite dielectrics, intrinsic breakdown, electromechanical breakdown and thermal breakdown, Partial discharge, applications of insulating materials.

Unit - II

Generation of High DC Voltages: Voltage Doubler Circuit, Cockcroft-Walton Voltage Multiplier Circuit, Vande-Graaff Generator, Electrostatic Generator.

Generation of High AC Voltages: Cascade Transformers, Resonant Transformers, Tesla Coil circuit.

Generation of Impulse Voltages and Impulse Currents: Generation of Impulse Voltage Waves**,** Waveshape Control, Multistage Impulse Generator and their components, Generation of Impulse Current Waves, Tripping and Control of Impulse Generators.

Unit - III

Measurement of High DC Voltages: Series Resistance Micro ammeter, Resistance Potential Divider, Generating Voltmeter.

Measurement of High AC and Impulse Voltages: Series Impedance Voltmeter, Series Capacitance Voltmeter, Capacitance Voltage Transformer, Electrostatic Voltmeter, Peak Reading AC Voltmeters, Sphere Gaps.

Measurement of High DC, AC and Impulse Currents: Hall Generators, Rogowski Coil, Cathode Ray Oscillographs.

Unit - IV Lightning Mechanism and Insulation Co-ordination

Lightning Mechanism-Charge formation in clouds, stepped leader, Dart leader- Mathematical model of the lightning stroke, Insulation coordination, insulation level, statistical approach to insulation coordination, correlation between insulation and protection levels.

Unit - V High Voltage Testing of Electrical Apparatus

Various standards for HV Testing of electrical apparatus, IS, IEC standards, testing of insulators and bushings, testing of isolators and circuit breakers, testing of cables, power transformers.

TEXT BOOKS

1. M. S. Naidu and V. Kamaraju, "High Voltage Engineering", McGraw Hill Education, 2013.
2. C. L. Wadhwa, "High Voltage Engineering", New Age International Publishers, 2007.

REFERENCE BOOKS

1. D. V. Razevig (Translated by Dr. M. P. Chourasia), "High Voltage Engineering Fundamentals", Khanna Publishers, 1993.
2. E. Kuffel, W. S. Zaengl and J. Kuffel, "High Voltage Engineering Fundamentals", Newnes Publication, 2000.
3. R. Arora and W. Mosch "High Voltage and Electrical Insulation Engineering", John Wiley &Sons, 2011.
4. Various IS standards for HV Laboratory Techniques and Testing.

B.Tech. IV Year II Semester

Course Code	Course Title	L	T	P	Credits
EE814PE	ELECTRIC ENERGY CONSERVATION & AUDITING	3	0	0	3

(Professional Elective-V)

Pre-requisites Power Systems – I

Course Description: This course provides a comprehensive understanding of energy sources, energy management, and efficiency measures in various systems. It explores the fundamentals of energy production and consumption, energy conservation techniques, and sustainable energy strategies. The course also covers energy auditing, power factor improvement, load management, **Energy Conservation Building Code (ECBC)** and various building energy conservation techniques.

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

C814.1: Analyze the current energy scenario and importance of energy conservation.

C814.2: Demonstrate the concepts of energy management and audit.

C814.3: Apply Energy Monitoring and Targeting Methods.

C814.4: Illustrate the methods of improving energy efficiency in different electrical systems.

C814.5: Evaluate the benefits of energy-efficient technologies in industries.

C814.6: Design and Implement Energy-Efficient and Sustainable Building Strategies.

Unit - I Energy Scenario

Commercial and Non-commercial energy, primary energy resources, commercial energy production, final energy consumption, energy needs of growing economy, long term energy scenario, energy pricing, energy sector reforms, energy and environment, energy security, energy conservation and its importance, restructuring of the energy supply sector, energy strategy for the future, air pollution, climate change. Energy Conservation Act-2001 and its features.

Unit - II Energy Management & Audit

Definition, energy audit, need, types of energy audit. Energy management (audit) approach-understanding energy costs, bench marking, energy performance, matching energy use to requirement, maximizing system efficiencies, optimizing the input energy requirements, fuel and energy substitution, energy audit instruments and metering, precautions.

Unit - III Energy Monitoring and Targeting

Defining monitoring & targeting, elements of monitoring & targeting, data and information-analysis, techniques - energy consumption, production, cumulative sum of differences (CUSUM), Energy Management Information Systems (EMIS).

Unit - IV Energy Efficiency in Electrical Systems

Electricity billing, electrical load management and maximum demand control, power factor improvement and its benefit, selection and location of capacitors, performance assessment of PF capacitors, distribution and transformer losses. Electric motors: Types, losses in induction motors, motor efficiency, factors affecting motor performance, rewinding and motor replacement issues, energy saving opportunities with energy efficient motor.

Unit - V Energy Conservation Building Codes (ECBC) and Energy conservation in Buildings

Dynamic power flow controller (DPFC), fault current limiter (FCL) Energy Conservation Building Codes (ECBC), building envelope, insulation, lighting, Green House Building Concepts -Heating, ventilation, air conditioning (HVAC), Smart controls and automation in HVAC, Star labeling for existing buildings, Net Zero Energy Buildings (NZEB), Building Energy Management Systems (BEMS).

TEXT BOOKS

1. Guide books for National Certification Examination for Energy Manager / Energy Auditors Book-1, General Aspects (available online).
2. Guide books for National Certification Examination for Energy Manager / Energy Auditors Book-3, Electrical Utilities (available online).
3. S. C. Treaty, "Utilization of Electrical Energy and Conservation", McGraw Hill, 1991.

REFERENCE BOOKS

1. Success stories of Energy Conservation by BEE, New Delhi (www.bee-india.org)

B.Tech. IV Year II Semester

Course Code	Course Title	L	T	P	Credits
EE821PE	SMART GRID TECHNOLOGIES	3	0	0	3

(Professional Elective-VI)

Prerequisites IoT and Power Systems

Course Description: This course explores the fundamentals of smart grid systems, focusing on design strategies to meet utility requirements. It covers electricity generation, supply-demand economics, and electricity market operations in both regulated and deregulated environments. Students will gain insights into the role of automation in transmission and distribution and learn to apply evolutionary algorithms for smart grid optimization. The course also delves into the operation and maintenance of key grid technologies such as PMUs, PDCs, WAMs, and micro grid control systems.

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

C821.1: Explain the definition, architecture, and benefits of Smart Grids.

C821.2: Compare traditional and smart grids with their key components.

C821.3: Describe smart generation with renewable, micro grids, and adaptive protection.

C821.4: Analyze PMUs, WAMS, and ML applications in smart transmission.

C821.5: Illustrate digital substation architecture, automation, and cyber security.

C821.6: Evaluate advanced distribution automation, DER management, and ML-based control.

Unit - I Introduction to Smart Grid

Smart Grid Definition, Motivation Behind Smart Grid Initiative, Traditional Vs Smart Grid, Components and Benefits of Smart Grid, Smart Grid Architecture, Smart Grid Technology Pillars (Generation, Transmission, Substation, Distribution and Utilization)

Unit - II Smart Generation

Renewable generation operation for smart grid – voltage & frequency ride through, smart grid architecture with renewables and DERs, "Micro grids integration, management and architecture", Residential Micro grids & Net-zero buildings, Adaptive Protection for Smart grid with renewables.

Unit - III Smart Transmission

Synchro phasors (PMUs), PMU device architecture and role of PDC, WAMS technology and applications, Operation of EMS with SCADA and WAMS – benefits, Dynamic Line Rating, ML applications with PMU data, Grid Inertia Management, Grid Forming Inverters

Unit - IV Smart Substation

Introduction to Renewable Energy Conventional Vs Digital Substations, Introduction to Digital Substation Architecture and its components, IEC 61850 based substation automation system – process bus & station bus architecture, HSR & PRP technologies, time synchronization, Intelligent Electronic Devices, Virtual IEDs, Communication Mechanisms and Protocols, Cyber security framework for OT & IT in substation, Digital substation to Dispatchable substation for future with renewable integration.

Unit - V Smart Distribution

Advanced Distribution Automation System and Architecture, "Fault location identification, isolation and restoration (FLISR)", integrated volt-var control, feeder reconfiguration, conservation voltage reduction, voltage control with DER integration, large-scale DER management, load dynamics with EV's and its management, demand-side management, model-predictive control with ML for autonomous distribution systems.

TEXT BOOKS

1. Stuart Borlase, Smart Grids, Infrastructure, Technology and Solutions, CRC Press, 2013.
2. Gil Masters, Renewable and Efficient Electric Power System, Wiley-IEEE Press, 2004.

REFERENCE BOOKS

1. A.G. Phadke and J.S. Thorp, "Synchronized Phasor Measurements and their Applications", Springer Edition, 2010.
2. T. Ackermann, Wind Power in Power Systems, Hoboken, NJ, USA, John Wiley, 2005.

B.Tech. IV Year II Semester

Course Code	Course Title	L	T	P	Credits
EE822PE	ELECTRICAL DISTRIBUTION SYSTEMS	3	0	0	3

(Professional Elective-VI)

Prerequisites Power System – I, Power System – II, Power System Protection

Course Description: This course deals with the general concept of distribution system, substations and feeders as well as discusses distribution system analysis, protection and coordination, voltage control and power factor improvement.

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

C822.1: Understand the Fundamentals of Distribution Systems
C822.2: Analyze the Substation Location and Optimization Techniques.
C822.3: Understand the importance of Distribution Management Systems (DMS) and Automation.
C822.4: Optimize the Distribution System Components.
C822.5: Evaluate Energy Efficiency and SCADA Integration in Distribution Systems.
C822.6: Address Challenges in the Implementation and Maintenance of Distribution Automation.

Unit - I

General Concepts: Introduction to distribution system, Distribution system Layout and planning, Factors effecting the Distribution system planning, Load modelling and characteristics. Coincidence factor - contribution factor – Loss factor - Relationship between the load factor and loss factor. Load growth, Classification of loads (Residential, commercial, Agricultural and Industrial) and their characteristics.

Unit - II

Substations: Location of Substations: Rating of distribution substation, service area with 'n' primary feeders. Benefits derived through optimal location of substations. Optimal location of Substations (Perpendicular bisector rule and X, Y co-ordinate method).

Unit - III

Advantages of Distribution Management System (D.M.S.), Distribution Automation: Definition, Restoration / Reconfiguration of Distribution Network, Different Methods and Constraints, Power Factor Correction.

Interconnection of Distribution, Control & Communication Systems, Remote Metering, Automatic Meter Reading and its implementation. SCADA: Introduction, Block Diagram, SCADA Applied to Distribution Automation. Common Functions of SCADA, Advantages of Distribution Automation through SCADA.

Unit - IV

Calculation of Optimum Number of Switches, Capacitors, Optimum Switching Device Placement in Radial, Distribution Systems, Sectionalizing Switches – Types, Benefits, Bellman's Optimality Principle, Remote Terminal Units, Energy efficiency in electrical distribution & Monitoring.

Unit - V

Maintenance of Automated Distribution Systems, Difficulties in Implementing Distribution. Automation in Actual Practice, Urban/Rural Distribution, Energy Management, AI techniques applied to Distribution Automation.

TEXT BOOKS

1. Turan Gonen, Electric Power Distribution System Engineering, CRC Press, 3rd Edition 2014.
2. V. Kamaraju, Electrical Power Distribution Systems, Tata Mc Graw Hill Publishing Company, 2nd edition, 2010.

REFERENCE BOOKS

1. G. Ram Murthy, Electrical Power Distribution hand book, 2nd edition, University press 2004.
2. A.S. Pabla, Electric Power Distribution, Tata McGraw Hill Publishing company, 6th edition, 2013.
3. M.K. Khedkar, G.M. Dhole, "A Text Book of Electrical power Distribution Automation", University Science Press, New Delhi.

B.Tech. IV Year II Semester

Course Code	Course Title	L	T	P	Credits
EE823PE	MACHINE LEARNING APPLICATIONS TO ELECTRICAL ENGINEERING (Professional Elective-VI)	3	0	0	3

Prerequisites Basic electrical engineering, Signal Processing, Probability and statistics.

Course Description: This course provides an understanding of machine learning (ML) principles and their applications in electrical engineering. Topics include data preprocessing, feature engineering, and ML algorithms like regression, classification, clustering, and neural networks. Practical applications focus on power system optimization, fault detection, smart grids, and signal processing, enabling students to implement ML solutions for real-world electrical engineering problems.

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

C823.1: Understand the fundamental concepts, types, and applications of artificial intelligence.

C823.2: Apply ML techniques to analyze and process electrical engineering data.

C823.3: Implement data preprocessing and feature engineering for ML models in electrical systems.

C823.4: Utilize ML algorithms for electrical engineering applications.

C823.5: Optimize power systems, fault detection, and control systems using ML.

C823.6: Analyze and apply ML-based solutions in various applications.

Unit - I Introduction to Machine Learning:

Evolution of Artificial intelligence, Introduction to machine learning and deep learning, Necessity of artificial intelligence in solving real world applications, Role of machine learning in solving complex problems and their computational requirements, Difference between machine learning and deep learning.

Unit - II Fundamentals of Electrical Engineering Relevant to ML:

Basic concepts of machine learning: supervised learning, unsupervised learning, reinforcement learning. Overview of electrical circuits and systems, Signal processing basics, Introduction to control systems.

Unit - III Data Preprocessing and Feature Engineering:

Methods to obtain data for machine learning, Data augmentation, Handling unbalanced data, Data cleaning and handling missing values, Features calling and normalization, Feature extraction and selection.

Unit - IV Machine Learning Algorithms for Electrical Engineering Applications

Regression and classification algorithms, Decision trees and ensemble methods, Neural networks and deep learning, Support vector machines, Clustering algorithms for pattern recognition.

Unit - V Case Studies and Applications in Electrical Engineering

Power system optimization using ML, Fault detection and diagnostic sin electrical systems, Smart grid applications, Signal processing with ML, Control system optimization and adaptive control using ML.

TEXT BOOKS

1. C. Aldrin Renold and Sumathi S, Pattern Recognition and Machine Learning, WileyIndia,2015.
2. S. Rajasekaran and G. Aghila, Machine Learning: An Algorithmic Perspective, Chapman and Hall/CRC,2018.
3. Chandra Shekhar Yadav, S. Ramakrishnan and U. Rajendra Acharya, Machine Learning: Concepts, Methodologies, Tools and Applications, Springer 2018.

REFERENCE BOOKS

1. Ethem Alpaydin, Introduction to Machine Learning, MIT Press 2010
2. Christopher M. Bishop, Pattern Recognition and Machine Learning, Springer, 2006.
3. Kevin P. Murphy, Machine Learning: A Probabilistic Perspective, MIT Press 2012.

B.Tech. IV Year II Semester

Course Code	Course Title	L	T	P	Credits
EE824PE	CYBER-PHYSICALSYSTEMS (Professional Elective-VI)	3	0	0	3

Prerequisites Basic Electrical Engineering, Control Systems, Communication Networks, and Computer Science Fundamentals.

Course Description: This course provides an introduction to Cyber-Physical Systems (CPS), their role in modern electrical and power systems, and their interaction with physical infrastructure. It covers system architecture, security challenges, control techniques, and applications in smart grids, industrial automation, and intelligent transportation systems.

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

C824.1: Explain the fundamental concepts, architecture, and components of Cyber-Physical Systems (CPS).

C824.2: Apply system modeling techniques to analyze CPS behavior and challenges.

C824.3: Examine communication architectures, protocols, and cybers security measures to mitigate threats and vulnerabilities in CPS.

C824.4: Implement real-time monitoring, control strategies, sensor fusion, and fault diagnosis techniques for enhancing CPS resilience.

C824.5: Evaluate CPS applications in electrical engineering.

C824.6: Investigate emerging trends such as AI/ML, block chain, 5G, and ethical considerations to understand future research directions in CPS.

Unit - I

Introduction to Cyber-Physical Systems: Definition, Scope, and Importance of CPS, Components of CPS: Cyber, Physical, and Communication Layers, CPS vs. Embedded Systems vs. IoT, System Modeling: Hybrid Systems and Feedback Control Challenges and Research Directions in CPS.

Unit - II

Communication Networks and Security in CPS: Communication Architectures for CPS (Wired and Wireless) Protocols for CPS: MQTT, CoAP, Zigbee, 5G, and IoT Protocols, Security Threats in CPS: Attack Vectors and Vulnerabilities, Cybersecurity Measures in CPS: Encryption, Firewalls, Intrusion Detection Systems (IDS), Case Study: Cyber Attacks on Smart Grids and Industrial Control Systems (ICS).

Unit - III

Control and Real-Time Monitoring in CPS: Real-Time Embedded Control in CPS Distributed and Networked Control Systems, Sensor Fusion and Edge Computing for CPS, Digital Twins and Simulation Techniques in CPS, Fault Detection, Diagnosis, and Resilient Control.

Unit - IV

Applications of CPS in Electrical Engineering: Smart Grid Technologies and Cyber-

Physical Integration, Industrial Automation and Process Control, Intelligent Transportation Systems and Smart Cities, CPS in Renewable Energy Management.

Unit - V

Emerging Trends and Future Challenges in CPS: Artificial Intelligence (AI) and Machine Learning (ML) in CPS, Blockchain for Secure CPS Communication, Role of 5G and Edge Computing in CPS, Human-CPS Interaction and Ethical Considerations, Future Research Directions in CPS.

TEXT BOOKS

1. Raj Rajkumar, Dionisio de Niz, Mark Klein, Cyber-Physical Systems, Addison-Wesley, 2016.
2. Al-Sakib Khan Pathan, Security of Cyber-Physical Systems, Springer, 2017.
3. Edward A. Lee, Sanjit A. Seshia, Introduction to Embedded Systems: A Cyber-Physical Systems Approach, MIT Press, 2017.

REFERENCE BOOKS

1. Houbing Song, Glenn A. Fink, Sabina Jeschke, Security and Privacy in Cyber-Physical Systems, Wiley, 2017.

B.Tech. IV Year II Semester

Course Code	Course Title	L	T	P	Credits
EE800OE	BASICS OF POWER PLANT ENGINEERING (Open Elective - III)	3	0	0	3

Prerequisites: Basic Electrical Engineering

Course Description: This course deals with different types of power plants including conventional and renewable energy systems which are used for the Energy generation. The advantages and disadvantages of each type of power plants and the safety aspects are discussed in the subject.

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

C800.1: Explain the components and layouts of a Thermal power plant.

C800.2: Explain the components and layouts of a Gas power plant.

C800.3: Elucidate various nuclear reactors.

C800.4: Discuss the principles of various non-conventional energy power plants.

C800.5: Examine the economic aspects for electrical power generation.

C800.6: Apply various pollution control techniques in power plants.

Unit - I

Coal Based Thermal Power Plants: Basic Rankine cycle, layout of modern coal power plant, super critical boilers, FBC boilers, fuel and ash handling, cogeneration systems.

Unit - II

Gas Turbine and Combined Cycle Power Plants: Brayton cycle, components of gas turbine power plants, combined cycle power plants, Integrated Gasifier based Combined Cycle (IGCC) systems.

Unit - III

Basics of Nuclear Energy Conversion: Layout and subsystems of nuclear power plants, CANDU Reactor, Pressurized Heavy Water Reactor (PHWR), Fast Breeder Reactors (FBR).

Unit - IV

Hydroelectric Power Plants: Classification, typical layout and components.

Non-conventional energy power plants: Principles of wind, tidal, solar PV, biogas and fuel cell power systems.

Unit - V

Energy, Economic and Environmental Issues: Power tariffs, load distribution parameters, load curve, capital and operating cost of different power plants, pollution control technologies including waste disposal options for coal and nuclear plants.

TEXT BOOKS:

1. Nag P.K., Power Plant Engineering, 3rd ed., Tata McGraw Hill, 2008.
2. El Wakil M.M., Power Plant Technology, Tata McGraw Hill, 2010.

REFERENCE BOOKS:

1. Elliot T.C., Chen K and Swanekamp R.C., Power Plant Engineering, 2nd ed., McGraw Hill, 1998.

B.Tech. IV Year II Semester

Course Code	Course Title	L	T	P	Credits
EE801OE	**ENERGY SOURCES AND APPLICATIONS**	3	0	0	3

(Open Elective-III)

Prerequisites Renewable energy sources, Environmental science

Course Description: This course explores various energy sources, including fossil fuels, renewable, and emerging technologies. It examines energy sustainability, environmental impacts, energy conservation strategies, and green building concepts. The course also covers economic and policy aspects of energy production and consumption, equipping students with knowledge of energy management, efficiency, and sustainability practices.

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

C801.1: Identify and explain various energy sources and their applications.

C801.2: Analyze the impact of different energy sources on the environment and climate.

C801.3: Compare renewable and non-renewable energy sources in terms of sustainability and efficiency.

C801.4: Understand energy conservation, efficiency, and clean energy technologies.

C801.5: Evaluate economic and policy aspects of energy production and consumption.

C801.6: Apply engineering principles in energy audits and green building practices.

Unit - I Introduction to Energy Science

Scientific principles and historical interpretation to place energy use in the context of pressing societal, environmental and climate issues Introduction to energy systems and resources; Introduction to Energy, sustainability & the environment.

Unit - II Energy Sources

Over view of energy systems, sources, transformations efficiency, and storage. Fossil fuels (coal, oil, oil-bearing shale and sands, coal gasification) -past, present & future, Remedies & alternatives for fossil fuels - biomass, wind, solar nuclear, wave, tidal and hydrogen;

Unit - III Sustainability and Environmental Trade-Offs of Different Energy Systems

Possibilities for energy storage or regeneration, Pumped storage hydro Power projects, superconductor-based energy storages, high efficiency batteries.

Unit - IV Energy & Environment

Energy efficiency and conservation; introduction to clean energy technologies and its importance in sustainable development; Carbon footprint, energy consumption and sustainability; introduction to the economics of energy; How the economic system determines production and consumption; linkages between economic and environmental outcomes; How future energy use can be influenced by economic environmental, trade, and research policy.

Unit - V Engineering for Energy Conservation

Concept of Green Building and Green Architecture; Green building concepts, LEED ratings; Identification of energy related enterprises that represent the breath of the industry and

prioritizing these as candidates; Embodied energy analysis and use as a tool for measuring sustainability. Energy Audit of Facilities and optimization of energy consumption.

TEXTBOOKS:

1. Boyle, Godfrey, “Renewable Energy: Power for a sustainable future”, 3rd edition, Oxford University Press, 2004.
2. Bob Everett, Stephen Peake, and James Warren, “Energy Systems and Sustainability: Power for a Sustainable Future”, 3rd Edition, Oxford University Press, 2021.

REFERENCEBOOKS:

1. N.K. Giri, "Alternate Energy (Sources, Applications and Technologies)", Khanna Publishers, 2012.
2. Mehmet KanoğluYunus A. ÇengelJohn M. Cimbala, "Fundamentals and Applications of Renewable Energy", McGraw-Hill Education, 2020.
3. K.M. Mittal "Non-Conventional Energy Systems", A H Wheeler Publishing Co Ltd, 1999

B.Tech. IV Year II Semester

Course Code	Course Title	L	T	P	Credits
EE802OE	BATTERY MANAGEMENT SYSTEMS	3	0	0	3

(Open Elective-III)

Prerequisites Basics of Electrical Engineering, Chemistry, Physics

Course Description: The objective of this course is to introduce learner to batteries, its parameters, modeling and charging requirements. The course will help learner to develop battery management algorithms for batteries.

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

C802.1: Interpret the role of battery management system.

C802.2: Identify the requirements of Battery Management System.

C802.3: Interpret the concepts associated with battery charging / discharging process.

C802.4: Estimate the SOC and state of health of battery and battery pack.

C802.5: Analysis of different battery charging technologies.

C802.6: Identify the safety measures and protection of BMS.

Unit - I Introduction

Introduction to Battery Management System (BMS), Cells & Batteries, Nominal voltage and capacity, C-rate, Energy and power, Cells connected in series, Cells connected in parallel, Electrochemical and lithium-ion cells, Rechargeable cell, Overcharge and Undercharge, Modes of Charging.

Unit - II Battery Management System Requirement

BMS Functionality, Battery pack topologies, Voltage Sensing, Temperature Sensing, Current Sensing, High-voltage contactor control, Isolation sensing, Thermal sensing, Cell total energy and total power.

Unit - III Battery State of Charge and State of Health Estimation, Cell Balancing

Battery state of charge estimation (SOC), Battery Health Estimation, Lithium-ion aging for Negative and Positive electrode, Cell Balancing, Circuits for cell balancing.

Unit - IV Battery Charging Technologies

Battery charging principles, Constant Current (CC) Mode, Constant Voltage (CV) Mode, Constant Current-Constant Voltage (CC-CV) Mode, Fast Charging Techniques (DC Charging).

Unit - V Safety Measures and Protections in BMS

Safety in BMS-Importance and Regulatory Compliance-Hazard Analysis and Risk Mitigation-Protection Mechanisms, Overvoltage Protection, Reverse Polarity Protection Over current Protection, Thermal Protection, Cooling Systems and Heat Dissipation.

TEXT BOOKS

1. Plett, Gregory L. Battery management systems, Volume I: Battery modeling. Artech House, 2015.
2. Plett, Gregory L. Battery management systems, Volume II: Equivalent-circuit methods. Artech House, 2015.

REFERENCE BOOKS

1. Bergveld, H.J., Kruijt, W.S., Notten, P.H.L "Battery Management Systems -Design by Modelling" Philips Research Book Series 2002.
2. Davide Andrea, "Battery Management Systems for Large Lithium-ion Battery Packs" Artech House, 2010.
3. Pop, Valer, et al. Battery management systems: Accurate state-of-charge indication for battery-powered applications. Vol. 9. Springer Science & Business Media, 2008.

SUSTAINABLE DEVELOPMENT GOALS

01 NO POVERTY

02 ZERO HUNGER

03 GOOD HEALTH AND WELL-BEING

04 QUALITY EDUCATION

05 GENDER EQUALITY

06 CLEAN WATER AND SANITATION

07 AFFORDABLE AND CLEAN ENERGY

08 DECENT WORK AND ECONOMIC GROWTH

09 INDUSTRY, INNOVATION AND INFRASTRUCTURE

10 REDUCED INEQUALITIES

11 SUSTAINABLE CITIES AND COMMUNITIES

12 RESPONSIBLE CONSUMPTION AND PRODUCTION

13 CLIMATE ACTION

14 LIFE BELOW WATER

15 LIFE ON LAND

16 PEACE, JUSTICE AND STRONG INSTITUTIONS

17 PARTNERSHIPS FOR THE GOALS