# Learning Outcomes based Curriculum Framework (LOCF)

For

B. Tech. (Electrical Engineering)

3rd year onwards

Full-Time

Graduate Programme


Faculty of Engineering and Technology

Chaudhary Devi Lal University Sirsa-125055

2022-2023

# Scheme of Examination

# &

# Detailed Syllabus

# of

# B.Tech. (EE)

# 3rd Yr. (onwards)

## Credit Scheme for B. Tech. (Electrical Engg.) III Year (V &VI Sem)

| Semester | Basic Science Courses (BSC) | | Program Core/ Program Elective/ Open Elective Courses (PC/PE/OE) | | Humanities, Social Sciences Courses (HSMC) | | Mandatory Courses (MC) | | Grand Total Credit |
|---|---|---|---|---|---|---|---|---|---|
| Sr. No. | No. of Courses | Total Credits | No. of Courses | Total Credits | No. of Courses | Total Credits | No. of Courses | Total Credits | |
| V | 00 | 00 | 08 | 24 | 01 | 03 | 01 | 00 | 27 |
| VI | 00 | 00 | 08 | 20 | 01 | 02 | 00 | 00 | 22 |

## B. Tech. III Year Semester-V

| Sr. No. | Course Code | Course Title | Workload/ Credit | | | |
|---|---|---|---|---|---|---|
| | | | Theory | Tutorial | Practical | Total |
| 1. | PC/EE/11-T | Advanced Power Electronics and Drives | 3/3 | 1/1 | 0/0 | 4/4 |
| 2. | PC/EE/12-T | Control Systems-I | 3/3 | 1/1 | 0/0 | 4/4 |
| 3. | PC/EE/13-T | Microprocessors & Microcontrollers | 3/3 | 0/0 | 0/0 | 3/3 |
| 4. | PC/EE/14-T | Electrical Engineering Materials | 3/3 | 0/0 | 0/0 | 3/3 |
| 5. | PC/EE/11-P | Advanced Power Electronics and Drives Laboratory | 0/0 | 0/0 | 2/1 | 2/1 |
| 6. | PC/EE/12-P | Control Systems-I Laboratory | 0/0 | 0/0 | 2/1 | 2/1 |
| 7. | PC/EE/13-P | Microprocessors & Microcontrollers Laboratory | 0/0 | 0/0 | 2/1 | 2/1 |
| 8. | Open Elective Course– I to be opted by students from another branch | | 3/3 | 0/0 | 0/0 | 3/3 |
| 9. | HSMC/3-T | Fundamentals of Management | 3/3 | 0/0 | 0/0 | 3/3 |
| 10. | EEC/EE/1-P | Industrial Training/ Internship-I | 0/0 | 0/0 | 0/4 | 0/4 |
| TOTAL | | | **18/18** | **2/2** | **6/7** | **26/27** |
| | | | | | **Total Credits** | **27** |

**Important Notes:**

**1.** Open Elective Course– I to be offered by departments other than Electrical Engineering.

**2.** Assessment of Industrial Training/ Internship-I will be based on presentation/seminar, viva-voce, report and certificate for the Industrial Training taken at the end of IV semester.

**3.** Students will be allowed to use non-programmable scientific calculator only, however sharing of calculator will not be permitted.

# B. Tech. III Year Semester-VI

| Sr. No. | Course Code | Course Title | Workload/ Credit | | | |
|---|---|---|---|---|---|---|
| | | | Theory | Tutorial | Practical | Total |
| 1. | PC/EE/15-T | Power Systems-II | 3/3 | 0/0 | 0/0 | 3/3 |
| 2. | PC/EE/16-T | Electrical Measurements and Instrumentation | 3/3 | 0/0 | 0/0 | 3/3 |
| 3. | PC/EE/17-T | Control Systems-II | 3/3 | 1/1 | 0/0 | 4/4 |
| 4. | PC/EE/15-P | Power Systems-II Laboratory | 0/0 | 0/0 | 4/2 | 4/2 |
| 5. | PC/EE/16-P | Electrical Measurements and Instrumentation Laboratory | 0/0 | 0/0 | 2/1 | 2/1 |
| 6. | PC/EE/17-P | Control Systems-II Laboratory | 0/0 | 0/0 | 2/1 | 2/1 |
| 7. | PE/EE/1-T to PE/EE/4-T | Program Elective Course– I | 3/3 | 0/0 | 0/0 | 3/3 |
| 8. | Open Elective Course– II to be opted by students from another branch | | 3/3 | 0/0 | 0/0 | 3/3 |
| 9. | *HSMC/4-T | Economics for Engineers | 2/2 | 0/0 | 0/0 | 2/2 |
| TOTAL | | | **17/17** | **1/1** | **8/4** | **28/22** |
| | | | | | **Total Credits** | **22** |
| 10. | **EEC/EE/2-P | Industrial Training/ Internship-II | 0/0 | 0/0 | 4/2 | 4/2 |

**Important Notes:**

*Non-credit qualifying course. The assessment will be completely internal.

****The students will have to prepare and submit a project report of the Industrial Training/ Internship of 6-8 weeks done during summer vacations after the examination of VI semester under the supervision of faculty during VII semester.**

**Note**: Students will be allowed to use non-programmable scientific calculators only; however, sharing of calculator should not be permitted.

## List of Program Electives for VI Semester

### Program Elective Course– I

| Sr. No. | Course Code | Nomenclature of Subject |
|---|---|---|
| 1. | PE/EE/1-T | Renewable Energy Resources |
| 2. | PE/EE/2-T | Electrical and Hybrid Vehicles |
| 3. | PE/EE/3-T | Network Synthesis and Filters |
| 4. | PE/EE/4-T | Modelling and Simulation |

## Credit Scheme for B.Tech.(Electrical Engg.) IV Year (VII & VIII Sem)

| Semester | Basic Science Courses (BSC) | | Program Core/ Program Elective/ Open Elective Courses (PC/PE/OE) | | Humanities, Social Sciences Courses (HSMC) | | Mandatory Courses (MC) | | Grand Total Credit |
|---|---|---|---|---|---|---|---|---|---|
| Sr. No. | No. of Courses | Total Credits | No. of Courses | Total Credits | No. of Courses | Total Credits | No. of Courses | Total Credits | |
| VII | 00 | 00 | 08 | 21 | 00 | 00 | 00 | 00 | 21 |
| VIII | 00 | 00 | 05 | 15 | 00 | 00 | 00 | 00 | 15 |

## B. Tech. IV Year Semester-VII

| Sr. No. | Course Code | Course Title | Workload/ Credit | | | |
|---|---|---|---|---|---|---|
| | | | Theory | Tutorial | Practical | Total |
| 1. | PC/EE/18-T | Power System Operation and Control | 3/3 | 1/1 | 0/0 | 4/4 |
| 2. | PC/EE/19-T | Power Distribution System | 3/3 | 0/0 | 0/0 | 3/3 |
| 3. | PE/EE/5-T to PE/EE/8-T | Program Elective Course- II | 3/3 | 0/0 | 0/0 | 3/3 |
| 4. | PE/EE/9-T to PE/EE/12-T | Program Elective Course- III | 3/3 | 0/0 | 0/0 | 3/3 |
| 5. | Open Elective Course– III to be opted by students from another branch | | 3/3 | 0/0 | 0/0 | 3/3 |
| 6. | PC/EE/20-P | Renewable Energy Lab | 0/0 | 0/0 | 2/1 | 2/1 |
| 7. | EEC/EE/2-P | Industrial Training/ Internship-II | 0/0 | 0/0 | 4/2 | 4/2 |
| 8. | EEC/EE/3-P | Minor Project Lab | 0/0 | 0/0 | 8/2 | 8/2 |
| TOTAL | | | **15/15** | **2/2** | **14/5** | **30/21** |
| **Total Credits** | | | | | | **21** |

**Important Notes:**

1. Open Elective Course– III to be offered by departments other than Electrical Engineering.
2. The Minor Project should be initiated by the student in the beginning of VII semester and will be evaluated at the end of the semester on the basis of its implementation, presentation, delivered, viva-voce and report.
3. The Viva-Voce for Minor Project by External Examiner and Chairperson of the Department / Internal Examiner at the end of the semester.
4. ****The students will have to prepare and submit a project report of the Industrial Training/ Internship of 6-8 weeks done during summer vacations after the examination of VI semester under the supervision of faculty during VII semester.**

## List of Program Electives for VII Semester

### Program Elective Course– II

| Sr. No. | Course Code | Nomenclature of Subject |
|---|---|---|
| 1. | PE/EE/5-T | Electrical Machine Design |
| 2. | PE/EE/6-T | Advanced Power Electronics |
| 3. | PE/EE/7-T | Wind and Solar Energy Systems |
| 4. | PE/EE/8-T | Utilization of Electrical Energy |
| | | |

### Program Elective Course– III

| Sr. No. | Course Code | Nomenclature of Subject |
|---|---|---|
| 1. | PE/EE/9-T | Energy Management & Auditing |
| 2. | PE/EE/10-T | Soft Computing |
| 3. | PE/EE/11-T | SCADA Systems and Applications |
| 4. | PE/EE/12-T | Internet of Things (IoT) |

## B. Tech. IV Year Semester-VIII

| Sr. No. | Course Code | Course Title | Workload/ Credit | | | |
|---|---|---|---|---|---|---|
| | | | Theory | Tutorial | Practical | Total |
| 1. | PC/EE/21-T | Computer Methods in Power Systems | 3/3 | 1/1 | 0/0 | 4/4 |
| 2. | PE/EE/13-T to PE/EE/16-T | Program Elective Course- IV | 3/3 | 0/0 | 0/0 | 3/3 |
| 3. | PE/EE/17-T to PE/EE/20-T | Program Elective Course- V | 3/3 | 0/0 | 0/0 | 3/3 |
| 4. | PC/EE/21-P | Computer Methods in Power Systems Lab | 0/0 | 0/0 | 2/1 | 2/1 |
| 5. | EEC/EE/4-P | Major Project Lab | 0/0 | 0/0 | 12/4 | 12/4 |
| TOTAL | | | **09/09** | **1/1** | **14/5** | **24/15** |
| | | | | | **Total Credits** | **15** |

**Important Notes:**

1. The Major Project should be initiated by the student in continuation of the VII semester and will be evaluated at the end of the semester on the basis of its implementation, presentation, delivered, viva-voce and report.
2. The Viva-Voce for Major Project by External Examiner and Chairperson of the Department / Internal Examiner at the end of the semester.
3. Students will be allowed to use non-programmable scientific calculator only, however sharing of calculator will not be permitted.

# List of Program Electives for VIII Semester

## Program Elective Course– IV

| Sr. No. | Course Code | Nomenclature of Subject |
|---|---|---|
| 1. | PE/EE/13-T | Flexible AC Transmission Systems (FACTS) |
| 2. | PE/EE/14-T | Distributed Generation |
| 3. | PE/EE/15-T | Power Quality |
| 4. | PE/EE/16-T | Smart Grid Technologies |

## Program Elective Course– V

| Sr. No. | Course Code | Nomenclature of Subject |
|---|---|---|
| 1. | PE/EE/17-T | EHV AC and DC Transmission |
| 2. | PE/EE/18-T | Restructured Power System |
| 3. | PE/EE/19-T | High Voltage Engineering |
| 4. | PE/EE/20-T | Big Data Analysis |

**Policy Document for providing exemptions in attendance to the B.Tech. students of the University for undertaking various internships/trainings during their final/penultimate semester**

## 1. Background:

It has been realized that the students pursuing B. Tech. programmes offered by the University/affiliated Institutes/Colleges are facing challenges as under:

1. Students selected in industry during their programme are asked to join the industry for internship/training of duration up to one semester.
2. The provision is not there in these programmes to allow the students to join the internship by way of getting the required attendance of semester from internship/training.
3. So, students are not able to join such internship/training consequential to two-fold loss:
   (a) Job opportunity.
   (b) Skill development in industry environment.

But, presently, in the B. Tech. Programmes run by the University, there is no provision for the students to join the industry for such internship/training of/for more than 6–8-week duration. To facilitate the students for joining longer duration internships/trainings, a need for framing a policy document was felt.

Keeping in view the above challenges/statutory position and to avoid hardship to students and to improve the employability of the students, Ch. Devi Lal University, Sirsa has framed a policy to accord exemptions in attendance to students undertaking various internships/trainings during their final/penultimate semester of the B. Tech. Programmes.

## 2. Applicability of the policy with following Provisions:

The policy is applicable to the students studying in the final semester/ penultimate semester of B. Tech. programmes.

### 2.1 Provisions:

Student covered as per section title 'Applicability of the Policy' will be governed by the following provisions:

1. The student will be allowed to join the organization for internship/training in the final semester/ penultimate semester of the course for a period of up to one semester only if he/she must be passed/ cleared in all courses/subjects in all the semester examination whose results have been declared.
2. The student will earn his attendance from the organization during the period of internship.
3. Attendance will be certified by the organization, failing which student will be debarred from appearing in the University examinations of that semester.
4. The student will have to give an undertaking that he/she will appear in all the internal/external examination/practical as per requirements of the Programme and as

per Schedule of the University examination for that programme. For this he/she will have to do the necessary preparation by himself/herself and Institute/department will not be responsible for the same.

5. If the student is selected in a company/industry/organization etc., and is asked to join the organization in the final semester/ penultimate semester for a period of upto one semester; then formally constituted Internship Facilitation Committee (IFC) will examine and give its recommendation as deemed fit.

## 2.2 Composition of Internship Facilitation Committee (IFC):

The composition of IFC will be as under:

1. Dean, Faculty of Engg. & Tech./Director/ Principal (or Nominee) (Chairperson)
2. Chairperson/Head/ In-charge of the concerned Department/Branch (Member)
3. In-Charge Academic Branch/Academic In-charge of Institute (Member)
4. Senior most faculty of the department other than Chairperson/ Director/Head of the Department/Branch (Member)
5. Training and Placement officer/ In-Charge TPO of the Institute /College/Department (Member Secretary)

Any offer by the organisations providing internship on demanding charges from a student will be discouraged by the Internship Facilitation Committee (IFC). Member Secretary of the IFC will schedule the meeting and maintain all the records.

## 3. Conclusion:

The students can only be allowed to join the internship/training in company/ industry/ organization etc. with exemptions in attendance on the final recommendation of Internship Facilitation Committee (IFC) of the Institute / Department and permission given by the Department/Institute/College authority.

## Open Elective Course-I for B. Tech. V Semester

| Sr. No. | Course Code | Course Nomenclature |
|---|---|---|
| 1 | OE/EE/1-T | Utilization of Electrical Energy |
| 2 | OE/EE/2-T | Wind and Solar Energy System |
| 3 | OE/EE/3-T | Electrical and Hybrid Vehicles |
| 4 | OE/EE/4-T | Introduction to Electrical Machines |

## Open Elective Course-II for B. Tech. VI Semester

| Sr. No. | Course Code | Course Nomenclature |
|---|---|---|
| 1 | OE/EE/5-T | Renewable Energy Resources |
| 2 | OE/EE/6-T | Special Electrical Machines |
| 3 | OE/EE/7-T | Smart Grid Technologies |
| 4 | OE/EE/8-T | Electrical Measurement and Instruments |

## Open Elective Course-III for B. Tech. VII Semester

| Sr. No. | Course Code | Course Nomenclature |
|---|---|---|
| 1 | OE/EE/9-T | Energy Management and Auditing |
| 2 | OE/EE/10-T | Power Plant Engineering |
| 3 | OE/EE/11-T | Transducers and Sensors |
| 4 | OE/EE/12-T | EHV AC and DC Transmission |

**Note:** ***Student can opt, for any open electives other than open Elective offered by his/her own department.***

# The Curriculum Book

# Bachelor of Technology

## 4-YEAR FULL TIME PROGRAMME

## III YEAR (ELECTRICAL ENGINEERING)

## Choice Based Credit System with

## Learning Outcomes based Curriculum Framework

## (LOCF)

## For Batch: 2022-23


**FACULTY OF ENGINEERING AND TECHNOLOGY**

**CHAUDHARY DEVI LAL UNIVERSITY**

**SIRSA-125055**

# Scheme of Examination

# &

# Detailed Syllabus

# of

# B.Tech. (EE)

# III Yr. (V& VI Sem)

# Program Specific Outcomes (PSOs)

| Sr. No. | Program Specific Outcomes |
|---|---|
| PSO1 | Ability to utilize logical and technical skills to model, simulate and analyse electrical components and systems. |
| PSO2 | Empowering to provide socially acceptable technical solutions to real time electrical engineering problems with the application of modern and appropriate techniques for sustainable development. |
| PSO3 | Graduates will demonstrate their knowledge in effective implementation during their practice of profession of Electrical Engineering with due regard to environment and social concerns. |

*****Programme Outcomes (POs) of Bachelor Programmes in Engineering and Technology have been specified in First year common curriculum of B.Tech. Programmes.

| Course Code | Definition/ Category |
|---|---|
| BSC | Basic Science Courses |
| ESC | Engineering Science Courses |
| HSMC | Humanities and Social Sciences including Management Courses |
| MC | Mandatory Courses |
| PC | Program Core |
| PE | Program Elective Courses |
| OE | Open Elective Courses |
| EEC | Employability Enhancement Courses (Project work/ Summer Training/ Industrial Training/ Practical Training/ Internship/Seminar, etc.) |

## Credit Credit Scheme for B.Tech.(Electrical Engg.) III Year (V&VI Sem)

| Semester | Basic Science Courses (BSC) | | Program Core/ Program Elective/ Open Elective Courses (PC/PE/OE) | | Humanities, Social Sciences Courses (HSMC) | | Mandatory Courses (MC) | | Grand Total Credit |
|---|---|---|---|---|---|---|---|---|---|
| Sr. No. | No. of Courses | Total Credits | No. of Courses | Total Credits | No. of Courses | Total Credits | No. of Courses | Total Credits | |
| V | 00 | 00 | 08 | 24 | 01 | 03 | 01 | 00 | 27 |
| VI | 00 | 00 | 08 | 20 | 01 | 02 | 00 | 00 | 22 |

# B. Tech. III Year Semester-V

| Sr. No. | Course Code | Course Title | Workload/ Credit | | | |
|---|---|---|---|---|---|---|
| | | | **Theory** | **Tutorial** | **Practical** | **Total** |
| 1. | PC/EE/11-T | Advanced Power Electronics and Drives | 3/3 | 1/1 | 0/0 | 4/4 |
| 2. | PC/EE/12-T | Control Systems-I | 3/3 | 1/1 | 0/0 | 4/4 |
| 3. | PC/EE/13-T | Microprocessors & Microcontrollers | 3/3 | 0/0 | 0/0 | 3/3 |
| 4. | PC/EE/14-T | Electrical Engineering Materials | 3/3 | 0/0 | 0/0 | 3/3 |
| 5. | PC/EE/11-P | Advanced Power Electronics and Drives Laboratory | 0/0 | 0/0 | 2/1 | 2/1 |
| 6. | PC/EE/12-P | Control Systems-I Laboratory | 0/0 | 0/0 | 2/1 | 2/1 |
| 7. | PC/EE/13-P | Microprocessors & Microcontrollers Laboratory | 0/0 | 0/0 | 2/1 | 2/1 |
| 8. | Open Elective Course– I to be opted by students from another branch | | 3/3 | 0/0 | 0/0 | 3/3 |
| 9. | HSMC/3-T | Fundamentals of Management | 3/3 | 0/0 | 0/0 | 3/3 |
| 10. | **EEC/EE/1-P | Industrial Training/ Internship-I | 0/0 | 0/0 | 0/4 | 0/4 |
| TOTAL | | | **18/18** | **2/2** | **6/7** | **26/27** |
| | | | | | **Total Credits** | **27** |

****The students will have to prepare and submit a project report of the Industrial Training/ Internship of 6-8 weeks done during summer vacations after the examination of IV semester under the supervision of faculty during V semester.**

**Important Notes:**

**1.** Open Elective Course– I to be offered by departments other than Electrical Engineering.

**2.** Students will be allowed to use non-programmable scientific calculator only, however sharing of calculator will not be permitted.

# B. Tech. III Year Semester-VI

| Sr. No. | Course Code | Course Title | Workload/ Credit | | | |
|---|---|---|---|---|---|---|
| | | | Theory | Tutorial | Practical | Total |
| 1. | PC/EE/15-T | Power Systems-II | 3/3 | 0/0 | 0/0 | 3/3 |
| 2. | PC/EE/16-T | Electrical Measurements and Instrumentation | 3/3 | 0/0 | 0/0 | 3/3 |
| 3. | PC/EE/17-T | Control Systems-II | 3/3 | 1/1 | 0/0 | 4/4 |
| 4. | PC/EE/15-P | Power Systems-II Laboratory | 0/0 | 0/0 | 4/2 | 4/2 |
| 5. | PC/EE/16-P | Electrical Measurements and Instrumentation Laboratory | 0/0 | 0/0 | 2/1 | 2/1 |
| 6. | PC/EE/17-P | Control Systems-II Laboratory | 0/0 | 0/0 | 2/1 | 2/1 |
| 7. | PE/EE/1-T to PE/EE/4-T | Program Elective Course– I | 3/3 | 0/0 | 0/0 | 3/3 |
| 8. | Open Elective Course– II to be opted by students from another branch | | 3/3 | 0/0 | 0/0 | 3/3 |
| 9. | *HSMC/4-T | Economics for Engineers | 2/2 | 0/0 | 0/0 | 2/2 |
| TOTAL | | | **17/17** | **1/1** | **8/4** | **28/22** |
| | | | | | **Total Credits** | **22** |
| 10. | **EEC/EE/2-P | Industrial Training/ Internship-II | 0/0 | 0/0 | 4/2 | 4/2 |

**Important Notes:**

*Non-credit qualifying course. The assessment will be completely internal.

****The students will have to prepare and submit a project report of the Industrial Training/ Internship of 6-8 weeks done during summer vacations after the examination of VI semester under the supervision of faculty during VII semester.**

**Note**: Students will be allowed to use non-programmable scientific calculators only; however, sharing of calculator should not be permitted.

## List of Program Electives for VI Semester

### Program Elective Course– I

| Sr. No. | Course Code | Nomenclature of Subject |
|---|---|---|
| 1. | PE/EE/1-T | Renewable Energy Resources |
| 2. | PE/EE/2-T | Electrical and Hybrid Vehicles |
| 3. | PE/EE/3-T | Network Synthesis and Filters |
| 4. | PE/EE/4-T | Modeling and Simulation |

# Detailed Syllabus
# of
# B. Tech. (EE)
# V Semester

# ADVANCED POWER ELECTRONICS AND DRIVE

**General Course Information:**

| | |
|---|---|
| Course Code: **PC/EE/11-T**<br>Course Credits: 4.0<br>Mode: Lecture: (L)<br>Type: Program Core<br>Teaching Schedule L T P: 3 1 0<br>Examination Duration: 3 hours | **Course Assessment Methods; Max. Marks: 100 (Internal: 30; External: 70)**<br>Three minor tests, each of 20 marks, will be conducted. The third minor will be conducted in open book mode by the Course Coordinator. No date sheet will be issued for the third minor at the level of the Departments. For the purpose of internal assessment, the average of the highest marks obtained by a student in any two minor examinations will be considered. All the minor examination question papers will be prepared and evaluated by following the Outcome Based Education framework. Class Performance will be measured through percentage of lectures attended (4 marks) Assignments (4 marks) and class performance (2 marks).<br><br>The end semester examination will be of 70 marks. For the end semester examination, nine questions are to be set by the examiner. Question number one will be compulsory and based on the entire syllabus. It will contain seven short answers type questions. Rest of the eight questions is to be given by setting two questions from each of the four units of the syllabus. A candidate is required to attempt any other four questions selecting one from each of the four units. All questions carry equal marks. |

**Course outcomes:**

| Sr. No. | Course outcomes<br>At the end of the course students will be able to: | RBT* Level |
|---|---|---|
| CO1. | Indicate the fundamental of electronics devices and circuit | **L1(Remembering)** |
| CO2. | Derive the basic operation and compare performance of various power converters circuits | **L2(Understanding)** |
| CO3. | Demonstrate the power converter circuits design and learn to select suitable power electronic devices by assessing the requirements of application fields. | **L3(Apply)** |
| CO4. | Compare, formulate and analyze a power electronic circuit design and control drive performance. | **L4(Analysis)** |
| CO5. | Evaluate the critical areas in application levels and derive typical alternative solutions, select suitable power converters to control Electrical Motors and other industry grade apparatus. | **L5(Evaluating)** |
| CO6. | Create the model on the applications basis of the controller | **L6(Creating)** |

***Revised Bloom's Taxonomy Action verbs/Levels**

## Course Content

### UNIT- I

**DC to DC converter:** Classification of choppers, Principle of step-down and step-up chopper, Control strategies: Time ratio control (Pulse Width Modulation &Frequency Modulation scheme) and Current-Limit control, output voltage control techniques, one, two, and four quadrant choppers. **Thyristor chopper circuits:** Forced commutation (Voltage commutated & current commutated chopper) and load commutated chopper.

**Switching mode Regulators**: Buck, Boost, Buck-Boost, Cuk regulators.

## UNIT- II

**Electrical Drives:** Definition, block diagram, parts of electrical drives (electrical motors & power modulators), types of electrical drives, advantages of electrical drives, choice of electrical drives, **Dynamics of electrical drives:** Fundamental torque equation, speed-torque conventions, multi-quadrant operation of electrical drives, classification of load torques. Steady state load torque-speed curves, closed loop control of drives, Duty Cycles, Selection of Rating of Electrical Motor, Electrical Braking of Machines, Rotor Energy Loss of Cage Induction Motors: During Acceleration, Stop and Reversal of Speed, Time taken during acceleration

## UNIT- III

**Converter Fed DC Drives:** Single-phase half controlled and fully controlled converter fed dc motor drives, operation of different dc drives- separately excited, shunt, series and compound, universal, permanent magnet, dc servo motors with continuous armature current, voltage and current waveforms.

**Chopper fed DC Drives:** Principle of operation and control techniques, chopper circuit configurations used in dc drives: Type A, B, C, D and E; Motoring operation of chopper fed separately excited dc motor.

## UNIT- IV

**AC Drives:** Three phase induction motor drives, Starting (Star-Delta starter, Auto transformer starter & Rotor-resistance starter) Rheostatic, Plugging & Regenerative braking, Constant torque mode and constant power mode operation, Speed control of three-phase induction motor drives: Voltage and Frequency Controlled Induction Motor Drive, Static rotor resistance control, space vector theory, conventional space vector modulation; constant V/f control of induction motor. Slip power recovery schemes: Static Kramer Drive & Static Scherbius drive.

**REFERENCES:**


1. PS Bhimbra, "Power Electronics", Khanna Publishers, 2015.
2. G.K. Dubey, "Fundamental of electric drive", CRC Press/ Narosa Publication.
3. Mohan N., Undeland T. M. and Robbins W. P., "Power Electronics Converters, Applications and Design", III ED, Wiley India.
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5. AK Gupta and LP Singh, Power Electronics, Dhanpat Rai Publishing Co.
6. Power Electronics and variable frequency drives- Technology and applications: Bimal K. Bose, Wiley India.
7. Modern Power Electronics and AC drives: Bimal K. Bose, Pearson.
8. GK Dubey, "Power semiconductor Controlled Drives, "Prentice Hall, Englewood cliffs, New Jersey, 1989.
9. EL Sharkawi & A Mohamad, "Fundamental of Electric Drive", Vikas Publishing House

**Course Articulation Matrix:**

| Course/Course Code: Advanced Power Electronics and Drive (**PC/EE/11-T**), | | | | | | | | | | | | | Semester: V | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
| CO1 | 2 | - | - | - | - | - | - | - | - | - | - | 1 | 1 | - | - |
| CO2 | 1 | - | - | - | - | - | - | - | - | - | - | 1 | 1 | 1 | - |
| CO3 | 2 | 1 | 1 | - | - | - | - | - | - | - | - | - | 1 | 1 | - |
| CO4 | 3 | 2 | 2 | - | - | - | - | - | - | - | - | - | 2 | 1 | - |
| CO5 | 2 | 2 | 3 | - | - | - | - | - | - | - | - | - | 3 | 1 | - |
| CO6 | 2 | 3 | - | - | - | - | - | - | - | - | - | 1 | 1 | - | - |

**Correlation level:** **1**- Slight /Low **2**-Moderate/ Medium **3**- Substantial/High

# CONTROL SYSTEMS-I

**General Course Information:**

| | |
|---|---|
| Course Code: **PC/EE/12-T**<br>Course Credits: 4.0<br>Mode: Lecture (L) and Tutorial (T)<br>Type: Program Core<br>Teaching Schedule L T P: 3 1 0<br>Examination Duration: 3 hours | **Course Assessment Methods; Max. Marks: 100 (Internal: 30; External: 70)**<br>Three minor tests, each of 20 marks, will be conducted. The third minor will be conducted in open book mode by the Course Coordinator. No date sheet will be issued for the third minor at the level of the Departments. For the purpose of internal assessment, the average of the highest marks obtained by a student in any two minor examinations will be considered. All the minor examination question papers will be prepared and evaluated by following the Outcome Based Education framework. Class Performance will be measured through percentage of lectures attended (4 marks) Assignments (4 marks) and class performance (2 marks).<br><br>The end semester examination will be of 70 marks. For the end semester examination, nine questions are to be set by the examiner. Question number one will be compulsory and based on the entire syllabus. It will contain seven short answers type questions. Rest of the eight questions is to be given by setting two questions from each of the four units of the syllabus. A candidate is required to attempt any other four questions selecting one from each of the four units. All questions carry equal marks. |

**Prerequisites:**

**Course Outcomes**

| Sr. No. | Course outcomes<br>At the end of the course students will be able to: | RBT* Level |
|---|---|---|
| CO1. | Memorize the basics of electric circuits and signal flow. | **L1(Remembering)** |
| CO2. | Describe the performance of different types of control systems and explain the stability by different methods on the basis of their transfer function. | **L2(Understanding)** |
| CO3. | Solve the problems related with different control system design and can illustrate briefly. | **L3(Apply)** |
| CO4. | Compare the performance characteristics of different control systems and examine the behavior of system. | **H1(Analysis)** |
| CO5. | Judge the control strategy on the basis of their performance. | **H2 (Evaluating)** |
| CO6. | Develop new controller and compensator on the basis of outcomes and requirement of system. | **H3 (Creating)** |

***Revised Bloom's Taxonomy Action verbs/Level**

## Course Content

### UNIT-I

### Introduction to Control System

**Introduction to Control Systems:** Open & Closed loop, Control System classification, Transfer function analysis, concept of poles and zeros, Force-Voltage and Force-Current Analogy, Mathematical modelling of electrical and mechanical systems, hydraulic, pneumatic systems.

**Description of Control System Components:** Error detectors, gears, gyroscope, DC motors, servomotors, techo-generators, servo amplifiers, synchros; block diagram and reduction techniques, signal flow graphs, mason's gain formulae, performance of feedback Systems.

## UNIT-II

## Time Response Analysis (Transient, Steady State and Stability Analysis)

**Transient Response Analysis:** Standard test signals, time response of first order systems, characteristic equation of feedback control systems, transient response of second order systems, time domain specifications, steady state response, steady state errors and error constants, Proportional, Integral, Derivative systems.

**Root Locus Analysis:** Development of root loci, root motions under close-looping, effects of pole/zero on loci, Case study- Speed Control of DC Motor using PID.

## UNIT-III

## Frequency Response Analysis

**Stability Analysis:**Stability, Routh-Hurwitz stability criterion, relative stability and frequency-domain specifications analysis using Bode plots, Gain margin and phase margin, Nyquist plot (Polar Plot), Use of Nyquist stability criterion for stability analysis, Case study- DC Motor Control.

## UNIT-IV

## Classical Control Design Techniques

**Compensator Design:** Feedback compensation –Lead, Lag compensation, Compensator design using Root locus, Compensator design using Bode Plot

**Controller Design:** Specifications of time-domain and frequency domain and interrelation between them, design of P, PD, PI, PID error control strategies, impact on transient response and steady-state response.

**REFERENCES:**


1. N.S. Nise, "Control System Engineering*", 7th Edition*, 2015, Wiley Publications.
2. K. Ogata, "Modern control engineering", *V* Edition, 2010, Prentice Hall.
3. F. Golnaraghi, and B.C Kuo, "Automatic control systems" 9th Edition, 2008, Prentice Hall.
4. I.J. Nagrath and M.Gopal, "Control Systems Engineering", *V* Edition, 2009, New Age Publishers.
5. D' Azzo and Houpis, "Linear Control Systems Analysis and Design", *V* Edition, 2003,McGraw Hill.
6. R.C. Dorf, and R.H. Bishop, "Modern Control systems", *12th*Edition, 2011, Addison-Wesley.
7. S. Hasan Saeed, "Automatic Control System", Katson Publications, 2008.
8. B. S. Manke, "Linear Control Systems with MatLab Applications", Khanna Publications.

**Course Articulation Matrix:**

| Course/Course Code: Control Systems-I (**PC/EE/12-T**) Semester: V | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
| CO1 | 2 | 2 | 1 | - | - | - | - | - | - | - | - | 1 | 1 | 2 | 2 |
| CO2 | 3 | 1 | 1 | - | - | - | - | - | - | - | - | 1 | 1 | 1 | 1 |
| CO3 | 3 | 3 | 3 | 3 | - | 1 | - | - | - | - | - | 1 | 2 | 1 | 1 |
| CO4 | 2 | 2 | 2 | - | - | - | - | - | - | - | - | 1 | 1 | 1 | 1 |
| CO5 | 3 | 2 | 2 | 1 | - | - | - | - | - | - | - | 1 | 2 | 1 | 1 |
| CO6 | 3 | 2 | 3 | 3 | - | - | - | - | - | - | - | 1 | 1 | 2 | 1 |

**Correlation level:** **1**- Slight /Low **2-** Moderate/ Medium **3**- Substantial/High

# MICROPROCESSORSAND MICROCONTROLLERS

**General Course Information:**

| | |
|---|---|
| Course Code: **PC/EE/13-T**<br>Course Credits: 3.0<br>Mode: Lecture (L)<br>Type: Program Core<br>Teaching Schedule L T P: 3 0 0<br>Examination Duration: 3 hours | **Course Assessment Methods; Max. Marks: 100 (Internal: 30; External: 70)**<br>Three minor tests, each of 20 marks, will be conducted. The third minor will be conducted in open book mode by the Course Coordinator. No date sheet will be issued for the third minor at the level of the Departments. For the purpose of internal assessment, the average of the highest marks obtained by a student in any two minor examinations will be considered. All the minor examination question papers will be prepared and evaluated by following the Outcome Based Education framework. Class Performance will be measured through percentage of lectures attended (4 marks) Assignments (4 marks) and class performance (2 marks).<br><br>The end semester examination will be of 70 marks. For the end semester examination, nine questions are to be set by the examiner. Question number one will be compulsory and based on the entire syllabus. It will contain seven short answers type questions. Rest of the eight questions is to be given by setting two questions from each of the four units of the syllabus. A candidate is required to attempt any other four questions selecting one from each of the four units. All questions carry equal marks. |

**Course outcomes:**

| Sr. No. | Course Outcomes<br>At the end of the semester, students will be able: | RBT* Level |
|---|---|---|
| **CO 1** | Describe the evolution of processor architectures. | L1 |
| **CO 2** | Explain the concepts of 8085 and 8086 microprocessor with their programming. | L2 |
| **CO 3** | Write simple programs in assembly language of 8085and8086 microprocessor | L3 |
| **CO 4** | Appraise Microprocessors and Microcontrollers for different interfacing applications for various application | L5 |
| **CO 5** | Develop the microprocessor and Microcontroller based Embedded System. | L6 |

***Revised Bloom's Taxonomy Action verbs/Levels**

## Course Content

### UNIT- I

**Introduction:** Introduction to Microprocessor & Microcontrollers Architectures: Harvard vs. Von Neumann, CISC vs. RISC, Brief history of microprocessors and microcontrollers.
8085 microprocessor architecture, Timing and control unit, Machine cycles, Addressing modes, Instruction set, Assembly language programming, program for multibyte addition/subtraction, multiplication, division, block transfer, Interrupts in 8085.

### UNIT- II

**Microprocessor 8086:** Block diagram of 8086, details of sub-blocks such as EU, BIU; memory segmentation and physical address computations, addressing modes, instruction formats, pin diagram, data transfer instructions, arithmetic instructions, branch instructions, looping instructions,

NOP and HLT instructions, flag manipulation instructions, logical instructions, shift and rotate instructions.

## UNIT- III

**Interfacing Device:** Basic principles of interfacing memory and I /O devices, Data transfer techniques

DMA: Introduction to DMA process, 8237 DMA controller, 8255 PPI chip: Architecture, control words, modes and examples, Interrupt and Timer: 8259 Programmable interrupt controller, Programmable interval timer chips.

## UNIT- IV

**Microcontroller 8051:** Introduction to 8051 Microcontroller: 8051 architecture and pin diagram, Introduction and History of microcontrollers, Block Diagram of 8051, Interrupts in 8051, Registers, Timers, Counters, Flags, Special Function Registers, Addressing Modes, Data types, Serial communication.

**REFERENCES:**


1. Microprocessor Architecture, Programming & Applications with 8085: Ramesh S Gaonkar; Wiley Eastern Ltd.
2. The Intel Microprocessors 8086- Pentium processor: Brey, PHI.
3. Microprocessors and interfacing: Hall; TMH
4. The 8088 & 8086 Microprocessors-Programming, interfacing, Hardware& Applications: Triebel& Singh; PHI
5. Microcomputer systems: the 8086/8088 Family: architecture, Programming &Design: Yu-Chang Liu & Glenn A Gibson; PHI.
6. Advanced Microprocessors and Interfacing:Badri Ram; TMH
7. Ayala, K.J., The 8051 Microcontroller Architecture, Programming and applications, Penram International Publishing (India) Pvt. Ltd. (2007).
8. Mazidi, M.A., The 8051 Microcontroller and Embedded System, Pearson Education (2008).

**Course Articulation Matrix:**

| Course/Course Code: Microprocessors and microcontrollers(**PC/EE/13-T**), Semester: V | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
| CO1 | 1 | - | - | - | - | - | - | - | - | - | - | 1 | 2 | - | - |
| CO2 | 2 | 1 | - | - | - | - | - | - | - | - | - | 1 | 2 | - | - |
| CO3 | 2 | 3 | - | - | 3 | - | - | - | - | - | - | 1 | - | 3 | 1 |
| CO4 | 2 | - | 3 | - | 2 | - | - | - | - | - | - | 1 | - | 1 | 1 |
| CO5 | 2 | - | 2 | 1 | 2 | - | - | - | - | - | - | 1 | 1 | 1 | 1 |

**Correlation level:** **1**- Slight /Low **2**-Moderate/ Medium **3**- Substantial/High

# ELECTRICAL ENGINEERING MATERIALS

**General Course Information:**

| | |
|---|---|
| Course Code: **PC/EE/14-T**<br>Course Credits: 3.0<br>Mode: Lecture (L)<br>Type: Program Core<br>Teaching Schedule L T P: 3 0 0<br>Examination Duration: 3 hours | **Course Assessment Methods; Max. Marks: 100 (Internal: 30; External: 70)**<br>Three minor tests, each of 20 marks, will be conducted. The third minor will be conducted in open book mode by the Course Coordinator. No date sheet will be issued for the third minor at the level of the Departments. For the purpose of internal assessment, the average of the highest marks obtained by a student in any two minor examinations will be considered. All the minor examination question papers will be prepared and evaluated by following the Outcome Based Education framework. Class Performance will be measured through percentage of lectures attended (4 marks) Assignments (4 marks) and class performance (2 marks).<br><br>The end semester examination will be of 70 marks. For the end semester examination, nine questions are to be set by the examiner. Question number one will be compulsory and based on the entire syllabus. It will contain seven short answers type questions. Rest of the eight questions is to be given by setting two questions from each of the four units of the syllabus. A candidate is required to attempt any other four questions selecting one from each of the four units. All questions carry equal marks. |

**Course outcomes:**

| Sr. No. | Course outcomes<br>At the end of the course students will be able to: | RBT* Level |
|---|---|---|
| CO1. | Recall the knowledge about the electrical materials. | **L1(Remembering)** |
| CO2. | Compare different type of electrical materials. | **L2(Understanding)** |
| CO3. | Use different type of conducting materials for power generation. | **L3(Apply)** |
| CO4. | Compare the different type of electrical components and materials. | **L4(Analysis)** |
| CO5. | Appraise the use of electrical materials in the field of power generation. | **L5(Evaluating)** |
| CO6. | Formulate agood material to remove the limitation related to the power generation | **L6(Creating)** |

***Revised Bloom's Taxonomy Action verbs/Levels**

## Course Content

### UNIT- I

**Dielectrics:** Definitions. Multipole development, Electrical dipole, General properties of dielectrics, Fundamental equation of dielectrics, Dielectric sphere, Energy and forces acting on the dielectrics. Polarization mechanisms in dielectrics: induced, orientation, electronic, ionic, and interfacial and lattice polarizations; combined mechanisms, Dielectric losses.

### UNIT-II

**Magneticmaterials** Classification of material-Dia, Para, and Ferro-magnetic materials and applications

**Magnetic Properties of materials:** Magnetic dipole moment of current loop. Magnetization from a macroscopic viewpoint. Orbital magnetic dipole moment and angular momentum of two simple atomic models. Lenz's law and induced dipole moments. Classification of magnetic materials.

## UNIT-III

**Conducting materials:**Types of Conducting Materials, Low Resistivity Materials, and High Resistivity Materials Contact Materials, Fusible (or Fuse) Materials, Filament Materials, Carbon as Filamentary and Brush Material.

**Conductors, Cables, and Wires**: Types and Materials, Solder Materials for Joining Wires and Joints in Power Apparatuses, Sheathing Materials, Sealing Materials

## UNIT-IV

**Insulating materials:** Gaseous materials-Oxide gases, electronegative gases, hydrocarbon gases; Liquid materials-mineral oils, silicon liquids, hydrocarbon liquids; Solid materials-Paper and boards, Resins (Polymers), Rubbers-natural and synthetic, glass, ceramics, asbestos.

**REFERENCES:**


1. S.P. Seth, P.V. Gupta, "A course in Electrical Engineering Materials", Dhanpat Rai & Sons
2. A.J. Dekker, "Electrical Engineering Materials", PHI.
3. Ian P. Jones, "Materials Science for Electrical & Electronics Engineers", Oxford
4. L. Solymar& D. Walsh, "Electrical Properties of Materials", Oxford
5. J.K. Shackelford & M.K. Muralidhara, Introduction to material science for engineers, Pearson Education
6. TTTI Madras, "Electrical Engineering Materials", McGraw Hill Education, 2004.
7. Adrianus J. Dekker, "Electrical Engineering Materials", PHI Publication, 2006.
8. K.M.Gupta&Nishu Gupta, "Advanced Electrical and Electronics Materials" Online ISBN:9781118998564

**Course Articulation Matrix:**

| Course/Course Code: ElectricalEngineering Materials(**PC/EE/14-T**),Semester: V | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
| CO1 | 3 | - | - | - | - | 2 | 1 | - | - | - | - | 1 | - | 1 | - |
| CO2 | 2 | - | - | - | - | 3 | 2 | - | - | - | - | 1 | 1 | 1 | - |
| CO3 | 2 | - | - | - | - | 1 | 1 | - | - | - | - | 1 | - | 1 | - |
| CO4 | 2 | - | - | - | - | 3 | 2 | - | - | - | - | 1 | 1 | 1 | - |
| CO5 | 1 | - | - | - | - | 3 | 2 | - | - | - | - | 1 | - | 1 | 1 |
| CO6 | 3 | - | - | - | - | 3 | 2 | - | - | - | - | - | - | 1 | 1 |

**Correlation level:** **1**- Slight /Low **2**-Moderate/ Medium **3**-Substantial/High

# ADVANCED POWER ELECTRONICS & DRIVES LABORATORY

**General Course Information:**

| | |
|---|---|
| Course Code: **PC/EE/11-P**<br>Course Credits: 1<br>Mode: Practical<br>Type: Program Core<br>Contact Hours: 2 hours per week. | **Course Assessment Methods (Internal: 50; External: 50)** Internal continuous assessment of 50 marks by course coordinator as per the course assessment method (Annexure I).<br><br>For the end semester practical examination the assessment will be done out of 50 marks by the external and internal examiners as per the course assessment method (Annexure I). |

**Course Outcomes:**

| Sr. No. | Course outcomes<br>At the end of the course students will be able to: | RBT* Level |
|---|---|---|
| CO1. | **Experimental** work and acquire technical knowledge to solve out the problems of various power converters (Chopper) and their use in electric drives control methods. | **HOTS L4 (Analyzing)** |
| CO2. | **Interpret** the performance characteristics of the DC-DC converter in the field of electrical drive. | **LOTS L3 (Applying)** |
| CO3. | **Calculate** the suitability of power converter applications and compare the experimental observations in comparison to theory. | **HOTS L5 (Evaluating)** |
| CO4. | **Appraise** single phase and three phase converters for electric drive applications in industries. | **HOTS L5 (Evaluating)** |
| CO5. | **Organize** reports based on experiments performed with effective demonstration and analysis of results. | **HOTS L4 (Analyzing)** |
| CO6. | **Inculcate** ethical practices while performing experiments individually and in groups. | **LOTS L3 (Applying)** |

***Revised Bloom's Taxonomy Action verbs/Level**

## LIST OF EXPERIMENTS:

1. To perform electrical braking on a DC shunt motor and discuss the results of various types of electrical braking.
2. To perform speed control on a DC motor using single-phase half and fully controlled bridge converter.
3. To study the variable frequency control of three phase induction motor and plot variation of speed and input power with frequency for constant voltage and constant (voltage/frequency) modes.
4. To perform speed control operation on single phase induction motor using TRIAC.
5. To study the Thyristor controlled D.C drive.
6. To study the performance of chopper fed DC motor drives.
7. To perform speed control operation on single-phase induction motor using a single-phase AC voltage regulator.
8. To perform speed control on a DC motor using three-phase half-controlled bridge converters.
9. To perform speed control on a DC motor using a single-phase dual converter.
10. To perform speed control on a DC motor using three-phase fully controlled bridge converters.
11. To study and perform electrical braking of a three-phase induction motor.
12. To perform speed control of a separately excited dc motor using chopper.
13. To study the performance of a VSI fed induction motor drive.
14. To study the performance of a CSI fed induction motor drive.
15. To study a permanent magnet synchronous motor drive fed by a PWM inverter.
16. To study regenerative/ dynamic braking operation for AC motor study using software.
17. To study PC/PLC based AC/DC motor control operation.

**NOTE:** At least eight experiments are to be performed in the semester, out of which at-least six experiments should be performed from the above list. Remaining experiments may either be performed from the above list or designed & set by the concerned course coordinator as per the scope of the syllabus.

**CO-PO Articulation Matrix**

| Course/Course Code: Advanced Power Electronics & Drives Laboratory (**PC/EE/11-P**), | | | | | | | | | | | | | | Semester V | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **List of Course Outcomes** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** | **PO11** | **PO12** | **PSO1** | **PSO2** | **PSO3** |
| CO1. **Experimental** work and acquire technical knowledge to solve out the problems of various power converters (Chopper) and their use in electric drives control methods. **(HOTS L4: Analyzing)** | 3 | 2 | - | 3 | - | - | - | - | 3 | - | - | 2 | 2 | 2 | - |
| CO2. **Interpret** the performance characteristics of the DC-DC converter in the field of electrical drive. **(LOTS L3:Applying)** | 3 | 2 | 2 | 2 | - | - | - | - | - | - | - | 2 | 2 | - | - |
| CO3. **Calculate** the suitability of power converter applications and compare the experimental observations in comparison to theory. **(HOTS L5: Evaluating)** | 3 | 2 | 1 | - | - | 2 | - | - | - | - | - | 1 | 2 | 1 | - |
| CO4. **Appraise** single phase and three phase converters for electric drive applications in industries. **(HOTS L5: Evaluating)** | 2 | 3 | 2 | 2 | - | - | - | - | - | - | - | 2 | 3 | 2 | - |
| CO5. **Organize** the basic requirements reports based on experiments for the controlling of electric drive. **(HOTS L4: Analyzing)** | 2 | 1 | 1 | - | - | - | - | - | - | 3 | - | - | - | - | 2 |
| CO6. **Inculcate** ethical practices while performing experiments individually and in groups. **(LOTS L3:Applying)** | - | - | - | - | - | - | - | 3 | 3 | - | - | - | - | - | 2 |
| Level of Attainments: | | | | | | | | | | | | | | | |

**Correlation level:** **1**- slight /Low **2-** Moderate/ Medium **3**- Substantial/High

# CONTROL SYSTEMS-I LABORATORY

## General Course Information:

| | |
|---|---|
| Course Code: **PC/EE/12-P**<br>Course Credits: 1<br>Mode: Practical<br>Type: Program Core<br>Contact Hours: 2 hours per week. | **Course Assessment Methods (Internal: 50; External: 50)** Internal continuous assessment of 50 marks by course coordinator as per the course assessment method (Annexure I).<br><br>For the end semester practical examination, the assessment will be done out of 50 marks by the external and internal examiners as per the course assessment method (Annexure I). |

## Course Outcomes:

| Sr. No. | Course outcomes<br>At the end of the course students will be able to: | RBT* Level |
|---|---|---|
| CO1. | **Perform** experiments to examine the performance of control system models with their transfer function. | **HOTS L4 (Analyzing)** |
| CO2. | **Examine** the behaviours and performance characteristics of control system models at different parameters practically and simulation with MATLAB. | **HOTS L4 (Analyzing)** |
| CO3. | **Determine** the frequency response, transfer function and the Operational Characteristics of the various devices used in control applications. | **HOTS L2 (Evaluating)** |
| CO4. | **Design** models for various engineering applications to achieve the desired efficiency of the system. | **HOTS L6 (Creating)** |
| CO5. | **Organize** reports based on experiments performed with effective demonstration and analysis of results. | **HOTS L4 (Analyzing)** |
| CO6. | **Inculcate** ethical practices while performing experiments individually and in groups. | **LOTS Level 3 (Applying)** |

***Revised Bloom's Taxonomy Action verbs/Level**

## LIST OF EXPERIMENTS:

1. To perform the time domain analysis of a first and second order system when subjected to unit step input.
2. To analyze the Error Detector Characteristics and Control Applications of the following:
   (i) LVDT, (ii) Potentiometer
3. To study the characteristics (using DIGIAC 1750) of (i) Voltage to Current Converter, (ii) Current to Voltage Converter, (iii) Voltage to Frequency Converter, (iv) Frequency to Voltage Converter.
4. To obtain the Frequency Response Characteristics and Design of Compensator for a given system.
5. To plot torque speed characteristics of the DC Servo Motor.
6. To obtain the Position Control performance of DC Servo Motor.
7. Simulation of PI, PD and PID controller using MATLAB software
8. To study the performance of P, PI, PID/Relay controllers used to control the temperature of an oven.
9. To obtain the Operational Characteristics for the Control Application of the following devices.
   (i) Stepper Motor, (ii) Temperature Detectors (Thermistor, Thermocouple etc.)
10. To find the performance of open loop and closed loop system using MATLAB.
11. To plot the torque speed characteristics of AC Servo Motor.
12. To analyze frequency response of a system by plotting Root locus using MATLAB software.
13. To analyze frequency response of a system by plotting Bode plot using MATLAB software.
14. To analyze frequency response of a system by plotting Polar plot using MATLAB software

**NOTE:** At least eight experiments are to be performed in the semester, out of which at-least six experiments should be performed from the above list. Remaining experiments may either be performed from the above list or designed & set by the concerned course coordinator as per the scope of the syllabus.

**CO-PO Articulation Matrix**

| Course/Course Code: Control System- I Laboratory (**PC/EE/12-P**), Semester: V | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **List of Course Outcomes** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** | **PO11** | **PO12** | **PSO1** | **PSO2** | **PSO3** |
| CO1. **Perform** experiments to examine the performance of control system models with their transfer function. **(HOTS L4: Analyzing)** | 3 | 3 | - | - | - | - | - | - | 3 | - | - | 2 | 3 | - | - |
| CO2. **Examine** the behaviors and performance characteristics of control system model at different parameters practically and simulation with MATLAB. **(HOTS L4: Analyzing)** | 3 | 2 | - | 2 | - | - | - | - | - | - | - | 1 | 3 | - | - |
| CO3. **Determine** the frequency response, transfer function and the Operational Characteristics of the various devices used in control applications. **(HOTS L2: Evaluating)** | 3 | 2 | - | 2 | - | - | - | - | - | - | - | 1 | 3 | - | - |
| CO4. **Design** models for various engineering applications to achieve the desired efficiency of system. **(HOTS L6: Creating)** | 3 | 2 | 3 | - | - | - | - | - | 3 | - | - | - | 3 | 2 | - |
| CO5. **Organize** reports based on experiments performed with effective demonstration and analysis of results. **(HOTS L4: Analyzing)** | - | | - | - | - | - | - | - | - | 3 | - | - | - | - | - |
| CO6. Inculcate ethical practices while performing experiments individually and in groups. **( LOTS L3: Applying)** | - | | - | - | - | - | - | 3 | 3 | - | - | - | - | - | 1 |
| Level of Attainments: | | | | | | | | | | | | | | | |

**Correlation level:** **1**- slight /Low **2**- Moderate/ Medium **3**- Substantial/High

# MICROPROCESSORSAND MICROCONTROLLERS LABORATORY

**General Course Information:**

| | |
|---|---|
| Course Code: **PC/EE/13-P**<br>Course Credits: 1<br>Mode: Practical<br>Type: Program Core<br>Contact Hours: 2 hours per week. | **Course Assessment Methods (Internal: 50; External: 50)** Internal continuous assessment of 50 marks based on class performance and attendance in practical classes (Annexure I).<br><br>For the end semester practical examination, the assessment will be done out of 50 marks by the external and internal examiners (Annexure I). |

**Course Outcomes:**

| Sr. No. | Course outcomes<br>At the end of the course students will be able to: | RBT* Level |
|---|---|---|
| CO1. | **Perform** experiment to examine the application of 8085 and 8086 microprocessor with their programming. | **HOTS L4 (Analyzing)** |
| CO2. | **Evaluate** Microprocessors and Microcontrollers for different interfacing applications. | **HOTS L4 (Analyzing)** |
| CO3. | **Compare**the performance of Microprocessors and Microcontrollers for implementation in different electrical system. | **HOTS L5 (Evaluating)** |
| CO4. | **Design** the microprocessor and Microcontroller based Embedded System. | **HOTS L6 (Creating)** |
| CO5. | **Organize** and illustrate reports based on experiments performed with effective demonstration and analysis of results. | **HOTS L4 (Analyzing)** |
| CO6. | **Inculcate** ethical practices while performing experiments individually and in groups. | **(LOTSL3 Applying)** |

***Revised Bloom's Taxonomy Action verbs/Level**

## LIST OF EXPERIMENTS:

1. Write and implement on 8085 kit, the program of multiplication of two 8 bit numbers.
   (a) Using bit wise multiplication method.
   (b) Using repetitive addition method.
2. To interface stepper motor and run clockwise and anti-clockwise at various speeds using 8085μP.
3. To generate square wave, saw tooth wave, triangular wave of 1 kHz frequency and 50% duty cycle using 8085 μP kit.
4. Write and implement 8085 μP Programme for
   (a) Factorial of a given number
   (b) Finding number of 1's in a given data stored in 2050H.
5. Write and implement a program on 8086 μP kit, the program for addition, subtraction of hexadecimal numbers.
6. To display SUPERAB on the LCD display of kit and operate the buzzer on/off at various duty cycle using 8086 μP To generate a square wave of 1 kHz frequency using
   (a) 8085-8253 interface
   (b) Timer of 8051
7. To display SUPERAB on the LCD display of kit and operate the buzzer on/off at various duty cycle using 8086 μP.
8. To study up/down 4- digit counter in decimal mode.
9. To display your name on the LCD display of kit and operate the buzzer on/off at various duty cycle using 8051 microcontroller.
10. To operate stepper motor in clockwise and anti-clockwise direction at various speeds using 8051 microcontroller.
11. To interface an A/D converter with 8085 microprocessor and store ten conversions in memory.

**NOTE:** At least eight experiments are to be performed in the semester, out of which at-least six experiments should be performed from above list. Remaining experiments may either be performed from the above list or designed & set by the concerned institution as per the scope of the syllabus.

**CO-PO Articulation Matrix**

| Course/Course Code: Microprocessors and Microcontrollers Laboratory (**PC/EE/13-P**), Semester: V | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **List of Course Outcomes** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** | **PO11** | **PO12** | **PSO1** | **PSO2** | **PSO3** |
| CO1. **Perform** experiments to examine the applications of 8085 and 8086 microprocessor with their programming. **(HOTS L4: Analyzing)** | 2 | - | 2 | - | - | - | - | - | 3 | - | - | 2 | 1 | 1 | - |
| CO2. **Evaluate** Microprocessors and Microcontrollers for different interfacing applications. **(HOTS L5: Evaluating)** | 2 | - | 2 | - | - | - | - | - | - | - | - | 1 | 2 | - | - |
| CO3. **Compare** the performance of Microprocessors and Microcontrollers for implementation in different electrical system. **(HOTS L5: Evaluating)** | 2 | - | 2 | - | - | - | - | - | - | - | - | 1 | 2 | 1 | - |
| CO4. **Design** the microprocessor and Microcontroller based Embedded System. **(HOTS L6: Creating)** | 2 | - | 1 | 1 | - | - | - | - | - | - | - | 1 | 2 | 2 | - |
| CO5. **Organize** and illustrate reports based on experiments performed with effective demonstration and analysis of results. **(HOTS L4: Analyzing)** | - | - | - | - | - | - | - | - | - | 3 | - | - | - | - | - |
| CO6. **Inculcate** ethical practices while performing experiments individually and in groups. **(LOTS L3:Applying)** | - | - | - | - | - | - | - | 3 | 3 | - | - | - | - | - | 1 |
| Level of Attainments: | | | | | | | | | | | | | | | |

**Correlation level:** **1**- slight /Low **2-** Moderate/ Medium **3**- Substantial/High

# FUNDAMENTALS OF MANAGEMENT

**General Course Information**

| | |
|---|---|
| Course Code: HSMC/2-T<br>Course Credits: 3<br>Type: Humanities and Social Sciences including Management<br>Contact Hours: 3 hours/week<br>Mode: Lecture (L)<br>Examination Duration: 3 hours | **Course Assessment Methods (internal: 30; external: 70)**<br>Three minor tests each of 20 marks will be conducted. The average of the highest marks obtained by a student in the any of the two minor examinations will be considered. Class Performance will be measured through percentage of lectures attended (04 marks). Assignments, quiz etc. will have weightage of 06 marks<br>For the end semester examination, nine questions are to be set by the examiner. A candidate is required to attempt 5 questions in all. All questions carry equal marks. Question number 1 will be compulsory and based on the entire syllabus. It will contain seven parts of 2 marks each. Question numbers 2 to 9 will be given by setting two questions from each of the four units of the syllabus. A candidate is required to attempt the remaining four questions by selecting one question from each of the four units. |

**Pre-requisites:** None

About the Course:

Fundamentals of Management for Engineers is a necessary course for B. Tech. (CSE) graduates wishing to work with organizations in their near future. It helps them acquiring managerial, planning and decision-making skills. This course makes students ready to work in teams as well as play leadership roles.

Course Outcomes: By the end of the course students will be able to:
CO1. **define** fundamental concepts of management (LOTS: Level 1: Remember)
CO2. **explain** the basic principles of management related to planning and decision making, HRM and motivation, and leadership. (LOTS: Level 2: Understand)
CO3. **apply** the managerial skills to solve real world management problems. (LOTS: Level 3:Apply)
CO4. **identify** leadership roles in various scenarios. (LOTS: Level 4: Analyse)
CO5. **evaluate** a business model based on principles of management. (LOTS: Level 5: Evaluate) CO6. **prepare** a plan for a start up in IT sector. (LOTS: Level 6: Create)

## Course Content

**Unit I**
Management Definition: Scope and process of management, Managerial Roles, Levels of Management, Managerial Skills, Challenges of Management, Evolution of Management, 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, Development of business strategy.
**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 HRM and Controls**: Organizational Design & Organizational Structures, Delegation, Empowerment, Centralization, Decentralization, Organizational culture, Organizational climate and Organizational change, Talent management, Talent management Models and strategic human Resource planning; Recruitment and selection; Training and development, Performance Appraisal. Types of controls and controlling Techniques.

**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.

Text and Reference Books:


- Robert N Lussier, *Management Fundamentals*, V edition, Cengage Learning, 2013.
- Stephen P. Robbins, *Fundamentals of Management*, Pearson Education, 2009.
- Weihrich Koontz, *Essentials of Management*, fifth edition, Tata Mc Graw Hill, 1990.
- Dubrin Andrew, *Management Essentials*, 9th edition, Cengage Learning, 2012.

## CO-PO Articulation Matrix Fundamentals of Management Course (HSMC/2-T)

| List of Course Outcomes | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1. **Define** fundamental concepts of management (LOTS: Level 1: Remember) | 1 | _ | _ | _ | _ | _ | _ | _ | _ | _ | _ | _ | _ | _ | _ |
| CO2. **Explain** the basic principles of management related to planning and decision making, HRM and motivation, and leadership. (LOTS: Level 2: Understand) | 1 | _ | _ | _ | _ | _ | _ | _ | _ | _ | _ | _ | _ | _ | _ |
| CO3. **Apply** the managerial skills to solve real world management problems. (LOTS: Level 3: Apply) | 2 | | 1 | _ | _ | _ | _ | _ | _ | _ | _ | _ | _ | _ | _ |
| CO4. **Identify** leadership roles in various scenarios. (LOTS: Level 4: Analyse). | _ | _ | _ | _ | _ | _ | _ | 3 | 3 | _ | _ | _ | _ | _ | _ |
| CO5. **Evaluate** business model based on principles of management. | 2 | 3 | 2 | | _ | _ | _ | _ | _ | _ | _ | 2 | _ | _ | _ |
| CO6. **Prepare** a plan for start-up in IT sector | 3 | 3 | 3 | 2 | _ | 3 | _ | _ | _ | 3 | 3 | _ | _ | _ | _ |
| Level of Attainments HSMC/2-T | | | | | | | | | | | | | | | |

# Industrial Training/ Internship-I

| | |
|---|---|
| Course Code: **EEC/EE/1-P**<br>Course Credits: 4<br>Type: Program Core<br>Mode: Practical<br>Contact Hours: 00 hours | **Course Assessment Method: (Internal:100)**<br>Assessment of Industrial Training/ Internship-I will be based on presentation/seminar, viva-voce, report and certificate for the practical training taken at the end of 4th semester. |

**Course Outcomes:**

| Sr. No. | Course Outcomes<br>At the end of the semester, students will be able to: | RBT Level |
|---|---|---|
| **CO 1** | Outline technical documents and give oral presentations related to the work completed. | L1 |
| **CO 2** | Prepared to engage in independent and lifelong learning in the industry. | L2 |
| **CO 3** | Acquire and apply fundamental principles of engineering for working in and actual working environment. | L3 |
| **CO 4** | Analyze practical application of the subjects taught during the program. | L4 |
| **CO 5** | Develop, social, cultural, global and environmental responsibilities as an engineer. | L5 |
| **CO6** | Design and implement solution methodologies with technical &managerial skills for solving engineering problems. | L6 |

**Course Articulation Matrix:**

| Course/Course Code: Practical Training-I (**EEC/EE/1-P**), | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Semester: V | | | | | | | | | | | | | | | |
| | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** | **PO11** | **PO12** | **PSO1** | **PSO2** | **PSO3** |
| **CO1** | 3 | 3 | 2 | 2 | 2 | 3 | 1 | 2 | 2 | 2 | 3 | 3 | 3 | 2 | 2 |
| **CO2** | 3 | 3 | 2 | 2 | 2 | 3 | 2 | - | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| **CO3** | 3 | 3 | 2 | 2 | 3 | 3 | 2 | - | 2 | 2 | 3 | 3 | 3 | 2 | 2 |
| **CO4** | 3 | 3 | 3 | 3 | 3 | 3 | 1 | 2 | 3 | 2 | 3 | 3 | 3 | 3 | 3 |
| **CO5** | 3 | 3 | 3 | 3 | 3 | 3 | 1 | 2 | 2 | 2 | 3 | 3 | 3 | 2 | 3 |
| **CO6** | 3 | 3 | 3 | 3 | 2 | 3 | 2 | 2 | 2 | 3 | 3 | 3 | 3 | 2 | 2 |

**Correlation level:** **1**- slight /Low **2-**Moderate/ Medium**3**- Substantial/High

# Detailed Syllabus
# of
# B. Tech. (EE)
# VI Semester

# POWER SYSTEMS - II

**General Course Information:**

| | |
|---|---|
| Course Code: **PC/EE/15-T**<br>Course Credits: 3.0<br>Mode: Lecture (L) and Tutorial (T)<br>Type: Program Core<br>Teaching Schedule L T P: 3 0 0<br>Examination Duration: 3 hours | **Course Assessment Methods; Max. Marks: 100 (Internal: 30; External: 70)**<br>Three minor tests, each of 20 marks, will be conducted. The third minor will be conducted in open book mode by the Course Coordinator. No date sheet will be issued for the third minor at the level of the Departments. For the purpose of internal assessment, the average of the highest marks obtained by a student in any two minor examinations will be considered. All the minor examination question papers will be prepared and evaluated by following the Outcome Based Education framework. Class Performance will be measured through percentage of lectures attended (4 marks) Assignments (4 marks) and class performance (2 marks).<br><br>The end semester examination will be of 70 marks. For the end semester examination, nine questions are to be set by the examiner. Question number one will be compulsory and based on the entire syllabus. It will contain seven short answers type questions. Rest of the eight questions is to be given by setting two questions from each of the four units of the syllabus. A candidate is required to attempt any other four questions selecting one from each of the four units. All questions carry equal marks. |

**Course outcomes:**

| Sr. No. | Course outcomes<br>At the end of the course students will be able to: | RBT* Level |
|---|---|---|
| CO1. | List and describe the construction, principle and working of different types of switchgear equipmentsalong with protective schemes. | **L1(Remembering)** |
| CO2. | Classify the circuit breakers, relays and protective schemes based on construction, principle of operation and requirement. | **L2(Understanding)** |
| CO3. | Deploy an appropriate switchgear and protective scheme for various components of power systems to protect against different types of faults. | **L3(Applying)** |
| CO4. | Analyze the causes and counter measures of over-voltages in power systems. | **L4(Analyzing)** |
| CO5. | Appraise the power systems with neutral grounding and various grounding Schemes. | **L5(Evaluating)** |

***Revised Bloom's Taxonomy Action verbs/Levels**

## Course Content

### UNIT- I

**Circuit breakers:** Theory of arc formation and its extinction (AC and DC), Re-striking and recovery voltages, Current chopping, Capacitance and resistance switching, Types of circuit breakers: Air blast, Air-break, Oil, Vacuum and $SF_6$, comparative merits and demerits, HVDC circuit breaker system, Testing of Circuit breakers, Rating and selection of Circuit breakers

### UNIT- II

**Protective Relays:** Requirement of Protective Relaying, Zones of protection, primary and backup protection, Essential qualities of Protective Relaying, Classification of Protective

Relays: Electromechanical - Electromagnetic, Attraction and induction type relays, Thermal relay, Gas actuated relay, Static and Numerical relays, Microprocessor based relays

**Protective Schemes:** Over current relaying: Instantaneous, time delayed, definite time, inverse time, IDMT relays and relay coordination, Differential relays: circulating current and voltage balance differential relays, Biased percentage differential relays, Directional over current and directional power relays, Distance relays

## UNIT- III

**Power Apparatus and lines Protection:**

Generator protection: faults in Generators, stator and rotor protection, Motor Protection: Protection against overload, unbalance, single phasing, under voltage and reverse phase, Loss of synchronism

Transformer protection: Faults in transformers, differential, over current and earth fault protection, Bucholz relay, Harmonic restraint relay, over flux protection

Protection of feeders: Differential pilot protection, Merz price protection, Translay system Protection of Lines: Over Current, Carrier Current and Three-zone distance relay protection using impedance relays

## . UNIT- IV

**Over voltages in power systems:** Power frequency over voltages-Switching over voltages, causes of over voltages, Protection against over voltages, surge arrestors, Wave propagation in transmission lines and cables, transmitted and reflected waves, Surge impedance

**Neutral Grounding:** Grounded and Ungrounded neutral Systems, Effects of Ungrounded neutral on system performance, Methods of Neutral Grounding: Solid, Resistance, Reactance, Arcing Grounds and Grounding practices

**REFERENCES:**


1. C. L. Wadhwa, "Electrical Power Systems", New Age Internationals, 7th edition, 2016.
2. A. Chakrabarty, P. V. Gupta, M. L. Soni and U. S. Bhatnagar, "A Course in Electrical Power" Dhanpat Rai Pub. Co.(P) Ltd., 2008.
3. R. Gupta, "Power System Analysis and Design", S. Chand, 7th edition, 2014.
4. S. S. Rao, 'Switchgear and Protection', Khanna Publishers, New Delhi, 2008.
5. Rabindranath and N. Chander, 'Power System Protection and Switchgear', New Age International (P) Ltd., First Edition 2011.
6. B. Ram, and B.H. Vishwakarma, 'Power System Protection and Switchgear', New Age International Pvt Ltd Publishers, Second Edition 2011.
7. Y.G.Paithankar and S.R.Bhide, 'Fundamentals of power system protection', Second Edition, Prentice Hall of India Pvt. Ltd., New Delhi, 2010.
8. R. P.Singh, "Switchgear and Power System Protection", PHI Learning Private Ltd., New Delhi, 2009.
9. S. K. Gupta, "Power System Engineering", Umesh Publications, 2009.

**Course Articulation Matrix:**

| Course/Course Code: Power Systems- II (**PC/EE/15-T**), | | | | | | | | | | | | Semester: VI | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
| CO1 | 3 | - | - | - | - | - | - | - | - | - | - | 1 | 3 | - | - |
| CO2 | 2 | - | - | - | - | 3 | - | - | - | - | - | 1 | 1 | - | - |
| CO3 | 2 | 2 | - | - | - | 2 | - | - | - | - | - | 1 | 1 | 1 | - |
| CO4 | 2 | 2 | - | - | - | 1 | - | - | - | - | - | - | 1 | 1 | - |
| CO5 | 2 | - | - | - | - | 1 | - | - | - | - | - | - | 1 | - | - |

**Correlation level:** **1**- Slight /Low **2-**Moderate/ Medium **3-** Substantial/High

# ELECTRICAL MEASUREMENTS AND INSTRUMENTATION

**General Course Information:**

| | |
|---|---|
| Course Code: **PC/EE/16-T**<br>Course Credits: 3.0<br>Mode: Lecture (L)+Tutorials(T)<br>Type: Program Core<br>Teaching Schedule L T P: 3 0 0<br>Examination Duration: 3 hours | **Course Assessment Methods; Max. Marks: 100 (Internal: 30; External: 70)**<br>Three minor tests, each of 20 marks, will be conducted. The third minor will be conducted in open book mode by the Course Coordinator. No date sheet will be issued for the third minor at the level of the Departments. For the purpose of internal assessment, the average of the highest marks obtained by a student in any two minor examinations will be considered. All the minor examination question papers will be prepared and evaluated by following the Outcome Based Education framework. Class Performance will be measured through percentage of lectures attended (4 marks) Assignments (4 marks) and class performance (2 marks).<br><br>The end semester examination will be of 70 marks. For the end semester examination, nine questions are to be set by the examiner. Question number one will be compulsory and based on the entire syllabus. It will contain seven short answers type questions. Rest of the eight questions is to be given by setting two questions from each of the four units of the syllabus. A candidate is required to attempt any other four questions selecting one from each of the four units. All questions carry equal marks. |

**Course outcomes:**

| Sr. No. | Course outcomes<br>At the end of the course students will be able to: | RBT* Level |
|---|---|---|
| CO1. | Exhibit memory of previously learned material by recalling facts, terms, basic concepts and answers. | **L1(Remembering)** |
| CO2. | Recognize the basic measuring instruments in the field of engineering | **L2(Understanding)** |
| CO3. | Choose the proper type of meter and measuring instruments for different industrial. | **L3(Apply)** |
| CO4. | Compare performance of MC, MI and Dynamometer types of measuring instruments, Energy meters and CRO | **L4(Analysis)** |
| CO5. | student will be able to select techniques, skills, and modern engineering tools necessary for electrical engineering practice | **L5(Evaluating)** |
| CO6. | Design an electrical and electronic project using new sensing and measuring schemes. | **L6(Creating)** |

***Revised Bloom's Taxonomy Action verbs/Levels**

## Course Content

### UNIT- I

**Measurements:** Method of measurement, Measurement system, Classification of instruments, Definition of accuracy, Precision, Resolution, Speed of response, Error in measurement, Classification of errors, loading effect due to shunt and series connected instruments.

**Analog meters:** General features, Construction, Principle of operation and torque equation of Moving coil, Moving iron, Electrodynamometer, Induction type instruments. Principle of operation of the Electrostatic, Thermoelectric, Rectifier type instruments, Extension of instrument ranges and multiplier, errors in the meters.

## UNIT-II

**Instrument transformer:** Disadvantage of shunt and multipliers, Advantage of Instrument transformers, Principle of operation of current & potential transformer, errors.

**Measurement of Power:** Principle of operation of Electrodynamic & Induction type Wattmeter. Wattmeter errors. Energy Meters and its types alongwith their operation.

**Measurement of resistance:**Methods for the measurement of medium, low and high resistances, Megger.

## UNIT-III

**Measurement of Energy:** Construction, theory and application of AC energy meter, testing of energy meters.

**Potentiometer:** Principle of operation and application of Crompton's DC potentiometer, Polar and Co-ordinate type AC potentiometer and application.

**AC Bridges:** Measurement of Inductance (self and mutual), Capacitance and frequency by AC bridges.

## UNIT-IV

**Cathode ray oscilloscope (CRO):** Measurement of voltage, current, frequency & phase by oscilloscope. Frequency limitation of CRO. Sampling and storage oscilloscope, Double beam CRO.

**Electronic Instruments:** Advantages of digital meter over analog meters, Digital voltmeter, Resolution and sensitivity of digital meters, Digital multimeter, Digital frequency meter, Signal generator.

**Sensors & Transducers:** Introduction to sensors & Transducers, Strain gauge, LVDT, Temperature transducers, Pressure Measurement, Flow measurement using magnetic flow measurement, Liquid Level Measurement, Humidity Measurement, Torque Measurement, Velocity Measurement etc.

**REFERENCES:**


1. AK Sawhney, "Electrical and Electronic Measurements &Instrumentation",Dhanpat Rai, Delhi.
2. C.T. Baldwin, "Fundamentals of Electrical Measurement", Lyall Book Depot.
3. E.W. Golding, "Electrical Measurement", Reem Publications.
4. W.D. Cooper "Electronics Instrumentation and Measurement Techniques", Prentice Hall India.
5. B.C. Nakra and K.K. Chaudhry "Instrumentation Measurement and Analysis", Tata McGrawHill Publishing Company Limited, New Delhi.
6. H.K.P. Neubert, "Instrument transducers", Oxford University press.
7. A.D. Heltric& W.C. Copper, "Modern Electronic instrumentation & Measuring instruments", Wheeler Publication.
8. H.S. Kalsi, "Electronic Instruments", Tata McGraw hill, 2nd Edition.

**Course Articulation Matrix:**

| Course/Course Code: Electrical Measurements and Instrumentation(**PC/EE/16-T**)Semester: VI | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
| CO1 | 2 | - | - | - | - | 1 | - | - | - | - | - | 1 | 2 | - | - |
| CO2 | 2 | - | - | - | - | 2 | - | - | - | - | - | 1 | 2 | - | - |
| CO3 | 3 | 1 | - | - | - | - | - | - | - | - | - | - | 3 | 1 | - |
| CO4 | 3 | 1 | - | - | - | - | - | - | - | - | - | - | 3 | 2 | - |
| CO5 | 3 | 3 | 1 | - | - | 1 | - | - | - | - | - | - | 3 | 2 | 1 |
| CO6 | 2 | 2 | 3 | - | - | 1 | - | - | - | - | - | - | 2 | - | - |

**Correlation level:** **1**- Slight /Low **2-** Moderate/ Medium **3-** Substantial/High

# CONTROL SYSTEMS-II

## General Course Information:

| | |
|---|---|
| Course Code: **PC/EE/17-T**<br>Course Credits: 4.0<br>Mode: Lecture (L) and Tutorial (T)<br>Type: Program Core<br>Teaching Schedule L T P: 3 1 0<br>Examination Duration: 3 hours | **Course Assessment Methods; Max. Marks: 100 (Internal: 30; External: 70)**<br>Three minor tests, each of 20 marks, will be conducted. The third minor will be conducted in open book mode by the Course Coordinator. No date sheet will be issued for the third minor at the level of the Departments. For the purpose of internal assessment, the average of the highest marks obtained by a student in any two minor examinations will be considered. All the minor examination question papers will be prepared and evaluated by following the Outcome Based Education framework. Class Performance will be measured through percentage of lectures attended (4 marks) Assignments (4 marks) and class performance (2 marks).<br><br>The end semester examination will be of 70 marks. For the end semester examination, nine questions are to be set by the examiner. Question number one will be compulsory and based on the entire syllabus. It will contain seven short answers type questions. Rest of the eight questions is to be given by setting two questions from each of the four units of the syllabus. A candidate is required to attempt any other four questions selecting one from each of the four units. All questions carry equal marks. |

**Prerequisites: PC/EE/12-T**

## Course Outcomes

| Sr. No. | Course outcomes<br>At the end of the course students will be able to: | RBT* Level |
|---|---|---|
| CO1. | Describe the state of system and recall the z-transform along with stability theory. | **L1(Remembering)** |
| CO2. | Illustrate the performance of different control system models and controllers on the basis of their transfer function model. | **L2(Understanding)** |
| CO3. | Solve the problems related with linear and non-linear systems and give some examples. | **L3(Apply)** |
| CO4. | Compare the performance characteristics of different control systems and examine the behavior of system. | **H1(Analysis)** |
| CO5. | Judge the control strategy on the basis of their performance and requirement. | **H2 (Evaluating)** |
| CO6. | Design controller and compensator with optimum set of equations on the basis of outcomes and requirement of system. | **H3 (Creating)** |

***Revised Bloom's Taxonomy Action verbs/Level**

## Course Content

### UNIT-I

### State Variable Approach

State space equations in canonical forms, modelling of electrical and mechanical systems in state space form, solution of time invariant/variant continuous/ discrete time system state equations, state

transition matrix, state transformation, Eigen values and Eigen vectors, controllability and observability, State space representation of transfer function systems

## UNIT-II
## Discrete Data Systems

**Introduction to digital control:** The digital control problem and solution possibilities, Signal processing in digital control, principles of signal conversion, sampling and reconstruction, principles of discretization, impulse and step invariance, finite difference approximation, bilinear transformation.

**Mathematical models of discrete-time systems:** Transfer function and system response, stability in the z-plane and the Jury stability criterion, sampling and data reconstruction process, z-domain description of closed loop systems, systems with dead-time.

## UNIT-III
## Digital Control Design

**Digital control design:** Implementation of digital controllers, digital controllers for deadbeat performance, root locus methods and frequency domain methods, effect of nonlinearity in root locus and Nyquist plot.

**Non-Linear Systems:** Linear and Non-Linear Systems & comparison, Properties of Non-Linear Systems, Different types of non-linearities.

## UNIT-IV
## Non-Linear Systems

**Introduction to nonlinear systems:** Characteristics of nonlinear systems,inherent and intentional nonlinearities, qualitative behavior of linear Vs nonlinear systems, multiple equilibrium points, limit cycle, bifurcation, jump response, chaos,

**Stability analysis of nonlinear systems:** Describing function of common nonlinear functions and stability analysis, phase plane analysis, BIBO stability, construction of phase portraits, singular points, concept of stability in the sense of Lyapunov, asymptotic stability, local and global stability, Schur cohn stability, construction of Lyapunov function using Krasovskii and variable gradient method.

**REFERENCES:**


1. Raymond T. Stephani, "Design of Feedback Control Systems", 4$^{th}$ Edition, 2002, Oxford University Press.
2. Donald M. Wiberg, "State Space and Linear Systems", 1$^{st}$ Edition, 1971, Schum's Outline Series,
3. Katsuhiko Ogata, "Discrete-Time Control Systems", 2$^{nd}$ Edition, 2015, Prentice-Hall.
4. M. Gopal, "Digital Control and State Variable Methods", 4$^{th}$ Edition, 2012, Tata McGrow Hill.
5. B. C. Kuo, "Digital Control System", 2$^{nd}$ Edition, 2006, Oxford University Press.
6. J. J. E. Slotine and W. Li, "Applied Nonlinear Control", 1$^{st}$ Edition, 1991, Prentice Hall.
7. Hassan. K. Khalil, "Nonlinear Systems", III Edition 2002, Prentice-Hall.

**Course Articulation Matrix:**

| Course/Course Code: Control System-II (**PC/EE/17-T**) Semester: VI | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
| CO1 | 3 | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| CO2 | 2 | - | 1 | - | - | - | - | - | - | - | - | - | 1 | - | - |
| CO3 | 3 | 3 | 1 | - | - | - | - | - | - | - | - | 1 | - | 2 | - |
| CO4 | 2 | 2 | 1 | - | - | - | - | - | - | - | - | - | - | 2 | - |
| CO5 | 1 | 1 | 2 | - | - | - | - | - | - | - | - | - | - | 1 | - |
| CO6 | 3 | 1 | 3 | 1 | - | - | - | - | - | - | - | - | 2 | 2 | - |

**Correlation level:** **1**- Slight /Low **2-** Moderate/ Medium **3**- Substantial/High

# POWER SYSTEMS - II LABORATORY

## General Course Information:

| | |
|---|---|
| Course Code: **PC/EE/15-P**<br>Course Credits: 2<br>Mode: Practical<br>Type: Program Core<br>Contact Hours: 4 hours per week. | **Course Assessment Methods (Internal: 50; External: 50)** Internal continuous assessment of 50 marks by course coordinator as per the course assessment method (Annexure I).<br><br>For the end semester practical examination the assessment will be done out of 50 marks by the external and internal examiners as per the course assessment method (Annexure I). |

## Course Outcomes:

| Sr. No. | Course outcomes<br>At the end of the course students will be able to: | RBT* Level |
|---|---|---|
| CO1. | **Perform** Experimental work and acquire specific technical knowledge to solve field problems of Power Systems and operation of various protective devices. | **HOTS L4 (Analyzing)** |
| CO2. | **Identify** the possible faults and employ appropriate protective scheme for various components of power systems. | **LOTS L3 (Applying)** |
| CO3. | **Evaluate** the operating characteristics of various types of relays. | **HOTS L5 (Evaluating)** |
| CO4. | **Design** a suitable protection scheme for different power system equipments. | **HOTS L6 (Creating)** |
| CO5. | **Organize** reports based on experiments performed with effective demonstration and analysis of results. | **HOTS L6 (Creating)** |
| CO6. | **Inculcate** ethical practices while performing experiments individually and in groups. | **LOTS L3 (Applying)** |

***Revised Bloom's Taxonomy Action verbs/Level**

**LIST OF EXPERIMENTS:**

1. To study construction and working of $SF_6$ and Vacuum circuit breakers.
2. To study construction and working of Air Blast circuit breakers.
3. To determine the time -current characteristics IDMT over-current relay (single phase).
4. To determine the operating characteristics of a percentage biased differential relay.
5. To implement the protection of transformer with percentage biased differential relay.
6. To study the construction and working of Buchholz relay.
7. To study microcontroller based over/under voltage relay.
8. To study operation of various Numerical relays and interfacing.
9. To realize the various Time-current characteristics of combined numerical over-current and earth fault relay.
10. To realize distance protection scheme on transmission line with a digital relay.
11. Realization and operation of parallel feeder protection.
12. To study the complete protection scheme for an alternator unit.
13. To visit the GIS Substation and analyse the working of various power system components.

**NOTE:** At least eight experiments are to be performed in the semester, out of which at-least six experiments should be performed from above list. Remaining experiments may either be performed from the above list or designed & set by the concerned institution as per the scope of the syllabus.

**CO-PO Articulation Matrix**

| Course/Course Code: Power Systems- II Laboratory (**PC/EE/15-P**), Semester: VI | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **List of Course Outcomes** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** | **PO11** | **PO12** | **PSO1** | **PSO2** | **PSO3** |
| CO1. **Perform** Experimental work and acquire specific technical knowledge to solve field problems of Power Systems and operation of various protective devices. **(HOTS L4: Analyzing)** | 3 | 2 | - | - | - | - | - | - | 3 | - | - | 2 | 3 | 2 | 1 |
| CO2. **Identify** the possible faults and employ appropriate protective scheme for various components of power systems. **(LOTS L3:Applying)** | 3 | 2 | - | 2 | - | - | - | - | - | - | - | 1 | 3 | - | - |
| CO3. **Evaluate** the operating characteristics of various types of relays. **(HOTS L5: Evaluating)** | 3 | 2 | 1 | - | - | 2 | - | - | - | - | - | 1 | 3 | 1 | - |
| CO4. **Design** the suitable protection scheme for different power system equipment. **(HOTS L6: Creating)** | 3 | 2 | 1 | 2 | - | - | - | - | - | - | - | 1 | 3 | 2 | - |
| CO5. **Organize** reports based on experiments performed with effective demonstration and analysis of results. **( HOTS L6: Creating)** | - | - | - | - | - | - | - | - | - | 3 | - | - | - | - | - |
| CO6. **Inculcate** ethical practices while performing experiments individually and in groups. **(LOTS L3:Applying)** | - | - | - | - | - | - | - | 3 | 3 | - | - | - | - | - | 1 |
| Level of Attainments: | | | | | | | | | | | | | | | |

**Correlation level:** 1- slight /Low 2- Moderate/ Medium 3- Substantial/High

# ELECTRICAL MEASUREMENTS AND INSTRUMENTATION LABORATORY

## General Course Information:

| | |
|---|---|
| Course Code: **PC/EE/16-P**<br>Course Credits: 1<br>Mode: Practical<br>Type: Program Core<br>Contact Hours: 2 hours per week. | **Course Assessment Methods (Internal: 50; External: 50)** Internal continuous assessment of 50 marks by course coordinator as per the course assessment method (Annexure I).<br>For the end semester practical examination the assessment will be done out of 50 marks by the external and internal examiners as per the course assessment method (Annexure I). |

## Course outcomes:

| Sr. No. | Course outcomes<br>At the end of the course students will be able to: | RBT* Level |
|---|---|---|
| CO1. | **Experimental** work and acquire basic technical knowledge to solve the measuring problems in the field of electrical engineering. | **HOTS L4 ( Analyzing)** |
| CO2. | **Interpret** the performance characteristics of different types of analog meters. | **LOTS L3 (Applying)** |
| CO3. | **Select** the suitable instrument for measurement of various electrical quantities with different method. | **HOTS L5 ( Evaluating)** |
| CO4. | **Calibration** of measuring instruments for accurate measurement. | **HOTS L5 ( Evaluating)** |
| CO5. | **Organize** the basic requirements reports based on experiments in the electrical engineering fields for measurements of electrical parameters. | **HOTS L6 (Creating)** |
| CO6. | **Inculcate** ethical practices while performing experiments individually and in groups. | **LOTS L3 (Applying)** |

***Revised Bloom's Taxonomy Action verbs/Level**

**LIST OF EXPERIMENTS:**

1. To measure the displacement of fluid flow using LVDT.
2. To calibrate an energy meter with the help of a standard wattmeter & a stop watch
3. To measure the capacitance by De Sauty's bridge and unknown capacitance sharing bridge method.
4. To measure the frequency by using Wien's bridge
5. To measure the power with the help of Current Transformer & Potential Transformer.
6. To measure magnitude & phase angle of a voltage by rectangular type potentiometer.
7. To measure high resistance by loss of charge method.
8. To measure the low resistance by using Kelvin Double method, medium resistance by using Wheatstone bridge and high resistance by using loss of charge method.
9. To calibrate permanent magnet moving coil (PMMC) ammeter and permanent magnet moving coil (PMMC) voltmeter.
10. To test Dielectric oil using Hip Pot (H.T) testing Kit.
11. To test Current transformer using mutual Inductor Measurement of percentage ratio error and phase angle of given Current Transformer by Null method.
12. To test Potential transformers using mutual inductor Measurement of Percentage ratio error and phase angle error of the given Potential Transformer by Null method.
13. To study Digital Instruments such as: Digital Voltmeter, Digital Frequency Meter, Digital Panel Meter, Digital Storage Oscilloscope.

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**NOTE:** At least eight experiments are to be performed in the semester, out of which at-least six experiments should be performed from above list. Remaining experiments may either be performed from the above list or designed & set by the concerned institution as per the scope of the syllabus.

CO-PO Articulation Matrix

| Course/Course Code: Electrical Measurements & Instrumentation Laboratory (**PC/EE/16-P**), Semester VI | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **List of Course Outcomes** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** | **PO11** | **PO12** | **PSO1** | **PSO2** | **PSO3** |
| CO1. **Experimental** work and acquire basic technical knowledge to solve out the measuring problems in the field of electrical engineering. **(HOTS L4: Analyzing)** | 3 | - | - | - | - | - | - | - | 3 | - | - | 2 | 2 | - | 1 |
| CO2. **Interpret** the performance characteristics of different types of analog meters. **(LOTS L3:Applying)** | 3 | - | - | - | - | - | - | - | - | - | - | 2 | 2 | - | 1 |
| CO3. **Select** the suitable instrument for measurement of various electrical quantities with different method. **(HOTS L5: Evaluating)** | 3 | 1 | - | - | - | 1 | - | - | - | - | - | - | 2 | - | 3 |
| CO4. **Calibration** of measuring instruments for accurate measurement. **(HOTS L6: Creating)** | 2 | - | - | - | - | - | - | - | - | - | - | 1 | 3 | - | - |
| CO5. **Organize** and illustrate the basic requirements reports based on experiments in the electrical engineering fields for measurements of electrical parameters. **(HOTS L4: Analyzing)** | - | - | - | - | - | - | - | - | - | 3 | - | - | - | - | - |
| CO6. I**nculcate** ethical practices while performing experiments individually and in groups. **(LOTS L3:Applying)** | - | - | - | - | - | - | - | 3 | 3 | - | - | - | - | - | 1 |
| Level of Attainments: | | | | | | | | | | | | | | | |

**Correlation level:** 1- slight /Low 2- Moderate/ Medium 3- Substantial/High

# CONTROL SYSTEM-II LABORATORY

## General Course Information:

| | |
|---|---|
| Course Code: **PC/EE/17-P**<br>Course Credits: 1<br>Mode: Practical<br>Type: Program Core<br>Contact Hours: 2 hours per week. | **Course Assessment Methods (Internal: 50; External: 50)** Internal continuous assessment of 50 marks by course coordinator as per the course assessment method (Annexure I).<br><br>For the end semester practical examination, the assessment will be done out of 50 marks by the external and internal examiners as per the course assessment method (Annexure I). |

## Course Outcomes:

| Sr. No. | Course outcomes<br>At the end of the course students will be able to: | RBT* Level |
|---|---|---|
| CO1. | **Perform** experimental work to test and compare the performance characteristics of different control systems. | **HOTS L4 (Analyzing)** |
| CO2. | **Illustrate** the performance of PID controller over different systems. | **LOTS L2 (Understanding)** |
| CO3. | **Judge** the micro controller interfacing. | **HOTS L2 (Evaluating)** |
| CO4. | **Design** controller and compensator with optimum set of equations based on outcomes and requirement of system. | **HOTS L6 (Creating)** |
| CO5. | **Organize** reports based on experiments performed with effective demonstration and analysis of results. | **HOTS L4 (Analyzing)** |
| CO6. | **Inculcate** ethical practices while performing experiments individually and in groups. | **LOTS L3 (Applying)** |

***Revised Bloom's Taxonomy Action verbs/Level**

## LIST OF EXPERIMENTS:

1. To design a PID controller for position Control of DC motor and plot its output characteristics.
2. To observe and plot the various Relay characteristics.
3. To transform a given Transfer Function to State Space Model and vice-versa using MATLAB.
4. To plot the step response of the State Space Model using MATLAB.
5. To study the heating process and its control.
6. To design and simulate LTI models of Feedback Control System using MATLAB.
7. Simulation and analysis of State space models for continuous time systems using MATLAB.
8. Study of micro controller kit with ADC interfacing.
9. To implement PID control for industrial processes.
10. To obtain the response of a stepper motor controlled by a microcontroller by changing the number of steps, direction of rotation & speed
11. Study of Control of Inverted Pendulum using LAB VIEW.

**NOTE:** At least eight experiments are to be performed in the semester, out of which at-least six experiments should be performed from the above list. Remaining experiments may either be performed from the above list or designed & set by the concerned course coordinator as per the scope of the syllabus.

**CO-PO Articulation Matrix**

| Course/Course Code: Control System- II Laboratory (**PC/EE/17-P**), Semester: VI | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **List of Course Outcomes** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** | **PO11** | **PO12** | **PSO1** | **PSO2** | **PSO3** |
| CO1. **Perform** experimental work to test and examine the performance of control system models with their transfer function. **(HOTS L4: Analyzing)** | 3 | 3 | - | - | - | - | - | - | 3 | - | - | 2 | 3 | - | - |
| CO2. **Illustrate** the performance of PID controller over different systems. **(LOTS L2: Understanding)** | 3 | 2 | - | 2 | - | - | - | - | - | - | - | 1 | 3 | - | - |
| CO3. **Judge** the micro controller interfacing. **(HOTS L2: Evaluating)** | 3 | 2 | - | 2 | - | - | - | - | - | - | - | 1 | 3 | - | - |
| CO4. **Design** controller and compensator with optimum set of equations on the basis of outcomes and requirement of system. **(HOTS L6: Creating)** | 3 | 2 | 3 | - | - | - | - | - | 3 | - | - | - | 3 | 2 | - |
| CO5. **Organize** reports based on experiments performed with effective demonstration and analysis of results. **(HOTS: Level 4: Analyzing)** | - | - | - | - | - | - | - | - | - | 3 | - | - | - | - | - |
| CO6. **Inculcate** ethical practices while performing experiments individually and in groups. **(LOTS: Level 3: Applying)** | - | - | - | - | - | - | - | 3 | 3 | - | - | - | - | - | 2 |
| Level of Attainments: | | | | | | | | | | | | | | | |

**Correlation level:** 1- slight /Low 2- Moderate/ Medium 3- Substantial/High

# Economics for Engineers

## General Course Information

| | |
|---|---|
| Course Code: HSMC/2-T<br>Course Credits: 2<br>Type: Humanities and Social Sciences including Management courses<br>Contact Hours: 2 hours/week<br>Mode: Lectures (L)<br>Examination Duration: 3 hours | **Course Assessment Methods (internal: 30; external: 70)**<br>Three minor tests each of 20 marks will be conducted. The average of the highest marks obtained by a student in the any of the two minor examinations will be considered. Class Performance will be measured through percentage of lectures attended (04 marks). Assignments, quiz etc. will have weightage of 06 marks<br>For the end semester examination, nine questions are to be set by the examiner. A candidate is required to attempt 5 questions in all. All questions carry equal marks. Question number 1 will be compulsory and based on the entire syllabus. It will contain seven parts of 2 marks each. Question numbers 2 to 9 will be given by setting two questions from each of the four units of the syllabus. A candidate is required to attempt the remaining four questions by selecting one question from each of the four units. |

**Pre-requisites:** None

**About the Course:** This course is designed to provide the elementary and essential knowledge of economics relevant to their profession as engineers. The graduating engineers will learn aboutthe basic principles of economics and cost benefit analysis for various economic alternatives. The course also gives an initial exposure to issues and challenges for sustainable development.

Course Outcomes: By the end of the course students will be able to:
CO1. **outline** the principles of economics in general and economics in Indian context.(LOTS: Level 1:Remember)
CO2. **discuss** concepts related to economics in general and particularly relevant to Indianscenario. (LOTS:Level 2: Understand)
CO3. **apply** the principles of economics for solving problems related to Engineering sector. (LOTS: Level3: Apply)
CO4. **carry** out cost/benefit/, life cycle and breakeven analyses on one or more economic alternatives.(LOTS: Level 4: Analyse)
CO5. **judge** the issues and challenges of sustainable development. (LOTS: Level 5: Evaluate)

## Course Content

### Unit I

Definition of Economics- various definitions, Nature of economic problem, Production possibility curve, Economics laws and their nature. Relation between Science, Engineering, Technology and Economics. Concepts and measurement of utility, Law of Diminishing Marginal Utility, Law of equi-marginal utility - its practical applications and importance.

### Unit II

Meaning of Demand, Individual and Market demand schedules, Law of demand, shape of demand curve, Elasticity of Demand, measurement of elasticity of demand, factors affecting elasticity of demand, practical importance and applications of the concept of elasticity of

demand.

Meaning of production and factors of production; Law of variable proportions, Returns to scale,Internal and External economics and diseconomies of scale.

**Unit III**

Various concepts of cost- Fixed cost, variable cost, average cost, marginal cost, money cost, real cost, opportunity cost. Shape of average cost, marginal cost, total cost etc. in short run and long run both.

Meaning of Market, Types of Market - Perfect Competition, Monopoly, Oligopoly, Monopolistic Competition(Main features of these markets)

Issues, Strategies and challenges for sustainable development for developing economies

**Unit VI**

Elements of Business/Managerial Economics and forms of organizations, Cost & Cost Control Techniques, Types of Costs, Lifecycle Costs, Budgets, Break Even Analysis, Capital Budgeting, Application of linear Programming. Investment Analysis- NPV, ROI, IRR, Payback Period, Depreciation, Time Value of Money (present and future worth of cash flows).

Business Forecasting- Elementary techniques. Statements- Cash Flows, Financial. Case Study Method. Nature and Characteristics of Indian Economy (brief and elementary introduction). Privatization - meaning, merits, and demerits. Globalisation of Indian economy- merits and demerits.WTO and TRIPs agreements.

**Text and Reference Books:**


- Alfred William Stonier, D. C. Hague, *A text book of Economic Theory*, V edition,Longman HigherEducation, 1980.
- K. K. Dewett, M. H. Navalur, *Modem EconornicTheory*, S. Chand, 2006.
- H. L. Ahuja, *Modern Microeconomic: Theory and Applications*, S. Chand, 2017.
- N. Gregory Mankiw, *Principles of Economics*, 7th edition, South-Western CollegePublishing, 2013.
- Ruddar Dutt & K. P. M. Sundhram, *Indian Economy*, S. Chand, 2004.
- V. Mote, S. Paul, G. Gupta, *Managerial, Economics*, McGraw Hill Education, 2017.
- Saroj Pareek, *Text book of Business Economics*, Neha Publishers and Distributors, 2013.


**CO-PO Articulation Matrix Economics for Engineers (HSMC/2-T)**

| Course Outcomes | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 1 1 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 1 | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| CO2 | 1 | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| CO3 | 2 | 2 | 2 | 2 | 2 | - | - | - | - | - | - | - | - | - | - |
| CO4 | 3 | 2 | 2 | 3 | 3 | - | - | - | 2 | - | - | 3 | - | - | - |
| CO5 | 3 | _ | 3 | 3 | _ | _ | 3 | - | | 3 | 3 | 3 | - | - | - |
| **3-High 2-Medium 1-Low** | | | | | | | | | | | | | | | |

# Detailed Syllabus
# of
# B. Tech. (EE)
# VI Semester
## Program Elective Course-I

# RENEWABLE ENERGY RERSOURCES

**General Course Information:**

| | |
|---|---|
| Course Code: **PE/EE/1-T**<br>Course Credits: 3<br>Mode: Lecture (L)<br>Type: Program Elective<br>Teaching Schedule L T P: 3 0 0<br>Examination Duration: 03 hours. | **Course Assessment Methods; Max. Marks: 100 (Internal: 30; External: 70)**<br>Three minor tests, each of 20 marks, will be conducted. The third minor will be conducted in open book mode by the Course Coordinator. No date sheet will be issued for the third minor at the level of the Departments. For the purpose of internal assessment, the average of the highest marks obtained by a student in any two minor examinations will be considered. All the minor examination question papers will be prepared and evaluated by following the Outcome Based Education framework. Class Performance will be measured through percentage of lectures attended (4 marks) Assignments (4 marks) and class performance (2 marks).<br><br>The end semester examination will be of 70 marks. For the end semester examination, nine questions are to be set by the examiner. Question number one will be compulsory and based on the entire syllabus. It will contain seven short answers type questions. Rest of the eight questions is to be given by setting two questions from each of the four units of the syllabus. A candidate is required to attempt any other four questions selecting one from each of the four units. All questions carry equal marks. |

**Course outcomes:**

| Sr. No. | Course outcomes<br>At the end of the course students will be able to: | RBT* Level |
|---|---|---|
| CO1. | List and describe the various conventional and renewable energy resources and technologies | **L1 (Remembering)** |
| CO2. | Recognize the impact of renewable energy utilization on society and environment | **L2 (Understanding)** |
| CO3. | Interpret and apply the concepts of renewable energy sources for electricity generation and grid integration | **L3 (Applying)** |
| CO4. | Make comparisons among renewable energy resources and technologies | **L4(Analyzing)** |
| CO5. | Assess and select the options among renewable energy resources and technologies | **L5 (Evaluating)** |
| CO6. | Do the basic design of various renewable energy systems for different requirements | **L6 (Creating)** |

***Revised Bloom's Taxonomy Action verbs/Levels**

## Course Content

### UNIT-I

**Introduction:**Over view of conventional & renewable energy sources, Limitations of conventional energy sources, need & development of alternate energy sources, basic schemes and applications of direct energy conversion types of renewable energy systems, Future of Energy Use, Global and Indian Energy scenario, Potential of renewable energy sources, renewable electricity and key elements, Global climate change, CO2 reduction potential of renewable energy, concept of Hybrid systems. ENERGY STORAGE: Sizing and Necessity of Energy Storage.

### UNIT-II

**Solar and Wind Energy**:

Solar radiation spectra, solar geometry, Earth Sun angles, observer Sun angles, solar day length, Estimation of solar energy availability, Photovoltaic effect, characteristics of photovoltaic cells, conversion efficiency, solar batteries and applications, Design of standalone PV system, Solar energy in India, solar collectors, solar furnaces & applications, Design of solar water heater,

History of wind power, wind generators, theory of wind power, wind speed statistics-probability distributions, wind speed and power- cumulative distribution functions characteristics of suitable wind power sites, scope in India, advantages and limitations.

## UNIT-III

**Thermo-electric and MHD Generators:**Seeback effect, Peltier effect, Thomson effect, Thermo-electric convertors, Brief description of the construction of thermoelectric generators, Applications and economic aspects.

Hall Effect, Basic principles of MHD generator, Different types of MHD generators, Conversion effectiveness, Practical MHD generators, Applications and economic aspects.

## UNIT-IV

**Fuel Cells and Miscellaneous Sources:**Principle of action, Gibbs free energy, general description of fuel cells, types, construction, operational characteristics and applications, Geo-thermal system, characteristics of geothermal resources, Low head hydro-plants, Network Integration Issues: Overview of grid code technical requirements, Power system interconnection experiences in the world

**REFERENCES:**


1 G.D. Rai, Non-Conventional sources of Energy, Khanna Publishers, 2009

2 R.A. Coobe, An Introduction to Direct Energy Conservation, Pitman, 1968

3 M. A. Kettani, Direct Energy Conversion, Addison-Wesley Educational Publishers Inc, 1970

4 Robert L. Loftness, Energy Hand book, Van Nostrand Reinhold, 1984

5 D. M. Considine, Energy Technology Hand Book, McGraw-Hill; 1977

6 S. S. Rao, B. B. Parulekar, Energy Technology, Khanna Publishers, 1994

7 A. Ter-Gazarian, Energy storage for Power system, Peter Peregrinus Ltd, 1994

8 G. N. Tiwari and M. K. Ghosal, “Renewable Energy Applications”, Narosa Publications, 2004

9 S. A. Abbasi. and N. Abbasi, Renewable Energy Sources and Their Environmental Impact, Prentice Hall of India, 2001

10 G. S. Sawhney, Non-Conventional Energy Resources, PHI Learning, 2012

11 B. H Khan., Non-Conventional Energy Resources, Tata McGraw Hill, 2009

**Course Articulation Matrix:**

| Course/Course Code: Renewable energy Resources (**PE/EE/1-T**), Semester: VI | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
| CO1 | 2 | - | 2 | - | - | 2 | 3 | - | - | - | - | 2 | 1 | 2 | 1 |
| CO2 | - | - | 2 | - | | 3 | 3 | - | - | - | - | 2 | 1 | 1 | 1 |
| CO3 | 2 | - | 2 | - | 1 | 2 | 3 | - | - | - | 1 | 1 | 2 | 2 | 1 |
| CO4 | 2 | - | 2 | 1 | 1 | 2 | 3 | - | - | - | 2 | 1 | 2 | 2 | 2 |
| CO5 | 1 | - | 2 | 1 | 2 | 3 | 3 | - | - | - | 2 | 1 | 1 | 3 | 2 |
| CO6 | 1 | - | 3 | 1 | 2 | 2 | 3 | - | - | - | 1 | 1 | 1 | 2 | 3 |

**Correlation level:** **1**- Slight /Low **2-**Moderate/ Medium **3**- Substantial/High

# ELECTRICAL & HYBRID VEHICLES

**General Course Information:**

| | |
|---|---|
| Course Code: **PE/EE/2-T**<br>Course Credits: 3<br>Mode: Lecture (L)<br>Type: Program Elective<br>Teaching Schedule L T P: 3 0 0<br>Examination Duration: 03 hours. | **Course Assessment Methods; Max. Marks: 100 (Internal: 30; External: 70)**<br>Three minor tests, each of 20 marks, will be conducted. The third minor will be conducted in open book mode by the Course Coordinator. No date sheet will be issued for the third minor at the level of the Departments. For the purpose of internal assessment, the average of the highest marks obtained by a student in any two minor examinations will be considered. All the minor examination question papers will be prepared and evaluated by following the Outcome Based Education framework. Class Performance will be measured through percentage of lectures attended (4 marks) Assignments (4 marks) and class performance (2 marks).<br><br>The end semester examination will be of 70 marks. For the end semester examination, nine questions are to be set by the examiner. Question number one will be compulsory and based on the entire syllabus. It will contain seven short answers type questions. Rest of the eight questions is to be given by setting two questions from each of the four units of the syllabus. A candidate is required to attempt any other four questions selecting one from each of the four units. All questions carry equal marks. |

**Course outcomes:**

| Sr. No. | Course outcomes<br>At the end of the course students will be able to: | RBT* Level |
|---|---|---|
| CO1. | Understand the basic concept and history of EV and HEV | **L1 (Remembering)** |
| CO2. | Understand the models to describe hybrid vehicles and their performance. | **L2 (Understanding)** |
| CO3. | Analysis of different possible ways of energy storage. | **L3 (Applying)** |
| CO4. | Analysis of the different strategies related to energy management systems | **L4(Analyzing)** |
| CO5. | Study of design of Vehicle to grid technology. | **L6 (Creating)** |

***Revised Bloom's Taxonomy Action verbs/Levels**

## Course Content

### UNIT-I

Introduction: History of hybrid and electric vehicles, social and environmental importance of hybrid and electric vehicles, impact of modern electric vehicles on energy supplies. Electric Vehicle Composition and Configurations, Basic concept of hybrid Electric vehicle, HEV configuration types – series, parallel, series-parallel and complex hybrid, Power flow control.

### UNIT-II

Electric Propulsion: major requirements of EV motor drive, characteristics and control of DC motor, Induction motor, Switched Reluctance motor and Permanent Magnet motor, power converters devices/topology, control hardware, software and strategy vehicle, power source characterization, transmission characteristics.

### UNIT-III

Energy Storage: Introduction to energy storage requirements in Hybrid and Electric Vehicles, Energy sources, Battery based energy storage and its analysis, Fuel fell based energy storage

and its analysis, super capacitor based energy storage and its analysis, Flywheel based energy storage and its analysis.

## UNIT-IV

Energy Management Strategies: Introduction to energy management strategies used in hybrid and electric vehicles, classification of different energy management strategies, comparison of different energy management strategies, implementation issues of energy management strategies. Plug-in electric vehicles, Vehicle to grid (V2G) and Grid to vehicle (G2V) fundamentals

**Text / References:**


1. C. Mi, M. A. Masrur and D. W. Gao, "Hybrid Electric Vehicles: Principles and Applications with Practical Perspectives", John Wiley & Sons, 2011.
2. S. Onori, L. Serrao and G. Rizzoni, "Hybrid Electric Vehicles: Energy Management Strategies", Springer, 2015.
3. M. Ehsani, Y. Gao, S. E. Gay and A. Emadi, "Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals, Theory, and Design", CRC Press, 2004.
4. T. Denton, "Electric and Hybrid Vehicles", Routledge, 2016.

**Course Articulation Matrix:**

| Course/Course Code: Electrical and Hybrid Vehicles (**PE/EE/2-T**), Semester: VI | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
| CO1 | 2 | 2 | 1 | 1 | 1 | 1 | - | - | 1 | 2 | 1 | 1 | 3 | 2 | 1 |
| CO2 | 2 | 2 | 2 | 1 | 1 | - | - | - | 1 | 2 | 1 | 1 | 3 | 2 | 1 |
| CO3 | 3 | 3 | 2 | 1 | 3 | - | - | - | 1 | - | 1 | 1 | 3 | 3 | 2 |
| CO4 | 3 | 3 | 2 | 1 | 3 | - | - | - | 1 | - | 1 | 1 | 3 | 3 | 2 |
| CO5 | 3 | 3 | 3 | 2 | 3 | 1 | 1 | 1 | 1 | 3 | 3 | 2 | 2 | 3 | 3 |

**Correlation level:** **1**- Slight /Low **2**-Moderate/ Medium **3**- Substantial/High

# NETWORK SYNTHESIS AND FILTERS

**General Course Information:**

| | |
|---|---|
| Course Code:**PE/EE/3-T**<br>Course Credits: 3.0<br>Mode: Lecture (L)<br>Type: Program Elective<br>Teaching Schedule L T P: 3 0 0<br>Examination Duration: 3 hours | **Course Assessment Methods; Max. Marks: 100 (Internal: 30; External: 70)**<br>Three minor tests, each of 20 marks, will be conducted. The third minor will be conducted in open book mode by the Course Coordinator. No date sheet will be issued for the third minor at the level of the Departments. For the purpose of internal assessment, the average of the highest marks obtained by a student in any two minor examinations will be considered. All the minor examination question papers will be prepared and evaluated by following the Outcome Based Education framework. Class Performance will be measured through percentage of lectures attended (4 marks) Assignments (4 marks) and class performance (2 marks).<br><br>The end semester examination will be of 70 marks. For the end semester examination, nine questions are to be set by the examiner. Question number one will be compulsory and based on the entire syllabus. It will contain seven short answers type questions. Rest of the eight questions is to be given by setting two questions from each of the four units of the syllabus. A candidate is required to attempt any other four questions selecting one from each of the four units. All questions carry equal marks. |

**Course outcomes:**

| Sr. No. | Course outcomes<br>At the end of the course students will be able to: | RBT* Level |
|---|---|---|
| CO1. | Recall the knowledge about the reliability of network functions | **L1(Remembering)** |
| CO2. | Convert the mathematical driving point or transfer relations into realizable electrical circuits | **L2(Understanding)** |
| CO3. | Solve the numerical problem for system stability checking stability of the network function. | **L3(Apply)** |
| CO4. | Compare the different type of electrical components and materials. | **L4(Analysis)** |
| CO5. | To select the electrical circuit and filters in the field of engineering application. | **L5(Evaluating)** |
| CO6. | Convert the mathematical expression in the design form. | **L6(Creating)** |

***Revised Bloom's Taxonomy Action verbs/Levels**

## Course Content

### UNIT- I

Fundamental Concepts: Energy considerations, positive real condition, Hurwitz polynomials, Bounded realness, scattering description of networks.

### UNIT-II

Lossless one port network functions, Foster reactance functions and theorem, canonical forms: Cauer's and Foster's, Synthesis of lossless LC Immittance functions, Synthesis of lossy RL and RC functions, Certain RLC function realizations. Fundamentals of two port network synthesis.

### UNIT-III

Passive Filter Design: Analysis and Design of Constant K and m-derived filters, Active Filter Design: Amplitude and phase functions, amplitude approximations, phase approximations,

simultaneous amplitude and phase approximations, Group delay response and equidistant linear phase approximations.

## UNIT-IV

Maximally flat and Equi-ripple filters, Magnitude and frequency normalizations, frequency transformations; high Pass, Band-Pass, Band-stop filters, Impedance matching networks, Phase shift networks.

**REFERENCES:**


1. M.E. Vanvalkenburg, "Network Analysis", PHI, III Edition, 2014.
2. H. Baher, "Synthesis of Electrical Networks", John Wiley & Sons, 1984.
3. S. P. Ghosh, A.K. Chakraborthy, "Network Analysis and Synthesis" McGraw Hill, 2010
4. Franklin Kuo, "Network Analysis and Synthesis", Second Edition, Wiley, 2009.
5. D. Roy Choudhury, "Networks and Systems", New Age International Publications, 1988.
6. W. H. Hayt and J. E. Kemmerly, "Engineering Circuit Analysis", 9th Edition, McGraw Hill Education, 2018.

**Course Articulation Matrix:**

| Course/Course Code: Network Synthesis and Filters (**PE/EE/3-T**), Semester: VI | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
| CO1 | 3 | 2 | 2 | 2 | 2 | 2 | 1 | - | - | - | 1 | 2 | 3 | 3 | 1 |
| CO2 | 3 | 2 | 3 | 2 | 2 | 3 | 1 | - | - | - | 1 | 1 | 2 | 3 | 1 |
| CO3 | 3 | 3 | 3 | 2 | 1 | 1 | 1 | - | - | - | 1 | 2 | 2 | 2 | 1 |
| CO4 | 3 | 2 | 3 | 1 | 3 | 2 | 2 | - | - | - | 2 | 1 | 3 | 2 | 1 |
| CO5 | 2 | 3 | 2 | 2 | 1 | 2 | 2 | - | - | - | 2 | 1 | 2 | 3 | - |
| CO6 | 1 | 2 | 3 | 2 | 2 | 1 | 2 | - | - | - | 2 | 1 | 2 | 3 | 1 |

**Correlation level:** **1**- Slight /Low **2**-Moderate/ Medium **3**- Substantial/High

# MODELING AND SIMULATION

## General Course Information:

| | |
|---|---|
| Course Code: **PE/EE/4-T**<br>Course Credits: 3.0<br>Mode: Lecture (L) and Tutorial (T)<br>Type: Program Core<br>Teaching Schedule L T P: 3 0 0<br>Examination Duration: 3 hours | **Course Assessment Methods; Max. Marks: 100 (Internal: 30; External: 70)**<br>Three minor tests, each of 20 marks, will be conducted. The third minor will be conducted in open book mode by the Course Coordinator. No date sheet will be issued for the third minor at the level of the Departments. For the purpose of internal assessment, the average of the highest marks obtained by a student in any two minor examinations will be considered. All the minor examination question papers will be prepared and evaluated by following the Outcome Based Education framework. Class Performance will be measured through percentage of lectures attended (4 marks) Assignments (4 marks) and class performance (2 marks).<br><br>The end semester examination will be of 70 marks. For the end semester examination, nine questions are to be set by the examiner. Question number one will be compulsory and based on the entire syllabus. It will contain seven short answers type questions. Rest of the eight questions is to be given by setting two questions from each of the four units of the syllabus. A candidate is required to attempt any other four questions selecting one from each of the four units. All questions carry equal marks. |

## Course Outcomes

| Sr. No. | Course outcomes<br>At the end of the course students will be able to: | RBT* Level |
|---|---|---|
| CO1. | Recall the mathematical formulation. | **L1(Remembering)** |
| CO2. | Illustrate the complexity of real life problems with stochastic modeling | **L2(Understanding)** |
| CO3. | Solve the real life problems with comprehensive solution. | **L3(Apply)** |
| CO4. | Compare the performance of different frameworks. | **H1(Analysis)** |
| CO5. | Judge and utilize the simulation model on the basis of their performance. | **H2 (Evaluating)** |
| CO6. | Formulate the solution of different problems in the field of research and development. | **H3 (Creating)** |

***Revised Bloom's Taxonomy Action verbs/Level**

## Course Content

### UNIT-I

Review of Probability and Random Number generation, Generating continuous and discrete time random variables, Discussions on deterministic and stochastic modeling of engineering systems, Need for stochastic models, Ideas of model validation.

### UNIT-II

Modeling of systems as discrete event systems (DES), Continuous time and discrete time Markov chains, Properties of DES (observability and controllability), Supervisory control of DES, Queuing models.

### UNIT-III

Heuristic modeling, Neural, Fuzzy and Neuro-Fuzzy modeling and simulation of dynamical systems, Modeling of time delays and introduction to networked dynamical systems.

## UNIT-IV

Dynamical system simulation, Monte Carlo simulations, generation of simulation data and its statistical analysis, Statistical validation techniques, Goodness of fit test $\chi 2$, and others, Agent based simulation, Numerical issues in simulation of dynamical systems.

**REFERENCES:**


1. Sheldom Ross, "Simulation", Academic Press, Elsevier Imprint, 2006.
2. Sankar Sen Gupta. "System Simulation and Modeling", Pearson Education, 2013.
3. J. Banks, J. S. Carson, B. Nelson and D. M. Nicol, "Discrete Event system simulation", Pearson Education, V Edition, 2014.
4. J. R. Jang and C. Sun, "Neuro-Fuzzy Modeling and Control", Proceedings of IEEE, Vol. 83, No. 3, March 1995.

**Course Articulation Matrix:**

| Course/Course Code: Modeling and Simulation (**PE/EE/4-T**), Semester: VI | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
| CO1 | 3 | 2 | 2 | 2 | 2 | - | - | - | 1 | - | 1 | 1 | 3 | 2 | 1 |
| CO2 | 2 | 2 | 2 | 2 | 2 | 2 | - | - | - | 1 | 1 | 1 | 3 | 2 | - |
| CO3 | 2 | 2 | 2 | 2 | 2 | 2 | - | - | - | 1 | 2 | 2 | 3 | 1 | - |
| CO4 | 2 | 3 | 3 | 3 | 2 | 1 | - | - | - | 1 | 2 | 2 | 3 | 2 | - |
| CO5 | 2 | 2 | 2 | 2 | 2 | 1 | - | - | - | 1 | 2 | 2 | 3 | 2 | - |
| CO6 | 2 | 2 | 3 | 2 | 3 | 1 | 1 | 1 | 1 | 1 | 3 | 3 | 3 | 2 | 1 |

**Correlation level:** **1**- Slight /Low **2-** Moderate/ Medium **3**- Substantial/High

# The Curriculum Book

# Bachelor of Technology

## 4-YEAR FULL TIME PROGRAMME

## IVYEAR (ELECTRICAL ENGINEERING)

## Choice Based Credit System with

## Learning Outcomes based Curriculum Framework

## (LOCF)

## For Batch: 2022-23


**FACULTY OF ENGINEERING AND TECHNOLOGY**

**CHAUDHARY DEVI LAL UNIVERSITY**

**SIRSA-125055**

**SESSION: 2025-26**

# Scheme of Examination

# &

# Detailed Syllabus

# of

# B.Tech. (EE)

# IV Yr. (VII& VIII Sem)

# Program Specific Outcomes (PSOs)

| Sr. No. | Program Specific Outcomes |
|---|---|
| PSO1 | Ability to utilize logical and technical skills to model, simulate and analyse electrical components and systems. |
| PSO2 | Empowering to provide socially acceptable technical solutions to real time electrical engineering problems with the application of modern and appropriate techniques for sustainable development. |
| PSO3 | Graduates will demonstrate their knowledge in effective implementation during their practice of profession of Electrical Engineering with due regard to environment and social concerns. |

*****Programme Outcomes (POs) of Bachelor Programmes in Engineering and Technology have been specified in First year common curriculum of B.Tech. Programmes.

| Course Code | Definition/ Category |
|---|---|
| BSC | Basic Science Courses |
| ESC | Engineering Science Courses |
| HSMC | Humanities and Social Sciences including Management Courses |
| MC | Mandatory Courses |
| PC | Program Core |
| PE | Program Elective Courses |
| OE | Open Elective Courses |
| EEC | Employability Enhancement Courses (Project work/ Summer Training/ Industrial Training/ Practical Training/ Internship/Seminar, etc.) |

## Credit Scheme for B. Tech.(Electrical Engg.) IV Year (VII&VIII Sem)

| Semester | Basic Science Courses (BSC) | | Program Core/ Program Elective/ Open Elective Courses (PC/PE/OE) | | Humanities, Social Sciences Courses (HSMC) | | Mandatory Courses (MC) | | Grand Total Credit |
|---|---|---|---|---|---|---|---|---|---|
| Sr. No. | No. of Courses | Total Credits | No. of Courses | Total Credits | No. of Courses | Total Credits | No. of Courses | Total Credits | |
| VII | 00 | 00 | 08 | 21 | 00 | 00 | 01 | 00 | 21 |
| VIII | 00 | 00 | 05 | 17 | 00 | 00 | 00 | 00 | 17 |

# B. Tech. IV Year Semester-VII

| Sr. No. | Course Code | Course Title | Workload/ Credit | | | |
|---|---|---|---|---|---|---|
| | | | Theory | Tutorial | Practical | Total |
| 1. | PC/EE/18-T | Power System Operation and Control | 3/3 | 1/1 | 0/0 | 4/4 |
| 2. | PC/EE/19-T | Power Distribution System | 3/3 | 1/1 | 0/0 | 4/4 |
| 3. | PE/EE/5-T to PE/EE/8-T | Program Elective Course- II | 3/3 | 0/0 | 0/0 | 3/3 |
| 4. | PE/EE/9-T to PE/EE/12-T | Program Elective Course- III | 3/3 | 0/0 | 0/0 | 3/3 |
| 5. | Open Elective Course– III to be opted by students from another branch | | 3/3 | 0/0 | 0/0 | 3/3 |
| 6. | PC/EE/20-P | Renewable Energy Lab | 0/0 | 0/0 | 2/1 | 2/1 |
| 7. | **EEC/EE/2-P | Industrial Training/ Internship-II | 0/0 | 0/0 | 2/1 | 2/1 |
| 8. | EEC/EE/3-P | Minor Project Lab | 0/0 | 0/0 | 8/2 | 8/2 |
| 9. | MC/5-P | General Proficiency | 0/0 | 0/0 | 0/0 | 0/0 |
| TOTAL | | | **15/15** | **2/2** | **12/4** | **29/21** |
| | | | | | **Total Credits** | **21** |

****The students will have to prepare and submit a project report of the Industrial Training/ Internship of 6-8 weeks done during summer vacations after the examination of VI semester under the supervision of faculty during VII semester.**

**Important Notes:**

1. Open Elective Course– III to be offered by departments other than Electrical Engineering.
2. The Minor Project should be initiated by the student in the beginning of VII semester and will be evaluated at the end of the semester on the basis of its implementation, presentation, delivered, viva-voce and report.
3. The Viva-Voce for Minor Project by External Examiner and Chairperson of the Department / Internal Examiner at the end of the semester.
4. General Proficiency is a non-credit Mandatory Course and the student has to get pass marks in order to qualify for the award of the degree.
5. Students will be allowed to use non-programmable scientific calculator only, however sharing of calculator will not be permitted.

## List of Program Electives for VII Semester

### Program Elective Course– II

| Sr. No. | Course Code | Nomenclature of Subject |
|---|---|---|
| 1. | PE/EE/5-T | Electrical Machine Design |
| 2. | PE/EE/6-T | Advanced Power Electronics |
| 3. | PE/EE/7-T | Wind and Solar Energy Systems |
| 4. | PE/EE/8-T | Utilization of Electrical Energy |

### Program Elective Course– III

| Sr. No. | Course Code | Nomenclature of Subject |
|---|---|---|
| 1. | PE/EE/9-T | Energy Management & Auditing |
| 2. | PE/EE/10-T | Soft Computing |
| 3. | PE/EE/11-T | SCADA Systems and Applications |
| 4. | PE/EE/12-T | Internet of Things (IoT) |

# Credit Scheme for B.Tech.(Electrical Engg.) IV Year (VII & VIII Sem)

| Semester | Basic Science Courses (BSC) | | Program Core/ Program Elective/ Open Elective Courses (PC/PE/OE) | | Humanities, Social Sciences Courses (HSMC) | | Mandatory Courses (MC) | | Grand Total Credit |
|---|---|---|---|---|---|---|---|---|---|
| Sr. No. | No. of Courses | Total Credits | No. of Courses | Total Credits | No. of Courses | Total Credits | No. of Courses | Total Credits | |
| VII | 00 | 00 | 08 | 21 | 00 | 00 | 00 | 00 | 21 |
| VIII | 00 | 00 | 05 | 15 | 00 | 00 | 00 | 00 | 15 |

## B. Tech. IV Year Semester-VII

| Sr. No. | Course Code | Course Title | Workload/ Credit | | | |
|---|---|---|---|---|---|---|
| | | | Theory | Tutorial | Practical | Total |
| 1. | PC/EE/18-T | Power System Operation and Control | 3/3 | 1/1 | 0/0 | 4/4 |
| 2. | PC/EE/19-T | Power Distribution System | 3/3 | 0/0 | 0/0 | 3/3 |
| 3. | PE/EE/5-T to PE/EE/8-T | Program Elective Course- II | 3/3 | 0/0 | 0/0 | 3/3 |
| 4. | PE/EE/9-T to PE/EE/12-T | Program Elective Course- III | 3/3 | 0/0 | 0/0 | 3/3 |
| 5. | Open Elective Course– III to be opted by students from another branch | | 3/3 | 0/0 | 0/0 | 3/3 |
| 6. | PC/EE/20-P | Renewable Energy Lab | 0/0 | 0/0 | 2/1 | 2/1 |
| 7. | EEC/EE/2-P | Industrial Training/ Internship-II | 0/0 | 0/0 | 4/2 | 4/2 |
| 8. | EEC/EE/3-P | Minor Project Lab | 0/0 | 0/0 | 8/2 | 8/2 |
| TOTAL | | | **15/15** | **2/2** | **14/5** | **30/21** |
| | | | | | **Total Credits** | **21** |

****The students will have to prepare and submit a project report of the Industrial Training/ Internship of 6-8 weeks done during summer vacations after the examination of VI semester under the supervision of faculty during VII semester.**

**Important Notes:**

1. Open Elective Course– III to be offered by departments other than Electrical Engineering.
2. The Minor Project should be initiated by the student in the beginning of VII semester and will be evaluated at the end of the semester on the basis of its implementation, presentation, delivered, viva-voce and report.
3. The Viva-Voce for Minor Project by External Examiner and Chairperson of the Department / Internal Examiner at the end of the semester.

## List of Program Electives for VII Semester

### Program Elective Course– II

| Sr. No. | Course Code | Nomenclature of Subject |
|---|---|---|
| 1. | PE/EE/5-T | Electrical Machine Design |
| 2. | PE/EE/6-T | Advanced Power Electronics |
| 3. | PE/EE/7-T | Wind and Solar Energy Systems |
| 4. | PE/EE/8-T | Utilization of Electrical Energy |
| | | |

### Program Elective Course– III

| Sr. No. | Course Code | Nomenclature of Subject |
|---|---|---|
| 1. | PE/EE/9-T | Energy Management & Auditing |
| 2. | PE/EE/10-T | Soft Computing |
| 3. | PE/EE/11-T | SCADA Systems and Applications |
| 4. | PE/EE/12-T | Internet of Things (IoT) |

## B. Tech. IV Year Semester-VIII

| Sr. No. | Course Code | Course Title | Workload/ Credit | | | |
|---|---|---|---|---|---|---|
| | | | **Theory** | **Tutorial** | **Practical** | **Total** |
| 1. | PC/EE/21-T | Computer Methods in Power Systems | 3/3 | 1/1 | 0/0 | 4/4 |
| 2. | PE/EE/13-T to PE/EE/16-T | Program Elective Course- IV | 3/3 | 0/0 | 0/0 | 3/3 |
| 3. | PE/EE/17-T to PE/EE/20-T | Program Elective Course- V | 3/3 | 0/0 | 0/0 | 3/3 |
| 4. | PC/EE/21-P | Computer Methods in Power Systems Lab | 0/0 | 0/0 | 2/1 | 2/1 |
| 5. | EEC/EE/4-P | Major Project Lab | 0/0 | 0/0 | 12/4 | 12/4 |
| TOTAL | | | **09/09** | **1/1** | **14/5** | **24/15** |
| | | | | | **Total Credits** | **15** |

**Important Notes:**

1. The Major Project should be initiated by the student in continuation of the VII semester and will be evaluated at the end of the semester on the basis of its implementation, presentation, delivered, viva-voce and report.
2. The Viva-Voce for Major Project by External Examiner and Chairperson of the Department / Internal Examiner at the end of the semester.
3. Students will be allowed to use non-programmable scientific calculator only, however sharing of calculator will not be permitted.

# List of Program Electives for VIII Semester

## Program Elective Course– IV

| Sr. No. | Course Code | Nomenclature of Subject |
|---|---|---|
| 1. | PE/EE/13-T | Flexible AC Transmission Systems (FACTS) |
| 2. | PE/EE/14-T | Distributed Generation |
| 3. | PE/EE/15-T | Power Quality |
| 4. | PE/EE/16-T | Smart Grid Technologies |

## Program Elective Course– V

| Sr. No. | Course Code | Nomenclature of Subject |
|---|---|---|
| 1. | PE/EE/17-T | EHV AC and DC Transmission |
| 2. | PE/EE/18-T | Restructured Power System |
| 3. | PE/EE/19-T | High Voltage Engineering |
| 4. | PE/EE/20-T | Big Data Analysis |

**Policy Document for providing exemptions in attendance to the B.Tech. students of the University for undertaking various internships/trainings during their final/penultimate semester**

## 1. Background:

It has been realized that the students pursuing B. Tech. programmes offered by the University/affiliated Institutes/Colleges are facing challenges as under:

1. Students selected in industry during their programme are asked to join the industry for internship/training of duration up to one semester.
2. The provision is not there in these programmes to allow the students to join the internship by way of getting the required attendance of semester from internship/training.
3. So, students are not able to join such internship/training consequential to two-fold loss:
   (a) Job opportunity.
   (b) Skill development in industry environment.

But, presently, in the B. Tech. Programmes run by the University, there is no provision for the students to join the industry for such internship/training of/for more than 6–8-week duration. To facilitate the students for joining longer duration internships/trainings, a need for framing a policy document was felt.

Keeping in view the above challenges/statutory position and to avoid hardship to students and to improve the employability of the students, Ch. Devi Lal University, Sirsa has framed a policy to accord exemptions in attendance to students undertaking various internships/trainings during their final/penultimate semester of the B. Tech. Programmes.

## 2. Applicability of the policy with following Provisions:

The policy is applicable to the students studying in the final semester/ penultimate semester of B. Tech. programmes.

### 2.1 Provisions:

Student covered as per section title 'Applicability of the Policy' will be governed by the following provisions:

1. The student will be allowed to join the organization for internship/training in the final semester/ penultimate semester of the course for a period of up to one semester only if he/she must be passed/ cleared in all courses/subjects in all the semester examination whose results have been declared.
2. The student will earn his attendance from the organization during the period of internship.
3. Attendance will be certified by the organization, failing which student will be debarred from appearing in the University examinations of that semester.
4. The student will have to give an undertaking that he/she will appear in all the internal/external examination/practical as per requirements of the Programme and as per Schedule of the University examination for that programme. For this he/she will have to do the necessary preparation by himself/herself and Institute/department will not be responsible for the same.

5. If the student is selected in a company/industry/organization etc., and is asked to join the organization in the final semester/ penultimate semester for a period of upto one semester; then formally constituted Internship Facilitation Committee (IFC) will examine and give its recommendation as deemed fit.

## 2.2 Composition of Internship Facilitation Committee (IFC):

The composition of IFC will be as under:

1. Dean, Faculty of Engg. & Tech./Director/ Principal (or Nominee) (Chairperson)
2. Chairperson/Head/ In-charge of the concerned Department/Branch (Member)
3. In-Charge Academic Branch/Academic In-charge of Institute (Member)
4. Senior most faculty of the department other than Chairperson/ Director/Head of the Department/Branch (Member)
5. Training and Placement officer/ In-Charge TPO of the Institute /College/Department (Member Secretary)

Any offer by the organisations providing internship on demanding charges from a student will be discouraged by the Internship Facilitation Committee (IFC). Member Secretary of the IFC will schedule the meeting and maintain all the records.

## 3. Conclusion:

The students can only be allowed to join the internship/training in company/ industry/ organization etc. with exemptions in attendance on the final recommendation of Internship Facilitation Committee (IFC) of the Institute / Department and permission given by the Department/Institute/College authority.

# Detailed Syllabus
# of
# B. Tech. (EE)
# VII Semester

# POWER SYSTEM OPERATION AND CONTROL

**General Course Information:**

| | |
|---|---|
| Course Code: **PC/EE/18-T**<br>Course Credits: 4.0<br>Mode: Lecture (L) & Tutorial (T)<br>Type: Program Core<br>Teaching Schedule L T P: 3 1 0<br>Examination Duration: 3 hours | **Course Assessment Methods; Max. Marks: 100 (Internal: 30; External: 70)**<br>Three minor tests, each of 20 marks, will be conducted. The third minor will be conducted in open book mode by the Course Coordinator. No date sheet will be issued for the third minor at the level of the Departments. For the purpose of internal assessment, the average of the highest marks obtained by a student in any two minor examinations will be considered. All the minor examination question papers will be prepared and evaluated by following the Outcome Based Education framework. Class Performance will be measured through percentage of lectures attended (4 marks) Assignments (4 marks) and class performance (2 marks).<br><br>The end semester examination will be of 70 marks. For the end semester examination, nine questions are to be set by the examiner. Question number one will be compulsory and based on the entire syllabus. It will contain seven short answers type questions. Rest of the eight questions is to be given by setting two questions from each of the four units of the syllabus. A candidate is required to attempt any other four questions selecting one from each of the four units. All questions carry equal marks. |

**Course outcomes:**

| Sr. No. | Course outcomes<br>At the end of the course students will be able to: | RBT* Level |
|---|---|---|
| CO1. | Explain the operation and control of all the major components of power systems | **L1(Remembering)** |
| CO2. | Understand the unit commitment problems and methods to solve the problems | **L2(Understanding)** |
| CO3. | Deploy frequency control, voltage control, active and reactive power control schemes on power system | **L3(Apply)** |
| CO4. | Compare various reactive power compensation schemes | **L4(Analysis)** |
| CO5. | Assess the best possible control for power system operation | **L5(Evaluating)** |
| CO6. | Develop generation dispatching, power system monitoring and control schemes for optimal operation and control | **L6(Creating)** |

***Revised Bloom's Taxonomy Action verbs/Levels**

## Course Content

### UNIT- I

**AUTOMATIC GENERATION CONTROL:** Introduction to AVR and ALFC loops, Modeling of turbine speed governing system, Generator Load model, load frequency control of an isolated area, its steady state performance and dynamic performance for first order approximate system, Load frequency Vs economic control, dead band, digital load flow control, decentralized control.

### UNIT-II

**EXCITATION & VOLTAGE CONTROL**: Role of Exciter and its control, Classification of Excitation System, Rotating self-excited and pilot excited type Voltage regulators, static excitation system, brushless excitation system, boost buck excitation system and development of block diagram and transfer function for it, Role of PID Controller in Excitation system, Voltage control

through shunt compensation; Series compensation; Tap changing transformer; Booster transformer; induction regulators,

## UNIT-III

**Power Systems Stability**: Definitions: angular stability- steady state stability, dynamic stability, transient stability, Dynamics of synchronous machine and swing equation, equal area criteria for various types of disturbances, critical clearing angle, solution of swing equation, technique of improving transient stability, Voltage stability, voltage stability concept for pure inductive load, Voltage collapse, voltage collapse proximate indicator.

## UNIT-IV

**ECONOMIC LOAD DISPATCH**: Generators operation cost, Economic dispatch problem, Economic Dispatch including transmission loss, derivation of transmission loss formula, Classification of hydro plants, Long range and short range problem, Short range fixed head hydrothermal scheduling.

**REFERENCES:**


1. A. J. Wood, B. F. Wollenberg, "Power Generation Operation and Control", Wiley India, 2nd edition, 2009.
2. Nagrath Kothari, "Modern Power System", TMH Publication New Delhi.
3. S K Gupta, "Power Systems Operation Control and Restructuring", Ik International Publishing House.
4. Abhijit Chakrabarti & Sunita Halder, "Power System Analysis- Operation & Control", PHI NewDelhi, 3rd edition, 2010.
5. K Uma Rao, "Power System Operation & Control", Wiley India, 1st edition, 2013.
6. Robert H.Miller, James H.Malinowski, "Power System Operation", Tata McGraw-Hill, 2nd edition, 2009.
7. H. Saadat, "Power System Analysis", PSA Pub., 3rd edition, 2011.
8. A Chakrabarti, D. P. Kothari, A. K. Mukhopadhyay, Abhinandan De, "An introduction to Reactive Power Control and Voltage Stability in Power Transmission Systems", PHI, 2010

**Course Articulation Matrix:**

| Course/Course Code: Power System operation and Control (**PC/EE/18-T**), Semester: VII | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
| CO1 | 2 | - | - | - | - | - | - | - | - | - | - | 1 | 2 | - | 1 |
| CO2 | 3 | 2 | - | - | - | - | - | - | - | - | - | 1 | 2 | 2 | - |
| CO3 | 3 | - | 3 | 2 | - | - | - | - | - | - | - | 1 | 3 | - | - |
| CO4 | 3 | 1 | - | 1 | - | - | - | - | - | - | - | 1 | 3 | 2 | - |
| CO5 | 3 | 3 | 3 | 2 | - | - | - | - | - | - | - | 1 | 3 | 2 | - |
| CO6 | 3 | - | 1 | 1 | - | - | - | - | - | - | - | 1 | 2 | - | 2 |

**Correlation level:** **1**- Slight /Low **2**-Moderate/ Medium **3**- Substantial/High

# POWER DISTRIBUTION SYSTEM

**General Course Information:**

| | |
|---|---|
| Course Code: **PC/EE/19-T**<br>Course Credits: 3.0<br>Mode: Lecture (L)<br>Type: Program Core<br>Teaching Schedule L T P: 3 0 0<br>Examination Duration: 3 hours | **Course Assessment Methods; Max. Marks: 100 (Internal: 30; External: 70)**<br>Three minor tests, each of 20 marks, will be conducted. The third minor will be conducted in open book mode by the Course Coordinator. No date sheet will be issued for the third minor at the level of the Departments. For the purpose of internal assessment, the average of the highest marks obtained by a student in any two minor examinations will be considered. All the minor examination question papers will be prepared and evaluated by following the Outcome Based Education framework. Class Performance will be measured through percentage of lectures attended (4 marks) Assignments (4 marks) and class performance (2 marks).<br><br>The end semester examination will be of 70 marks. For the end semester examination, nine questions are to be set by the examiner. Question number one will be compulsory and based on the entire syllabus. It will contain seven short answers type questions. Rest of the eight questions is to be given by setting two questions from each of the four units of the syllabus. A candidate is required to attempt any other four questions selecting one from each of the four units. All questions carry equal marks. |

**Course outcomes:**

| Sr. No. | Course outcomes<br>At the end of the course students will be able to: | RBT* Level |
|---|---|---|
| CO1. | Understand Power Distribution System, an important aspect of overall Electricity Supply System | **L1(Remembering)** |
| CO2. | Understand the various components of power distribution systems. | **L2(Understanding)** |
| CO3. | Analyze the T&D losses in the power distribution system | **L3(Apply)** |
| CO4. | Understand the issues in the existing power distribution system. | **L4(Analysis)** |
| CO5. | Evaluating AT&C losses in the distribution system. | **L5( Evaluating)** |

***Revised Bloom's Taxonomy Action verbs/Levels**

## Course Content

### UNIT- I

**Introduction**: Introduction to sub-transmission and distribution system; classification of loads – residential, commercial, agricultural, industrial and their characteristics; distribution system planning – short-term, mid-term, long-term, Load scheduling & dispatch, Load balancing, load modeling and characteristics; definition of demand factor, utilization factor, load factor, plant factor, diversity factor, loss factor; computer applications to distribution system automation; tariff

### UNIT-II

**Electrical System Components:** Basic Distribution System, Components of the distribution system, Distribution feeders, transformers and sub-stations; primary feeders – voltage level, radial and loop types, Operation & Maintenance (O&M) objectives, Activities involved in O&M,

Distribution transformers - Reasons for DT failures, design considerations for secondary system – voltage level, location of substation, rating, service area with primary feeders, existing system improvement.

## UNIT-III

**Power Distribution System Analysis:** System analysis – voltage drop and power loss calculation; methods of solution for radial networks, three-phase balanced primary lines, loss reduction, voltage regulation, voltage control and improvement, issues in quality of service – voltage sag, swell and flicker, power factor correction, economic justification for capacitor with cost-benefit analysis aiming at most economic power factor, optimum location of capacitor, Distribution sub-station bus schemes.

## UNIT-IV

**T&D losses in Power Distribution system:** Energy Accounting in power distribution system: Need, objectives & functions, Energy flow diagram in power distribution system, Concepts of T&D, AT&C losses in distribution system, factors contributing to high technical & commercial losses. Measures for Technical and commercial loss reduction, long term plans for technical loss reduction, case studies.

**Text / References:**


1. Turan Gonen, "Electric Power Distribution System Engineering", McGraw Hill Dale
2. R. Patrick," Electrical Distribution System", 2nd Edition, CRC Press.
3. James A. Momoh, "Electric Power Distribution Automation, Protection and Control", CRC Press.
4. A. S. Pabla, "Electric Power Distribution", Tata McGraw Hill

**Course Articulation Matrix:**

| Course/Course Code: Power Distribution Systems (**PC/EE/19-T**), Semester: VII | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
| CO1 | 2 | - | - | - | - | - | - | - | - | - | - | 1 | 2 | - | 1 |
| CO2 | 3 | 2 | - | - | - | - | - | - | - | - | - | 1 | 2 | 2 | - |
| CO3 | 3 | - | 3 | 2 | - | - | - | - | - | - | - | 1 | 3 | - | - |
| CO4 | 3 | 1 | - | 1 | - | - | - | - | - | - | - | 1 | 3 | 2 | - |
| CO5 | 3 | 3 | 3 | 2 | - | - | - | - | - | - | - | 1 | 3 | 2 | - |
| CO6 | 3 | - | 1 | 1 | - | - | - | - | - | - | - | 1 | 2 | - | 2 |

**Correlation level:** **1**- Slight /Low **2**-Moderate/ Medium **3**- Substantial/High

# RENEWABLE ENERGY LABORATORY

**General Course Information:**

| | |
|---|---|
| Course Code: **PC/EE/20-P**<br>Course Credits: 1.0<br>Mode: Practical (P)<br>Type: Program Core<br>Teaching Schedule L T P: 0 0 2 | **Course Assessment Methods (Internal: 50; External: 50)** Internal continuous assessment of 50 marks by course coordinator as per the course assessment method (Annexure I).<br><br>For the end semester practical examination, the assessment will be done out of 50 marks by the external and internal examiners as per the course assessment method (**Annexure I**). |

**Course outcomes:**

| Sr. No. | Course outcomes<br>At the end of the course students will be able to: | RBT* Level |
|---|---|---|
| CO1. | **Experimental** work and acquire technical knowledge to solve out the problems of renewable energy systems and control. | **HOTS L4 (Analyzing)** |
| CO2. | **Interpret** the performance characteristics of the linear and non-linear loads on the operation of renewable energy systems. | **LOTS L3 (Applying)** |
| CO3. | **Calculate** the suitability of renewable energy system devices and implementation of its control devices. | **HOTS L5 (Evaluating)** |
| CO4. | **Appraise** the implementation of these methods in the Simulation environment as well as in the industries. | **HOTS L5 (Evaluating)** |
| CO5. | **Organize** reports based on experiments performed with effective demonstration and analysis of results. | **HOTS L4 (Analyzing)** |
| CO6. | **Inculcate** ethical practices while performing experiments individually and in groups. | **LOTS L3 (Applying)** |

***Revised Bloom's Taxonomy Action verbs/Level**

**LIST OF EXPERIMENTS:**

1. Observation of current waveform for linear & non-linear loads & calculations
2. Impact of transmission line inductance on voltage quality at PCC.
3. Power factor correction using capacitor bank and its impact on power quality at PCC
4. Synchronization of solar PV inverter and it's 4 performance analysis.
5. Evaluation of active and reactive power & apparent energy flow between grid tied inverter, grid & load & net metering concept.

   **SIMULATION EXPERIMENTS**
6. Modelling of PV cell
7. Effect Of Temperature Variation On Photovoltaic Array.
8. Effect of irradiation on a photovoltaic array.
9. Design of solar PV boost converter using P&O MPPT technique.

**NOTE:** At least eight experiments are to be performed in the semester, out of which at-least six experiments should be performed from the above list. Remaining experiments may either be performed from the above list or designed & set by the concerned course coordinator as per the scope of the syllabus.

**CO-PO Articulation Matrix**

| Course/Course Code: Renewable Energy Laboratory (**PC/EE/20-P**),Semester- VII | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **List of Course Outcomes** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** | **PO11** | **PO12** | **PSO1** | **PSO2** | **PSO3** |
| CO1. **Experimental** work and acquire technical knowledge to solve out the problems of renewable energy systems and control. **(HOTS L4: Analyzing)** | 3 | 2 | - | 3 | - | - | - | - | 3 | - | - | 2 | 2 | 2 | - |
| CO2. **Interpret**the performance characteristics of the linear and non-linear loads on the operation of renewable energy systems. **(LOTS L3:Applying)** | 3 | 2 | 2 | 2 | - | - | - | - | - | - | - | 2 | 2 | - | - |
| CO3. **Calculate**the suitability of renewable energy system devices and implementation of its control devices. **(HOTS L5: Evaluating)** | 3 | 2 | 1 | - | - | 2 | - | - | - | - | - | 1 | 2 | 1 | - |
| CO4. **Appraise** the implementation of these methods in the Simulation environment as well as in the industries. **(HOTS L5: Evaluating)** | 2 | 3 | 2 | 2 | - | - | - | - | - | - | - | 2 | 3 | 2 | - |
| CO5. **Organize**reports based on experiments performed with effective demonstration and analysis of results. **(HOTS L4: Analyzing)** | 2 | 1 | 1 | - | - | - | - | - | - | 3 | - | - | - | - | 2 |
| CO6. **Inculcate**ethical practices while performing experiments individually and in groups. **(LOTS L3:Applying)** | - | - | - | - | - | - | - | 3 | 3 | - | - | - | - | - | 2 |
| Level of Attainments: | | | | | | | | | | | | | | | |

**Correlation level:** **1**- slight /Low **2-** Moderate/ Medium **3**- Substantial/High

# Industrial Training/ Internship-II

| | |
|---|---|
| Course Code: **EEC/EE/2-P**<br>Course Credits : 2<br>Type: Program Core<br>Mode: Practical<br>Contact Hours: 4/week | **Course Assessment Method: (Internal:100)**<br>Assessment of Industrial Training/ Internship-II will be based on presentation/seminar, viva-voce, report and certificate for the practical training taken at the end of 6th semester.<br><br>The Viva-Voce/ presentation will be conducted by the respective department as its own level. |

**Course Outcomes:**

| Sr. No. | Course Outcomes<br>At the end of the semester, students will be able to: | RBT Level |
|---|---|---|
| **CO 1** | Outline technical documents and give oral presentations related to the work completed. | L1 |
| **CO 2** | Prepared to engage in independent and lifelong learning in the industry. | L2 |
| **CO 3** | Acquire and apply fundamental principles of engineering for working in an actual working environment. | L3 |
| **CO 4** | Analyze practical application of the subjects taught during the program. | L4 |
| **CO 5** | Develop, social, cultural, global and environmental responsibilities as an engineer. | L5 |
| **CO6** | Design and implement solution methodologies with technical &managerial skills for solving engineering problems. | L6 |

**Course Articulation Matrix:**

| Course/Course Code: Practical Training-II (**EEC/EE/2-P**), Semester: VII | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** | **PO11** | **PO12** | **PSO1** | **PSO2** | **PSO3** |
| **CO1** | 3 | 3 | 2 | 2 | 2 | 3 | 1 | 2 | 2 | 2 | 3 | 3 | 3 | 2 | 2 |
| **CO2** | 3 | 3 | 2 | 2 | 2 | 3 | 2 | - | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| **CO3** | 3 | 3 | 2 | 2 | 3 | 3 | 2 | - | 2 | 2 | 3 | 3 | 3 | 2 | 2 |
| **CO4** | 3 | 3 | 3 | 3 | 3 | 3 | 1 | 2 | 3 | 2 | 3 | 3 | 3 | 3 | 3 |
| **CO5** | 3 | 3 | 3 | 3 | 3 | 3 | 1 | 2 | 2 | 2 | 3 | 3 | 3 | 2 | 3 |
| **CO6** | 3 | 3 | 3 | 3 | 2 | 3 | 2 | 2 | 2 | 3 | 3 | 3 | 3 | 2 | 2 |

**Correlation level:** **1**- Slight /Low **2**-Moderate/ Medium**3**- Substantial/High

# MINOR PROJECT

| | |
|---|---|
| Course Code: **EEC/EE/3-P**<br>Course Credits :2<br>Mode: Practical<br>Contact Hours: 8/week | **Course Assessment Method: (Internal: 50; External: 50):**<br>• The Minor Project should be initiated by the student at the beginning of VII semester and will be evaluated at the end of the semester on the basis of its implementation, presentation, viva-voce and report.<br>• The Viva-Voce for Minor Project will be conducted by the External Examiner and Internal Examiner at the end of the semester. |

**Course Outcomes:**

| Sr. No. | Course Outcomes<br>At the end of the semester, students will be able: | RBT Level |
|---|---|---|
| **CO 1** | Relate practical knowledge within the chosen area of technology for project development | L1 |
| **CO 2** | Understand methodologies and professional way of documentation and communication. | L2 |
| **CO 3** | Illustrate the key stages in development of the project. | L3 |
| **CO 4** | Identify, analyze, formulate and handle projects with a comprehensive and systematic approach | L4 |
| **CO 5** | Contribute as an individual or in a team in development of technical projects | L5 |
| **CO6** | Develop effective communication skills for presentation of project related activities | L6 |

**NOTE:** The minor project will be completed and evaluated at the end of the VII semester on the basis of its implementation, presentation, viva-voce and report.

**Course Articulation Matrix:**

| Course/Course Code: Minor Project (**EEC/EE/3-P**) Semester: VII | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** | **PO11** | **PO12** | **PSO1** | **PSO2** | **PSO3** |
| **CO1** | 3 | 3 | 2 | 2 | 2 | 3 | 1 | 2 | 2 | 2 | 3 | 3 | 3 | 2 | 2 |
| **CO2** | 3 | 3 | 2 | 2 | 2 | 3 | 2 | - | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| **CO3** | 3 | 3 | 2 | 2 | 3 | 3 | 2 | - | 2 | 2 | 3 | 3 | 3 | 2 | 2 |
| **CO4** | 3 | 3 | 3 | 3 | 3 | 3 | 1 | 2 | 3 | 2 | 3 | 3 | 3 | 3 | 3 |
| **CO5** | 3 | 3 | 3 | 3 | 3 | 3 | 1 | 2 | 2 | 2 | 3 | 3 | 3 | 2 | 3 |
| **CO6** | 3 | 3 | 3 | 3 | 2 | 3 | 2 | 2 | 2 | 3 | 3 | 3 | 3 | 2 | 2 |

**Correlation level:** **1**- Slight /Low **2**-Moderate/ Medium**3**- Substantial/High

# Detailed Syllabus
# of
# B. Tech. (EE)
# VIII Semester

# COMPUTER METHODS IN POWER SYSTEMS

**General Course Information:**

| | |
|---|---|
| Course Code: **PC/EE/21-T**<br>Course Credits: 4.0<br>Mode: Lecture (L) and Tutorial (T)<br>Type: Program Core<br>Teaching Schedule L T P: 3 1 0<br>Examination Duration: 3 hours | **Course Assessment Methods; Max. Marks: 100 (Internal: 30; External: 70)**<br>Three minor tests, each of 20 marks, will be conducted. The third minor will be conducted in open book mode by the Course Coordinator. No date sheet will be issued for the third minor at the level of the Departments. For the purpose of internal assessment, the average of the highest marks obtained by a student in any two minor examinations will be considered. All the minor examination question papers will be prepared and evaluated by following the Outcome Based Education framework. Class Performance will be measured through percentage of lectures attended (4 marks) Assignments (4 marks) and class performance (2 marks).<br><br>The end semester examination will be of 70 marks. For the end semester examination, nine questions are to be set by the examiner. Question number one will be compulsory and based on the entire syllabus. It will contain seven short answers type questions. Rest of the eight questions is to be given by setting two questions from each of the four units of the syllabus. A candidate is required to attempt any other four questions selecting one from each of the four units. All questions carry equal marks. |

**Course outcomes:**

| Sr. No. | Course outcomes<br>At the end of the course students will be able to: | RBT* Level |
|---|---|---|
| CO1. | Memorize the formulation of various network matrices and model the powe system components | **L1(Remembering)** |
| CO2. | Understand the importance of computer applications in electrical power system operation | **L2(Understanding)** |
| CO3. | Investigate the state of power system of any size by applying various computer methods under steady state and fault condition | **L3(Applying)** |
| CO4. | Perform load flow, short circuit and stability applicable in various power system problems | **L4(Analyzing)** |
| CO5. | Compare and identify the most appropriate algorithm for load flow, short circuit and stability studies | **L5(Evaluating)** |
| CO6. | Develop appropriate mathematical models of power systems for performanc analysis, planning and control | **L6(Creating)** |

***Revised Bloom's Taxonomy Action verbs/Levels**

## Course Content

## UNIT- I

**Network Topology and Matrices:** Elementary Graph theory, Incidence matrices, Primitive network and primitive network matrices, Formation of various network matrices by singular transformations, Building algorithm for Bus Impedance matrix ($Z_{bus}$), Modification of bus

impedance matrix for change of reference bus and network changes, formation of bus admittance matrix.

## UNIT- II

**Load-Flow Studies:** Introduction, Importance of load flow studies, Classification of buses, load-flow equations, Iterative methods, Computer algorithms and load flow solutions using Gauss- Seidel and Newton-Raphson methods, Decoupled and fast decoupled Load-flow solutions, Representation of regulating and off-nominal ratio transformers, Comparison of load-flow solution methods.

## UNIT- III

**Fault studies:**Symmetrical faults, Calculation of fault currents, Use of current limiting reactors, Unsymmetrical faults, Symmetrical components theory, Transformation matrix, Unsymmetricalshort circuit analysis: LG, LL, LLG using matrix method,

## UNIT- IV

**Stability Studies:**Steady state and transient stability, swing equation, Steady state stability analysis, Transient stabilityanalysis, Equal area criterion, Algorithms and flow charts for transient stability solution using Runge-Kutta and modified Euler methods, multi-machine stability analysis

**REFERENCES:**


1. G. W. Stagg and A. EI-Abiad, “Computer Methods in Power System Analysis”, McGraw-Hill, 1986.
2. L.P Singh, “Advanced Power System Analysis and Dynamics”, New Age International.
3. B. R. Gupta, “Power System Analysis and Design”, S. Chand, VII edition, 2014.
4. G. L. Kusic, “Computer-Aided Power Systems Analysis”, PHI
5. J. J. Grainger and W. D. Stevenson, “Power System Analysis”, McGraw-Hill, 2003.
6. D. P. Kothari, I. .J Nagrath, “Modern Power System Analysis”, 3rd Edition, 2011.
7. H. Saadat, ‘Power System Analysis ’, Tata McGraw - Hill Education, 2nd Edition, 2002.
8. M.A. Pai,“Computer Techniques in Power System Analysis”, Tata McGraw-Hill, Education2005.
9. K.U. Rao,“Computer Methods and Models in Power Systems”, I.K. International, 2009.

**Course Articulation Matrix:**

| Course/Course Code: Computer Methods in Power Systems (**PC/EE/21-T**), Semester: VIII | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
| CO1 | 3 | 2 | 3 | - | 1 | - | - | - | - | - | - | - | 3 | 2 | 1 |
| CO2 | 3 | 2 | 2 | - | 3 | - | - | - | - | - | - | - | 3 | 3 | 1 |
| CO3 | 3 | 2 | 2 | 2 | 1 | - | - | - | - | - | - | - | 3 | 2 | 1 |
| CO4 | 3 | 3 | 1 | - | 2 | - | - | - | - | - | - | - | 3 | 3 | 1 |
| CO5 | 3 | 3 | - | - | 2 | - | - | - | - | - | - | - | 3 | 3 | 2 |
| CO6 | 2 | 3 | 3 | 1 | 2 | - | - | - | - | - | - | - | 3 | 3 | 2 |

**Correlation level:** **1**- Slight /Low **2**-Moderate/ Medium**3**- Substantial/High

# COMPUTER METHODS IN POWER SYSTEMS LABORATORY

**General Course Information:**

| | |
|---|---|
| Course Code: **PC/EE/21-P**<br>Course Credits: 1<br>Mode: Practical<br>Type: Program Core<br>Contact Hours: 2 hours per week.<br>. | **Course Assessment Methods (Internal: 50; External: 50)**<br>Internal continuous assessment of 50 marks based on class performance and attendance in practical classes (Annexure I).<br><br>For the end semester practical examination, the assessment will be done out of 50 marks by the external and internal examiners (Annexure I). |

**Course Outcomes:**

| Sr. No | Course outcomes<br>At the end of the course students will be able to: | RBT* Level |
|---|---|---|
| CO1. | **Implement** MATLAB based software tools for electrical power system analysis. | **LOTSL3 (Apply)** |
| CO2. | **Identify** the state of power system of any size under steady state and fault conditions. | **HOTS L4 (Analyzing)** |
| CO3. | **Appraise** the most appropriate algorithm for load flow, short circuit and stability studies. | **HOTS L5 (Evaluating)** |
| CO4. | **Develop** Programs for analysis of real time power systems with acquired skill of implementing various computer methods. | **HOTS L6 (Creating)** |
| CO5. | **Organize** reports based on experiments performed with effective demonstration and analysis of results. | **HOTS L4 (Analyzing)** |
| CO6. | **Inculcate** ethical practices while performing experiments individually and in groups. | **LOTS L3 (Applying)** |

***Revised Bloom's Taxonomy Action verbs/Level**

**LIST OF EXPERIMENTS:**

The following experiments may be performed with the help of MATLAB based power system analysis tools PSAT, PST, PSCAD, ETAP etc.

1. Formation of $Y_{bus}$ matrix by using inspection / analytical method.
2. Formation of $Z_{bus}$ using building algorithm.
3. Load flow analysis using Gauss Seidel method.
4. Load flow analysis using Newton Raphson method.
5. Load flow analysis using Fast Decoupled method
6. Simulation of single line to ground fault.
7. Simulation of single line to Line fault.
8. Simulation of double line to ground fault.
9. Simulation of Three Phase Short Circuit fault.
10. Transient stability simulation for single machine and multi-machine system.

**NOTE:** At least eight experiments are to be performed in the semester, out of which at-least six experiments should be performed from above list. Remaining experiments may either be performed from the above list or designed & set as per the scope of the syllabus.

**CO-PO Articulation Matrix**

| Course/Course Code: Computer Methods in Power Systems Laboratory (**PC/EE/21-P**), Semester: VIII | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **List of Course Outcomes** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** | **PO11** | **PO12** | **PSO1** | **PSO2** | **PSO3** |
| CO1. **Implement** MATLAB based software tools for electrical power system analysis. **(LOTS L3: Applying)** | 3 | - | - | - | 2 | - | - | - | - | - | - | 2 | 1 | 2 | - |
| CO2. **Identify** the state of power system of any size under steady state and fault conditions. **(HOTS L4: Analyzing)** | 3 | - | - | 2 | - | - | - | - | - | - | - | 1 | 3 | - | - |
| CO3. **Appraise** the most appropriate algorithm for load flow, short circuit and stability studies. **(HOTS L5: Evaluating)** | 3 | - | 2 | - | 1 | - | - | - | - | - | - | 1 | 3 | 1 | - |
| CO4. **Develop** Programs for analysis of real time power systems with acquired skill of implementing various computer methods. **(HOTS L6: Creating)** | 3 | - | - | 2 | 3 | - | - | - | - | - | - | 1 | 3 | 2 | - |
| CO5. **Organize** reports for experiments performed with effective demonstration and analysis of results. **(HOTS L4: Analyzing)** | - | - | - | - | - | - | - | - | - | 3 | - | - | - | - | - |
| CO6. **Inculcate** ethical practices while performing experiments individually and in groups. **(LOTS L3: Applying)** | - | - | - | - | - | - | - | 3 | 3 | - | - | - | - | - | 1 |
| Level of Attainments: | | | | | | | | | | | | | | | |

**Correlation level:** 1- slight /Low 2- Moderate/ Medium 3- Substantial/High

# MAJOR PROJECT

| | |
|---|---|
| Course Code: **EEC/EE/4-P**<br>Course Credits : 4<br>Mode: Practical<br>Contact Hours: 12/week | **Course Assessment Method: (Internal: 50; External: 50)**<br><br>The Major Project should be initiated by the student in continuation of the VII semester and will be evaluated at the end of the semester on the basis of its implementation, presentation, delivered, viva-voce and report.<br><br>The Viva-Voce for Major Project by the External Examiner and Internal Examiner at the end of the semester. |

**Course Outcomes:**

| Sr. No. | Course Outcomes<br>At the end of the semester, students will be able: | RBT Level |
|---|---|---|
| **CO 1** | Extend or use the idea in minor project for major project. | L1 |
| **CO 2** | Describe a through and systematic understanding of project contents | L2 |
| **CO 3** | Use effectively oral, written and visual communication | L3 |
| **CO 4** | Identify, analyze, and solve problems creatively through sustained critical investigation. | L4 |
| **CO 5** | Demonstrate an awareness and application of appropriate personal, societal, and professional ethical standards. | L5 |
| **CO6** | Know the key stages in development of the project. | L6 |

**NOTE:** The Major Project will be completed and evaluated at the end of the VIII semester on the basis of its implementation, presentation, viva-voce and report.

**Course Articulation Matrix:**

| Course/Course Code: Major Project (**EEC/EE/4-P**), Semester: VIII | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** | **PO11** | **PO12** | **PSO1** | **PSO2** | **PSO3** |
| **CO1** | 3 | 3 | 2 | 2 | 2 | 3 | 1 | 2 | 2 | 2 | 3 | 3 | 3 | 2 | 2 |
| **CO2** | 3 | 3 | 2 | 2 | 3 | 3 | 2 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| **CO3** | 3 | 3 | 2 | 2 | 3 | 3 | 2 | - | 2 | 2 | 3 | 3 | 3 | 2 | 2 |
| **CO4** | 3 | 3 | 3 | 3 | 2 | 3 | 1 | 2 | 3 | 2 | 3 | 3 | 3 | 3 | 3 |
| **CO5** | 3 | 3 | 3 | 3 | 3 | 3 | 1 | 2 | 3 | 2 | 3 | 3 | 3 | 2 | 3 |
| **CO6** | 3 | 3 | 3 | 3 | 2 | 3 | 2 | 2 | 3 | 3 | 3 | 3 | 3 | 2 | 2 |

**Correlation level:** **1**- Slight /Low **2-**Moderate/ Medium**3-** Substantial/High

# Detailed Syllabus

# of

# B. Tech. (EE)

# VII Semester

## Program Elective Course-II

# ELECTRICAL MACHINE DESIGN

**General Course Information:**

| | |
|---|---|
| Course Code: **PE/EE/5-T**<br>Course Credits: 3.0<br>Mode: Lecture (L) and Tutorial (T)<br>Type: Program Elective<br>Teaching Schedule L T P: 3 0 0<br>Examination Duration: 3 hours | **Course Assessment Methods; Max. Marks: 100 (Internal: 30; External: 70)**<br>Three minor tests, each of 20 marks, will be conducted. The third minor will be conducted in open book mode by the Course Coordinator. No date sheet will be issued for the third minor at the level of the Departments. For the purpose of internal assessment, the average of the highest marks obtained by a student in any two minor examinations will be considered. All the minor examination question papers will be prepared and evaluated by following the Outcome Based Education framework. Class Performance will be measured through percentage of lectures attended (4 marks) Assignments (4 marks) and class performance (2 marks).<br><br>The end semester examination will be of 70 marks. For the end semester examination, nine questions are to be set by the examiner. Question number one will be compulsory and based on the entire syllabus. It will contain seven short answers type questions. Rest of the eight questions is to be given by setting two questions from each of the four units of the syllabus. A candidate is required to attempt any other four questions selecting one from each of the four units. All questions carry equal marks. |

**Course Outcomes**

| Sr. No. | **Course outcomes**<br>At the end of the course students will be able to: | **RBT* Level** |
|---|---|---|
| CO1. | Recall the basics of electric machines | **L1(Remembering)** |
| CO2. | Understand the performance of different types of electric machines. | **L2(Understanding)** |
| CO3. | Solve the problems related with electric machines. | **L3(Apply)** |
| CO4. | Compare the performance characteristics of electric machines. | **H1(Analysis)** |
| CO5. | Judge and use the machines on the basis of their utilization and performance. | **H2 (Evaluating)** |

***Revised Bloom's Taxonomy Action verbs/Level**

## Course Content

### UNIT-I

**INTRODUCTION TO DC MACHINES:** Major considerations in Electrical Machine Design, Electrical Engineering Materials, Space factor, Choice of Specific Electrical and Magnetic loading, Thermal considerations, Heat flow, Temperature rise, Rating of machines, Standard specifications.

DC machines, Output Equations, Design of main dimensions, Magnetic circuit calculations, Carter's Coefficient, Net length of Iron, Real and Apparent flux densities, Selection of number of poles, Design of Armature, Design of commutator and brushes.

### UNIT-II

**TRANSFORMERS:** Output Equations, 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 Tank, Methods of cooling of Transformers

## UNIT-III

**INDUCTION MOTOR:** Output equation of Induction motor, Design of main dimensions, Length of air gap, Rules for selecting rotor slots of squirrel-cage machines, Design of rotor bars and slots, Design of end rings.

**SYNCHRONOUS MACHINES:** Pole construction, run away speed, output equation, choice of specific loading, Short circuit ratio, shape of pole face, Armature design, Armature parameters, Estimation of air gap length, Design of field system.

## UNIT-IV

**COMPUTER AIDED DESIGN:** Introduction, manual versus Computer aided design, Approach to Computer aided design, Design synthesis, Special Requirements, Program for Different machines, Computer aided design in industry, Illustrative design, limitations in Computer aided designs.

**REFERENCES:**


1. A. K. Sawhney, "A Course in Electrical Machine Design", Dhanpat Rai & Sons, New Delhi, 2013
2. M.V. Deshpande, "Design and Testing of Electrical Machines", PHI learning Pvt Ltd, 2015.
3. G. Veinot Cyril, "Computer Aided Design of Electrical Machinery", MIT press London, UK.
4. H.M. Rai, "Electrical Machine Design", Sathiya Prakashan Publications, Third edition, 2004.
5. A.Shanmugasundaram, G.Gangadharan, R.Palani, "Electrical Machine Design Data Book", New Age Intenational Pvt. Ltd., Reprint 2007.


**Course Articulation Matrix:**

| Course/Course Code: Electrical Machine Design (**PE/EE/5-T**) Semester: VII | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
| CO1 | 3 | 2 | 1 | 2 | - | - | - | - | - | - | - | 2 | 1 | 1 | 1 |
| CO2 | 3 | 2 | 1 | 2 | 2 | 1 | - | - | - | - | - | 1 | 2 | 2 | 1 |
| CO3 | 3 | 3 | 2 | 1 | 1 | - | - | - | 1 | - | - | 1 | 3 | 3 | 1 |
| CO4 | 3 | 2 | 2 | 2 | 1 | - | - | - | 1 | - | 1 | 2 | 2 | 3 | 1 |
| CO5 | 3 | 2 | 2 | 1 | - | 1 | - | 2 | - | 2 | 3 | 2 | 2 | 2 | 2 |

**Correlation level:** **1**- Slight /Low **2-** Moderate/ Medium **3**- Substantial/High

# ADVANCE POWER ELECTRONICS

**General Course Information:**

| | |
|---|---|
| Course Code: **PE/EE/6-T**<br>Course Credits: 3.0<br>Mode: Lecture (L)<br>Type: Program Elective<br>Teaching Schedule L T P: 3 0 0<br>Examination Duration: 3 hours | **Course Assessment Methods; Max. Marks: 100 (Internal: 30; External: 70)**<br>Three minor tests, each of 20 marks, will be conducted. The third minor will be conducted in open book mode by the Course Coordinator. No date sheet will be issued for the third minor at the level of the Departments. For the purpose of internal assessment, the average of the highest marks obtained by a student in any two minor examinations will be considered. All the minor examination question papers will be prepared and evaluated by following the Outcome Based Education framework. Class Performance will be measured through percentage of lectures attended (4 marks) Assignments (4 marks) and class performance (2 marks).<br><br>The end semester examination will be of 70 marks. For the end semester examination, nine questions are to be set by the examiner. Question number one will be compulsory and based on the entire syllabus. It will contain seven short answers type questions. Rest of the eight questions is to be given by setting two questions from each of the four units of the syllabus. A candidate is required to attempt any other four questions selecting one from each of the four units. All questions carry equal marks. |

**Course outcomes:**

| Sr. No. | Course outcomes<br>At the end of the course students will be able to: | RBT* Level |
|---|---|---|
| CO1. | Reproduce technical and intellectual capability in Power Electronics & Power System and to develop interest for life-long learning. | **L1(Remembering)** |
| CO2. | Identify the drawbacks of speed control of motor by conventional methods. | **L2(Understanding)** |
| CO3. | Solve problems satisfactorily in the field of Power Electronics and Power System and arrive at appropriate solution. | **L3(Apply)** |
| CO4. | Compare, formulate and analyze a power electronic software based circuit design and its control drive performance. | **L4(Analysis)** |
| CO5. | Select the simulation software based on alternative solutions in an industries. | **L5( Evaluating)** |
| CO6. | Formulate and design mathematical modeling for various engineering problems | **L6(Creating)** |

***Revised Bloom's Taxonomy Action verbs/Levels**

## Course Content

### UNIT- I

Introduction to ordinary differential equation solvers, steps of using ODE solvers, Types of mathematical models, developing a model, Mathematical modeling of simple electrical, Mechanical and electro mechanical systems.

### UNIT-II

Simulation of power electronic converters: State-space representation, Trapezoidal integration, M and N method.

## UNIT-III

**Modeling:** Steady state analysis of converters, dynamic analysis of converters, state space average modeling, PWM modeling, modeling of converters operating in continuous and discontinuous conduction mode, converter transfer functions.

**Simulation of electric drives:** Modeling of different PWM Techniques, Modeling and simulation of Induction motor, Vector controlled 3-Ph Induction motor.

## UNIT-IV

**Control Techniques in Power Electronics:** State space modelling and simulation of linear systems, conventional controllers using small signal models, Fuzzy control, Hysteresis controllers, Output and state feedback switching controllers. Modeling, simulation of switching converters with state space averaging, State Space Averaging Technique and its application in simulation and design of power converters.

**REFERENCES:**


1. M. B. Patil, V. Ramnarayanan and V. T. Ranganathan, "Simulation of Power Electronic Converters"1st Edition, Narosa Publishers, 2010.
2. Ned Mohan, T.M. Undeland and William P.Robbins, "Power Electronics-Converters, Applications", 3rd Edition, John Wiley & Sons, 2009.
3. Chee-Mun Ong, "Dynamic Simulation of Electric Machinery", Using Matlab/Simulink.

**Course Articulation Matrix:**

| Course/Course Code: Advance Power Electronics **(PE/EE/6-T)**, | | | | | | | | | | | Semester: VII | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
| CO1 | 3 | 3 | 2 | 1 | 1 | 2 | 1 | - | - | - | 2 | 3 | 2 | 3 | 1 |
| CO2 | 2 | 2 | 2 | 1 | 2 | 2 | 1 | - | - | - | 3 | 3 | 2 | 2 | 1 |
| CO3 | 3 | 3 | 3 | 2 | 3 | 1 | 1 | - | - | - | 1 | 2 | 2 | 2 | - |
| CO4 | 2 | 3 | 2 | 1 | 2 | 2 | - | - | - | - | 2 | 2 | 2 | 3 | 1 |
| CO5 | 3 | 1 | 2 | 2 | 1 | 2 | 1 | - | - | - | 1 | 2 | 3 | 2 | - |
| CO6 | 3 | 3 | 1 | 2 | 2 | 2 | 1 | - | - | - | 3 | 2 | 2 | 3 | 1 |

**Correlation level:** **1**- Slight /Low **2-** Moderate/ Medium **3-** Substantial/High

# WIND AND SOLAR ENERGY SYSTEMS

## General Course Information:

| | |
|---|---|
| Course Code: **PE/EE/7-T**<br>Course Credits: 3.0<br>Mode: Lecture (L)<br>Type: Program Elective<br>Teaching Schedule L T P: 3 0 0<br>Examination Duration: 3 hours | **Course Assessment Methods; Max. Marks: 100 (Internal: 30; External: 70)**<br>Three minor tests, each of 20 marks, will be conducted. The third minor will be conducted in open book mode by the Course Coordinator. No date sheet will be issued for the third minor at the level of the Departments. For the purpose of internal assessment, the average of the highest marks obtained by a student in any two minor examinations will be considered. All the minor examination question papers will be prepared and evaluated by following the Outcome Based Education framework. Class Performance will be measured through percentage of lectures attended (4 marks) Assignments (4 marks) and class performance (2 marks).<br><br>The end semester examination will be of 70 marks. For the end semester examination, nine questions are to be set by the examiner. Question number one will be compulsory and based on the entire syllabus. It will contain seven short answers type questions. Rest of the eight questions is to be given by setting two questions from each of the four units of the syllabus. A candidate is required to attempt any other four questions selecting one from each of the four units. All questions carry equal marks. |

## Course outcomes:

| Sr. No. | Course outcomes<br>At the end of the course students will be able to: | RBT* Level |
|---|---|---|
| CO1. | Understanding the energy scenario and the consequent growth of the power generation from renewable energy sources | **L1 (Remembering)** |
| CO2. | Understanding the basic physics of wind and solar power generation. | **L2 (Understanding)** |
| CO3. | Applications of power electronic interfaces for wind and solar generation. | **L3 (Applying)** |
| CO4. | Evaluating the issues related to the grid-integration of solar and wind energy systems. | **L4(Analyzing)** |
| CO5. | To create and design the Network Integrating Systems of Wind and Solar Systems | **L6 (Creating)** |

***Revised Bloom's Taxonomy Action verbs/Levels**

## Course Content

### UNIT-I

Physics of Wind Power: History of wind power, Indian and Global statistics, Wind physics, Betz limit, Tip speed ratio, stall and pitch control, Wind speed statistics-probability distributions, Wind speed and power-cumulative distribution functions.

Solar thermal power generation: Technologies, Parabolic trough, central receivers, parabolic dish, Fresnel, solar pond, elementary analysis.

## UNIT-II

Wind generator topologies: Review of modern wind turbine technologies, Fixed and Variable speed wind turbines, Induction Generators, Doubly-Fed Induction Generators and their characteristics, Permanent Magnet Synchronous Generators, Power electronics converters. Generator-Converter 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, monocrystalline, polycrystalline; V-I characteristics of a PV cell, PV module, array, Power Electronic Converters for Solar Systems, Maximum Power Point Tracking (MPPT) algorithms. Converter Control.

## 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.

**Text / References:**


**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.

**3.** S. P. Sukhatme, “Solar Energy: Principles of Thermal Collection and Storage”, McGraw Hill, 1984.

**4.** H. Siegfried and R. Waddington, “Grid integration of wind energy conversion systems” John Wiley and Sons Ltd., 2006.

**5.** G. N. Tiwari and M. K. Ghosal, “Renewable Energy Applications”, Narosa Publications, 2004.

**Course Articulation Matrix:**

| Course/Course Code: Wind and Solar Energy Systems (**PE/EE/7-T**), Semester: VII | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
| CO1 | 3 | 2 | 2 | 1 | 1 | 2 | 1 | - | 1 | - | 2 | 2 | 1 | 2 | 1 |
| CO2 | 3 | 3 | 2 | 1 | 1 | 2 | 1 | - | 1 | - | 2 | 2 | 2 | 2 | 1 |
| CO3 | 2 | 3 | 2 | 2 | 2 | 1 | 1 | - | 1 | - | 3 | 2 | 2 | 3 | 1 |
| CO4 | 2 | 3 | 2 | 2 | 2 | 3 | 1 | - | 1 | - | 3 | 2 | 2 | 3 | 1 |
| CO5 | 2 | 3 | 2 | 3 | 2 | 1 | 1 | - | 1 | - | 2 | 2 | 2 | 3 | 1 |
| CO6 | 3 | 3 | 2 | 2 | 2 | 2 | 1 | - | 1 | - | 3 | 2 | 2 | 3 | 1 |

**Correlation level:** **1**- Slight /Low **2-**Moderate/ Medium **3-** Substantial/High

# UTILIZATIONOF ELECTRICAL ENERGY

**General Course Information:**

| | |
|---|---|
| Course Code: **PE/EE/8-T**<br>Course Credits: 3.0<br>Mode: Lecture (L)<br>Type: Program Elective<br>Teaching Schedule L T P: 3 0 0<br>Examination Duration: 3 hours | **Course Assessment Methods; Max. Marks: 100 (Internal: 30; External: 70)**<br>Three minor tests, each of 20 marks, will be conducted. The third minor will be conducted in open book mode by the Course Coordinator. No date sheet will be issued for the third minor at the level of the Departments. For the purpose of internal assessment, the average of the highest marks obtained by a student in any two minor examinations will be considered. All the minor examination question papers will be prepared and evaluated by following the Outcome Based Education framework. Class Performance will be measured through percentage of lectures attended (4 marks) Assignments (4 marks) and class performance (2 marks).<br><br>The end semester examination will be of 70 marks. For the end semester examination, nine questions are to be set by the examiner. Question number one will be compulsory and based on the entire syllabus. It will contain seven short answers type questions. Rest of the eight questions is to be given by setting two questions from each of the four units of the syllabus. A candidate is required to attempt any other four questions selecting one from each of the four units. All questions carry equal marks. |

**Course outcomes:**

| Sr. No. | Course outcomes<br>At the end of the course students will be able to: | RBT* Level |
|---|---|---|
| CO1. | State the working principle of electric power utilization and their application in real life | **L1(Remembering)** |
| CO2. | Select proper traction systems depending upon application considering economic and technology up-gradation. | **L2(Understanding)** |
| CO3. | Employ mathematical and graphical analysis considering different practical issues to design of traction system; analyze the performance parameter of the traction system. | **L3(Apply)** |
| CO4. | Examine various applications in indoor and outdoor application areas where use of light sources are essential. | **L4(Analysis)** |
| CO5. | Develop a clear idea on various illumination techniques and hence design lighting scheme for specific applications. | **L5( Evaluating)** |
| CO6. | State the working principle of electric power utilization and their application in real life | **L6(Creating)** |

***Revised Bloom's Taxonomy Action verbs/Levels**

## Course Content

### UNIT- I

**Illumination:** Terminology, Laws of illumination, Photometry, lighting calculations. Electric lamps – Different types of lamps, LED lighting and Energy efficient lamps. Design of lighting schemes – factory lighting - flood lighting – street lighting.

### UNIT-II

**Electric Heating:** Types of heating and applications, Electric furnaces - Resistance, inductance and Arc Furnaces, Electric welding and sources of welding, Electrolytic processes – electro-metallurgy and

electro-plating. Refrigeration-Domestic refrigerator and water coolers – Air -Conditioning-Various types of air conditioning system and their applications, smart air conditioning units - Energy Efficient motors

## UNIT-III

**Electrolytic Processes:** Introduction, Electrolyte, Ionization, Definition of various terms used in Electrolysis, Faradays' laws of Electrolysis, Extraction of Metals, Refining of metals, Electro-Deposition, Power Supply for Electrolytic Processes.

## UNIT-IV

**Traction System:** Requirement of an ideal traction system, power supply, traction drives, electric braking, Train movement (speed time curve, simplified speed time curve, average speed and schedule speed).Use of AC series motor and Induction motor for traction.

**Traction motor control:** DC series motor control, multiple unit control, braking of electric motors.

**REFERENCES:**


1. Dr. Uppal S.L. and Prof. S. Rao, "Electrical Power Systems", Khanna Publishers, New Delhi, 15th Edition, 2014.
2. Gupta, J.B., "Utilization of Electrical Energy and Electric Traction", S. K. Kataria and Sons, 10th Edition, 2012.
3. Rajput R.K., "Utilization of Electrical Power", Laxmi Publications, 1st Edition, 2006.
4. N. V. Suryanarayana, "Utilization of Electrical Power", New Age International Publishers, Reprinted 2005.
5. C. L. Wadhwa, "Generation Distribution and Utilization of Electrical Energy", New Age International Publishers, IV Edition, 2011.
6. H. Partab, "Modern Electric Traction", Dhanpat Rai & Co., 3rd Edition, 2012.

**Course Articulation Matrix:**

| Course/Course Code:Utilization of Electrical Energy(**PE/EE/8-T**), Semester: VII | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
| CO1 | 3 | 3 | 2 | 1 | 2 | 2 | 1 | - | - | - | 1 | 3 | 3 | 3 | 1 |
| CO2 | 3 | 2 | 2 | 1 | 2 | 2 | 1 | - | - | - | 3 | 3 | 2 | 2 | 1 |
| CO3 | 2 | 3 | 1 | 2 | 3 | 2 | 2 | - | - | - | 2 | 2 | 3 | 2 | - |
| CO4 | 3 | 3 | 2 | 1 | 2 | 2 | - | - | - | - | 2 | 2 | 2 | 3 | 1 |
| CO5 | 3 | 2 | 2 | 2 | 1 | 2 | 1 | - | - | - | 1 | 2 | 2 | 2 | - |
| CO6 | 3 | 3 | 1 | 2 | 2 | 2 | 2 | - | - | - | 2 | 2 | 2 | 3 | 1 |

**Correlation level:** **1**- Slight /Low **2-** Moderate/ Medium **3-** Substantial/High

# Detailed Syllabus
# of
# B. Tech. (EE)
# VII Semester
## Program Elective Course-III

# ENERGY MANAGEMENT AND AUDITING

**General Course Information:**

| | |
|---|---|
| Course Code: **PE/EE/9-T**<br>Course Credits: 3.0<br>Mode: Lecture (L) and Tutorial (T)<br>Type: Program Elective<br>Teaching Schedule L T P: 3 0 0<br>Examination Duration: 3 hours | **Course Assessment Methods; Max. Marks: 100 (Internal: 30; External: 70)**<br>Three minor tests, each of 20 marks, will be conducted. The third minor will be conducted in open book mode by the Course Coordinator. No date sheet will be issued for the third minor at the level of the Departments. For the purpose of internal assessment, the average of the highest marks obtained by a student in any two minor examinations will be considered. All the minor examination question papers will be prepared and evaluated by following the Outcome Based Education framework. Class Performance will be measured through percentage of lectures attended (4 marks) Assignments (4 marks) and class performance (2 marks).<br><br>The end semester examination will be of 70 marks. For the end semester examination, nine questions are to be set by the examiner. Question number one will be compulsory and based on the entire syllabus. It will contain seven short answers type questions. Rest of the eight questions is to be given by setting two questions from each of the four units of the syllabus. A candidate is required to attempt any other four questions selecting one from each of the four units. All questions carry equal marks. |

**Course Outcomes**

| Sr. No. | Course outcomes<br>At the end of the course students will be able to: | RBT* Level |
|---|---|---|
| CO1. | Describe the present state of energy scenario | **L1(Remembering)** |
| CO2. | Describe the energy management and savings through the different levels during utilization | **L2(Understanding)** |
| CO3. | Solve the problems related with energy management and audit. | **L3(Apply)** |
| CO4. | Perform economic and energy efficiency analysis of various electrical devices on the behalf of their energy audit repot. | **H1(Analysis)** |
| CO5. | Create energy audit report for industrial, residential and commercial consumers | **H3 (Creating)** |

***Revised Bloom's Taxonomy Action verbs/Level**

## Course Content

### UNIT-I

**Energy Scenario:** Commercial and Non-Commercial Energy, Primary and Secondary Energy Resources, Conventional and non-conventional energy, Commercial Energy Production, Final Energy Consumption, Energy Needs of Growing Economy, Long Term Energy Scenario, Energy Pricing, Energy Sector Reforms, Energy and Environment: Air Pollution, Climate Change, Energy Security, Energy Conservation and its Importance, Energy Strategy for the Future

## UNIT-II

**Energy Management Functions:** Need for energy management, Energy management program, Organizational Structure, Energy Policy, Planning, Audit Planning, Educational Planning, Strategic Planning, Reporting

## UNIT-III

**Electrical Energy Management:** Electricity tariff, Electrical Load Management and Maximum Demand Control, Maximum demand controllers, Power Factor & Its importance, Automatic power factor controllers, Energy efficient motors, Soft starters with energy saver, Energy efficient transformers, Electronic ballast, Energy efficient lighting controls

## UNIT-IV

**Energy Audit:** Definition, Energy audit- need, Types of energy audit, Energy Auditing Services, Basic Components of an Energy Audit, Specialized Audit Tools, Industrial Audits, Commercial Audits, Residential Audits, Indoor Air Quality and basics of economic analysis.

**REFERENCES**:


1. Wayne C. Turner, Steve Doty, "Energy Management Hand book", The Fairmont Press, 6th Edition, 2007
2. Amit K. Tyagi, "Handbook on Energy Audits and Management", Tata Energy Research Institute, 2nd reprint, 2003.
3. Barney L. Capehart, Wayne C. Turner, William J. Kennedy, "Guide to Energy Management", CRC Press.
4. www.bee-india.nic.in, BEE Reference book: no.1/2/3/4.

**Course Articulation Matrix:**

| Course/Course Code: Energy Management and Auditing (**PE/EE/9-T**) Semester: VII | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
| CO1 | 2 | 2 | 2 | - | - | 3 | 3 | - | - | - | - | 3 | 2 | 2 | 2 |
| CO2 | 3 | 2 | 1 | - | 2 | - | - | - | 2 | - | - | - | 2 | 2 | 1 |
| CO3 | 2 | 3 | 2 | 2 | - | - | - | - | - | - | 2 | - | 3 | 3 | 2 |
| CO4 | 2 | 2 | 2 | - | 2 | - | - | 2 | - | 2 | 3 | 3 | 2 | 3 | 2 |
| CO5 | 2 | 2 | 2 | 2 | 2 | - | - | 2 | 3 | 3 | 3 | 2 | 3 | 3 | 3 |

**Correlation level:** **1**- Slight /Low **2-** Moderate/ Medium **3**- Substantial/High

# SOFT COMPUTING

## General Course Information:

| | |
|---|---|
| Course Code: **PE/EE/10-T**<br>Course Credits: 3.0<br>Mode: Lecture (L)<br>Type: Program Core<br>Teaching Schedule L T P: 3 0 0<br>Examination Duration: 3 hours | **Course Assessment Methods; Max. Marks: 100 (Internal: 30; External: 70)**<br>Three minor tests, each of 20 marks, will be conducted. The third minor will be conducted in open book mode by the Course Coordinator. No date sheet will be issued for the third minor at the level of the Departments. For the purpose of internal assessment, the average of the highest marks obtained by a student in any two minor examinations will be considered. All the minor examination question papers will be prepared and evaluated by following the Outcome Based Education framework. Class Performance will be measured through percentage of lectures attended (4 marks) Assignments (4 marks) and class performance (2 marks).<br><br>The end semester examination will be of 70 marks. For the end semester examination, nine questions are to be set by the examiner. Question number one will be compulsory and based on the entire syllabus. It will contain seven short answers type questions. Rest of the eight questions is to be given by setting two questions from each of the four units of the syllabus. A candidate is required to attempt any other four questions selecting one from each of the four units. All questions carry equal marks. |

## Prerequisites:

## Course Outcomes

| Sr. No. | Course outcomes<br>At the end of the course students will be able to: | RBT* Level |
|---|---|---|
| CO1. | Recall the basics of power system. | **L1(Remembering)** |
| CO2. | Describe the performance of different soft computing techniques in the context of power system. | **L2(Understanding)** |
| CO3. | Solve the problems related with soft computing techniques in the context of power system. | **L3(Apply)** |
| CO4. | Compare the performance soft computing techniques for optimization of system. | **H1(Analysis)** |
| CO5. | Judge and analyze the performance of system with the implementation of soft computing techniques. | **H2 (Evaluating)** |
| CO6. | Create new algorithm (model) for the betterment of power system operation with economics parameters. | **H3 (Creating)** |

***Revised Bloom's Taxonomy Action verbs/Level**

## Course Content

### UNIT-I

**Soft Computing:** Introduction, requirement, different soft computing techniques and their characteristics, comparison with hard computing, applications.

### UNIT II

**Fuzzy sets and Fuzzy logic:** Introduction, Fuzzy sets versus crisp sets, properties of fuzzy sets, operations on fuzzy sets, Extension principle, Fuzzy relations, Linguistic variables, linguistic terms, Linguistic hedges, Fuzzy reasoning, Mamdani and TSK fuzzy inference systems, Applications.

### UNIT III

**Artificial Neural Network:** Introduction, comparison with biological neural network, basic models of artificial neuron, different architectures of ANN, Learning techniques, Applications.

### UNIT IV

**Evolutionary algorithms:** Genetic Algorithm (GA), different operators of GA, convergence of Genetic Algorithm, Particle swarm optimization algorithm, other Applications of GA.

**REFERENCES:**


1. J.S.R.Jang, C.T.Sun, E.mizutani, "Neuro Fuzzy & Soft Computing", Pearson Education.
2. S. Rajasekaran, GA Vijayalakshmi Pai, "Neural Networks, Fuzzy Logic & Genetic Algorithms -Synthesis & Applications", PHI Publication.
3. D.E.Goldberg, "Genetic Algorithms in Search optimization & Machine Learning", Addison - Wesley Pub. Co.
4. J.M. Zurada, "Artificial Neural Systems", West Publishing Co., New York.
5. Simon Haykin, "Neural Networks - A Comprehensive Foundation", Prentice Hall.
6. Bart Kosko, "Neural Networks & Fuzzy Systems", PHI Publication.

**Course Articulation Matrix:**

| Course/Course Code: Soft Computing (**PE/EE/10-T)**Semester: VII | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
| CO1 | 2 | 1 | 1 | 1 | 1 | - | - | - | - | - | - | 1 | 2 | 1 | 1 |
| CO2 | 2 | 2 | 2 | 2 | 3 | - | - | - | - | - | - | 1 | 2 | 2 | 1 |
| CO3 | 3 | 2 | 2 | 2 | 2 | - | - | - | - | - | - | 1 | 3 | 3 | 1 |
| CO4 | 3 | 2 | 2 | 2 | 2 | - | 1 | - | - | - | - | 1 | 2 | 3 | 1 |
| CO5 | 3 | 2 | 2 | 2 | 2 | - | 1 | - | - | - | - | 1 | 2 | 2 | 1 |
| CO6 | 3 | 2 | 2 | 2 | 3 | 1 | 1 | 1 | 2 | 1 | 3 | 2 | 2 | 2 | 1 |

**Correlation level:** **1**- Slight /Low **2-** Moderate/ Medium **3-** Substantial/High

# SCADA SYSTEM AND APPLICATIONS

**General Course Information:**

| | |
|---|---|
| Course Code: **PE/EE/11-T**<br>Course Credits: 3.0<br>Mode: Lecture (L)<br>Type: Program Elective<br>Teaching Schedule L T P: 3 0 0<br>Examination Duration: 3 hours | **Course Assessment Methods; Max. Marks: 100 (Internal: 30; External: 70)**<br>Three minor tests, each of 20 marks, will be conducted. The third minor will be conducted in open book mode by the Course Coordinator. No date sheet will be issued for the third minor at the level of the Departments. For the purpose of internal assessment, the average of the highest marks obtained by a student in any two minor examinations will be considered. All the minor examination question papers will be prepared and evaluated by following the Outcome Based Education framework. Class Performance will be measured through percentage of lectures attended (4 marks) Assignments (4 marks) and class performance (2 marks).<br><br>The end semester examination will be of 70 marks. For the end semester examination, nine questions are to be set by the examiner. Question number one will be compulsory and based on the entire syllabus. It will contain seven short answers type questions. Rest of the eight questions is to be given by setting two questions from each of the four units of the syllabus. A candidate is required to attempt any other four questions selecting one from each of the four units. All questions carry equal marks. |

**Course outcomes:**

| Sr. No. | Course outcomes<br>At the end of the course students will be able to: | RBT* Level |
|---|---|---|
| CO1. | Describe the basic tasks of Supervisory Control Systems (SCADA) as well as their typical applications | **L1(Remembering)** |
| CO2. | Identify different elements of SCADA. | **L2(Understanding)** |
| CO3. | Solve the problems related to I/O module, Data Acquisition System and Communication Networks using Standard Devices. | **L3(Apply)** |
| CO4. | Examine the problem associated with the industrial application. | **L4(Analysis)** |
| CO5. | Evaluate the SCADA performance on the basis of application and behaviour. | **L5( Evaluating)** |
| CO6. | Design and analysis of general structure of an automated process for real time applications using SCADA | **L6(Creating)** |

***Revised Bloom's Taxonomy Action verbs/Levels**

## Course Content

### UNIT- I

**Introduction:** Introduction to SCADA systems, Fundamental Principle of Modern SCADA Systems, Monitoring and supervisory functions, Application area of SCADA system.

### UNIT- II

SCADA System Components, Remote Terminal Unit-(RTU), Intelligent Electronic Devices (IED), Programmable Logic Controller (PLC), Communication Network, SCADA Server, SCADA/HMI Systems.

## UNIT- III

**SCADA Architecture:** Various SCADA architectures, advantages and disadvantages of each system - single unified standard architecture -IEC 61850 SCADA Communication: various industrial communication technologies -wired and wireless methods and fiber optics. Open standard communication protocols.

## UNIT- IV

**SCADA Applications:** Utility applications- Transmission and Distribution sector -operations, monitoring, analysis and improvement. Industries - oil, gas and water. Case studies, Implementation, Simulation exercises.

**REFERENCES:**


1. Stuart A. Boyer,"SCADA-Supervisory Control and Data Acquisition", Instrument Society of America Publications,USA,2004
2. William T. Shaw, "Cybersecurity for SCADA systems", Penn Well Books, 2006
3. David Bailey, Edwin Wright, "Practical SCADA for industry", Newnes Publication, 2003
4. KLS Sharma, "Overview of Industrial Process Automation", Elsevier Publication

**Course Articulation Matrix:**

| Course/Course Code: SCADA System and Applications(**PE/EE/11-T**),Semester: VII | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
| CO1 | 3 | 3 | 3 | 2 | 2 | 1 | - | - | - | - | 2 | 3 | 2 | 3 | 2 |
| CO2 | 3 | 2 | 3 | 2 | 3 | 2 | - | - | - | - | 2 | 3 | 2 | 3 | 1 |
| CO3 | 2 | 3 | 3 | 2 | 2 | 3 | - | - | - | - | 3 | 2 | 3 | 3 | 1 |
| CO4 | 3 | 2 | 2 | 2 | 3 | 1 | - | - | - | - | 3 | 1 | 2 | 2 | 1 |
| CO5 | 2 | 3 | 3 | 2 | 2 | 1 | - | - | - | - | 2 | 1 | 2 | 2 | 2 |
| CO6 | 2 | 3 | 2 | 2 | 2 | 2 | - | - | - | - | 2 | 2 | 2 | 1 | 1 |

**Correlation level:** **1**- Slight /Low **2-**Moderate/ Medium **3-** Substantial/High

# INTERNET OF THINGS (IoT)

**General Course Information:**

| | |
|---|---|
| Course Code: **PE/EE/12-T**<br>Course Credits: 3.0<br>Mode: Lecture (L) and Tutorial (T)<br>Type: Program Core<br>Teaching Schedule L T P: 3 0 0<br>Examination Duration: 3 hours | **Course Assessment Methods; Max. Marks: 100 (Internal: 30; External: 70)**<br>Three minor tests, each of 20 marks, will be conducted. The third minor will be conducted in open book mode by the Course Coordinator. No date sheet will be issued for the third minor at the level of the Departments. For the purpose of internal assessment, the average of the highest marks obtained by a student in any two minor examinations will be considered. All the minor examination question papers will be prepared and evaluated by following the Outcome Based Education framework. Class Performance will be measured through percentage of lectures attended (4 marks) Assignments (4 marks) and class performance (2 marks).<br><br>The end semester examination will be of 70 marks. For the end semester examination, nine questions are to be set by the examiner. Question number one will be compulsory and based on the entire syllabus. It will contain seven short answers type questions. Rest of the eight questions is to be given by setting two questions from each of the four units of the syllabus. A candidate is required to attempt any other four questions selecting one from each of the four units. All questions carry equal marks. |

**Course Outcomes**

| Sr. No. | Course outcomes<br>At the end of the course students will be able to: | RBT* Level |
|---|---|---|
| CO1. | Memorize the basic concepts of Internet, embedded system and wireless network. | **L1(Remembering)** |
| CO2. | Understand the concepts of Internet of Things | **L2(Understanding)** |
| CO3. | Choose the specific application to apply the concept of IOT. | **L3(Apply)** |
| CO4. | Analyze basic protocols in wireless sensor network. | **H1(Analysis)** |
| CO5. | Design IOT applications in different domain and be able to analyze their performance | **H3 (Creating)** |

***Revised Bloom's Taxonomy Action verbs/Level**

## Course Content

### UNIT-I

**Introduction and Concepts of IOT:** Introduction to IOT, definition and characteristics of IOT, Architecture of Internet of Things, Physical and logical design of IOT, IOT enabling technologies, IOT levels and deployment templates, Domain specific IOTs, home automation, cities, environment, Domain specific IOTs, Energy, retail, agriculture, industry, health and lifestyle.

### UNIT-II

**IOT Challenges & IOT-M2M Communication:** Design challenges, Development challenges, Security challenges, Other challenges, Machine to Machine, Difference between IoT and M2M,

Software define Network, Wireless medium access issues, MAC protocol survey, Survey routing protocols, Sensor deployment & Node discovery, Data aggregation & dissemination,

## UNIT-III

**Introduction to Hardware used for IoT:** Microcontrollers, Microprocessors, Sensors, Introduction to Arduino, RF Protocols: RFID, NFC, Bluetooth Low Energy (BLE), IPv6 for Low Power and Lossy Networks (6LoWPAN) and Routing, Protocol for Low power and lossy networks (RPL).

## UNIT-IV

**Developing IOTs:** Introduction to Python, Introduction to different IOT tools, Developing applications through IOT tools, Developing sensor based application through embedded system platform, Implementing IOT concepts with python.

**REFERENCES:**


1. Arshdeep Bahga, Vijay Madisetti, "Internet of Things, A Hands -on Approach", 1st Edition University Press, 2015.
2. Oliver Hersent, David Boswarthick, Omar Elloumy, "The Internet of Things",1st Edition , 2015.
3. Michael Miller, "The Internet of Things, How Smart TVs, Smart Cars, Smart Homes, and Smart Cities are changing the World", 1st edition, Pearson 2015.


**Course Articulation Matrix:**

| Course/Course Code: Internet of Things (**PE/EE/12-T**) Semester: VII | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
| CO1 | 2 | - | 2 | 1 | - | - | - | - | - | - | - | 1 | 2 | - | 1 |
| CO2 | 3 | 2 | - | - | - | - | - | - | - | - | - | 1 | 2 | 2 | - |
| CO3 | 3 | - | 3 | 2 | - | - | - | - | - | - | - | 1 | 3 | - | - |
| CO4 | 3 | 1 | - | 1 | - | - | - | - | - | - | - | 1 | 3 | 2 | - |
| CO5 | 3 | 3 | 3 | 2 | - | - | - | - | - | - | - | 1 | 3 | 2 | - |

**Correlation level:** **1**- Slight /Low **2-** Moderate/ Medium **3-** Substantial/High

# Detailed Syllabus
# of
# B. Tech. (EE)
# VIII Semester
## Program Elective Course-IV

# FLEXIBLE AC TRANSMISSION SYSTEMS

**General Course Information:**

| | |
|---|---|
| Course Code: **PE/EE/13-T**<br><br>Course Credits: 3.0<br><br>Mode: Lecture (L)<br><br>Type: Program Elective<br><br>Teaching Schedule L T P: 3 0 0<br><br>Examination Duration: 03 hours | **Course Assessment Methods; Max. Marks: 100 (Internal: 30; External: 70)**<br>Three minor tests, each of 20 marks, will be conducted. The third minor will be conducted in open book mode by the Course Coordinator. No date sheet will be issued for the third minor at the level of the Departments. For the purpose of internal assessment, the average of the highest marks obtained by a student in any two minor examinations will be considered. All the minor examination question papers will be prepared and evaluated by following the Outcome Based Education framework. Class Performance will be measured through percentage of lectures attended (4 marks) Assignments (4 marks) and class performance (2 marks).<br><br>The end semester examination will be of 70 marks. For the end semester examination, nine questions are to be set by the examiner. Question number one will be compulsory and based on the entire syllabus. It will contain seven short answers type questions. Rest of the eight questions is to be given by setting two questions from each of the four units of the syllabus. A candidate is required to attempt any other four questions selecting one from each of the four units. All questions carry equal marks. |

**Course outcomes:**

| Sr. No. | Course outcomes<br>At the end of the course students will be able to: | RBT* Level |
|---|---|---|
| CO1. | Revise the basics of power transmission networks and need for FACTS controllers | **L1(Remembering)** |
| CO2. | Understand and classify different power system FACTS Controllers | **L2(Understanding)** |
| CO3. | Demonstrate the scope of the specific FACTS controllers for power flow control issues in transmission lines. | **L3(Apply)** |
| CO4. | Analyze the operation of various FACTS controllers and solve simple powe systems with FACTS controllers | **L4(Analysis)** |
| CO5. | Select the specific FACTS controllers for power system compensation | **L5( Evaluating)** |
| CO6. | Design simple FACTS controllers | **L6(Creating)** |

***Revised Bloom's Taxonomy Action verbs/Levels**

## Course Content

## UNIT- I

**Introduction:** Review of basics of power transmission networks, Control of power flow in AC transmission line, Types of Flexible AC Transmission System Controllers: Shunt, Series, combined Shunt-. Applications of FACTS controllers in Distribution System, Uncompensated AC Transmission line, Passive reactive power compensation, Series and shunt compensation at the mid-point of the line.

## UNIT- II

**Static Shunt Compensators (SVC and STATCOM):** Objectives of Shunt Compensation, **Static VAR Compensator (SVC)**: Typical SVC Configuration, Control Characteristics of SVC, SVC Controller, Modelling of SVC, Application, **Static synchronous compensator (STATCOM):** Principle of operation, Three Phase Six Pulse STATCOM, Voltage & Current waveforms, Application, Comparison of SVC and STATCOM

## UNIT- III

**Static Synchronous Series Compensator (SSSC):** Concepts of Controlled Series Compensation, operation of SSSC, Operating region and control characteristics of SSSC, **Thyristor Controlled Series Capacitor (TCSC):** Operation of TCSC, Block diagram, circuit, voltage and current waveforms, Applications **GTO thyristor Controlled Series Controller (GCSC):** Operation of GCSC, circuit, voltage and current waveforms, Applications

## UNIT- IV

**Combined Compensators: Unified Power Flow Controller (UPFC)**: Basic operating principle & characteristics, UPFC connected at the receiving end, UPFC connected at the Midpoint, Control of UPFC, Applications, **Interline Power Flow Controllers (IPFC)**: Basic operating principle & characteristics, representation, Applications, Comparison of UPFC and IPFC

.

**REFERENCES:**


1. R. M. Mathur, , R. K. Varma, "Thyristor – Based Facts Controllers for ElectricalTransmission Systems", IEEE press and John Wiley & Sons, Inc.
2. K.R. Padiyar, "FACTS Controllers in Power Transmission and Distribution", New AgeInternational (P) Ltd., Publishers, New Delhi, Reprint 2008,
3. A.T. John, "Flexible AC Transmission System", Institution of Electrical and ElectronicEngineers (IEEE), 1999.
4. N. G. Hingorani, L. Gyugyi, "Understanding FACTS Concepts and Technology of Flexible AC Transmission System", Standard Publishers, Delhi 2001.
5. V. K. Sood, "HVDC and FACTS controllers- Applications of Static Converters in Power System", 2004, Kluwer Academic Publishers.
6. T. J. E. Miller, "Reactive Power Control In Electric Systems", Wiley Publications, 1982.

**Course Articulation Matrix:**

| Course/Course Code: Flexible AC Transmission System(**PE/EE/13-T**), Semester: VIII | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
| CO1 | 3 | - | 1 | - | 2 | 2 | 2 | - | - | - | 1 | 2 | 1 | 1 | 1 |
| CO2 | 2 | - | 1 | 1 | 1 | - | 1 | - | - | - | - | 2 | 2 | 1 | 1 |
| CO3 | 2 | 1 | 2 | 1 | 1 | 1 | 1 | - | 1 | - | 1 | 2 | 2 | 1 | 1 |
| CO4 | 2 | 3 | 2 | 2 | 2 | 3 | 1 | - | 1 | - | 1 | 2 | 2 | 1 | 1 |
| CO5 | 2 | 2 | 2 | 3 | 2 | 1 | 1 | - | 1 | - | 1 | 2 | 2 | 3 | 1 |
| CO6 | 2 | 2 | 3 | 2 | 2 | 2 | 1 | - | 1 | - | 1 | 2 | 2 | 3 | 1 |

**Correlation level:** **1**- Slight /Low **2-** Moderate/ Medium **3**- Substantial/High

# DISTRIBUTED GENERATION

**General Course Information:**

| | |
|---|---|
| Course Code: **PE/EE/14-T**<br>Course Credits: 3.0<br>Mode: Lecture (L)<br>Type: Program Elective<br>Teaching Schedule L T P: 3 0 0<br>Examination Duration: 3 hours | **Course Assessment Methods; Max. Marks: 100 (Internal: 30; External: 70)**<br>Three minor tests, each of 20 marks, will be conducted. The third minor will be conducted in open book mode by the Course Coordinator. No date sheet will be issued for the third minor at the level of the Departments. For the purpose of internal assessment, the average of the highest marks obtained by a student in any two minor examinations will be considered. All the minor examination question papers will be prepared and evaluated by following the Outcome Based Education framework. Class Performance will be measured through percentage of lectures attended (4 marks) Assignments (4 marks) and class performance (2 marks).<br><br>The end semester examination will be of 70 marks. For the end semester examination, nine questions are to be set by the examiner. Question number one will be compulsory and based on the entire syllabus. It will contain seven short answers type questions. Rest of the eight questions is to be given by setting two questions from each of the four units of the syllabus. A candidate is required to attempt any other four questions selecting one from each of the four units. All questions carry equal marks. |

**Course outcomes:**

| Sr. No. | Course outcomes<br>At the end of the course students will be able to: | RBT* Level |
|---|---|---|
| CO1. | Describe the various technical and economic benefits of Distributed Generations. | **L1(Remembering)** |
| CO2. | Recognize the need of siting and sizing of distributed generation along with their effect on distribution system. | **L2(Understanding)** |
| CO3. | Apply economic feasibility analysis | **L3(Apply)** |
| CO4. | Examine the technical issue in Distributed Generations system | **L4(Analysis)** |
| CO5. | Evaluate the appropriate optimization technique suitable for Distributed Generations. | **L5( Evaluating)** |
| CO6. | Develop a Model a micro grid taking into consideration the planning and operational issues of the Distributed Generations to be connected in the system | **L6(Creating)** |

***Revised Bloom's Taxonomy Action verbs/Levels**

## Course Content

### UNIT- I

**Introduction:** Conventional power generation: advantages and disadvantages, Energy crises, Nonconventional energy (NCE) resources: basics of Solar PV, Wind Energy systems, Fuel Cells, micro-turbines, biomass, and tidal sources.

## UNIT-II

**Distributed Generations:** Concept of distributed generations, Topologies, selection of sources, regulatory standards/ framework, Standards for interconnecting Distributed resources to electric power systems: IEEE 1547, Energy storage elements: Batteries, ultra-capacitors, flywheels, Superconducting magnetic energy storage.

## UNIT-III

**Micro grids:** Concept and definition of micro grid, micro grid drivers and benefits, review of sources of Micro grids, typical structure and configuration of a Micro grid, AC and DC Micro grids, Power Electronic interfaces in DC and AC Micro grids.

## UNIT-IV

**Impact of Grid Integration:** Requirements for grid interconnection, limits on operational parameters: voltage, frequency, THD Impact of grid integration with NCE sources on existing power system: reliability, stability and power quality issues.

**REFERENCES:**


1. D. N. Gaonkar, "Distributed Generation", In-Tech publications.
2. Magdi S. Mahmoud, Fouad M. AL-Sunni, "Control and Optimization of Distributed Generation Systems", Springer International Publishing.
3. Loi Lei Lai, Tze Fun Chan, "Distributed Generation: Induction and Permanent Magnet Generators", October 2007, Wiley-IEEE Press.
4. M.Godoy Simoes, Felix A.Farret, 'Renewable Energy Systems – Design and Analysis with Induction Generators', CRC press.
5. F. Katiraei, M.R. Iravani, "Transients of a Micro-Grid System with Multiple Distributed Energy Resources", International Conference on Power Systems Transients (IPST'05) in Montreal, Canada on June 19-23, 2005.

**Course Articulation Matrix:**

| Course/Course Code: Distributed Generation(**PE/EE/14-T**), Semester: VIII | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
| CO1 | 2 | 1 | 2 | - | - | 2 | 3 | - | - | - | -[ | 2 | 1 | 2 | 1 |
| CO2 | - | 1 | 2 | - | | 3 | 3 | - | - | - | - | 2 | 1 | 1 | 1 |
| CO3 | 2 | 2 | 2 | - | 1 | 2 | 3 | - | - | - | 1 | 1 | 2 | 2 | 1 |
| CO4 | 2 | 2 | 2 | 1 | 1 | 2 | 3 | - | - | - | 2 | 1 | 2 | 2 | 2 |
| CO5 | 2 | 2 | 2 | 1 | 2 | 3 | 3 | - | - | - | 2 | 1 | 1 | 3 | 2 |
| CO6 | 2 | 3 | 3 | 1 | 2 | 2 | 3 | - | - | - | 1 | 1 | 1 | 2 | 3 |

**Correlation level:** **1**- Slight /Low **2-**Moderate/ Medium **3-** Substantial/High

# POWER QUALITY

**General Course Information:**

| | |
|---|---|
| Course Code: **PE/EE/15-T**<br>Course Credits: 3.0<br>Mode: Lecture (L)<br>Type: Program Elective<br>Teaching Schedule L T P: 3 0 0<br>Examination Duration: 3 hours | **Course Assessment Methods; Max. Marks: 100 (Internal: 30; External: 70)**<br>Three minor tests, each of 20 marks, will be conducted. The third minor will be conducted in open book mode by the Course Coordinator. No date sheet will be issued for the third minor at the level of the Departments. For the purpose of internal assessment, the average of the highest marks obtained by a student in any two minor examinations will be considered. All the minor examination question papers will be prepared and evaluated by following the Outcome Based Education framework. Class Performance will be measured through percentage of lectures attended (4 marks) Assignments (4 marks) and class performance (2 marks).<br><br>The end semester examination will be of 70 marks. For the end semester examination, nine questions are to be set by the examiner. Question number one will be compulsory and based on the entire syllabus. It will contain seven short answers type questions. Rest of the eight questions is to be given by setting two questions from each of the four units of the syllabus. A candidate is required to attempt any other four questions selecting one from each of the four units. All questions carry equal marks. |

**Course Outcomes**

| Sr. No. | Course outcomes<br>At the end of the course students will be able to: | RBT* Level |
|---|---|---|
| CO1. | Describe the basics of power electronic devices and quality of power supply. | **L1(Remembering)** |
| CO2. | Illustrate the issues related with power quality. | **L2(Understanding)** |
| CO3. | Solve the problems related with power quality. | **L3(Apply)** |
| CO4. | Compare the power quality problems. | **H1(Analysis)** |
| CO5. | Evaluate and judge the solutions related with power quality. | **H2 (Evaluating)** |
| CO6. | Design can be formulated as per required specification and issue. | **H3 (Creating)** |

***Revised Bloom's Taxonomy Action verbs/Level**

## Course Content

### UNIT-I

**Introduction to Power Quality:** Introduction to power distribution system- deregulated environment, Power Quality (PQ): definitions, concerns, and evaluations, Terminology: under-voltage, over voltage, transients, harmonics, voltage unbalance, voltage sags, voltage swells, flicker, interruptions, and power frequency variations, Concepts of transients - short duration variations such as interruption -long duration variation such as sustained interruption, International standards of power quality, Computer Business Equipment Manufacturers Associations (CBEMA) curve.

### UNIT-II

**Voltage Sags, Interruptions and Over voltages:** Sources of sags and interruptions - estimating voltage sag performance, Voltage sag due to induction motor starting, Estimation of the sag severity,

Active Series Compensator, Static transfer switches and fast transfer switches, Sources of over voltages - Capacitor switching - lightning, Mitigation of voltage swells - surge arresters - power conditioners, Lightning protection - shielding - line arresters.

## UNIT-III

**Power System Harmonics:** Harmonic sources from commercial and industrial loads, locating harmonic sources, Power system response characteristics - Harmonics Vs transients, Effect of harmonics - harmonic distortion - voltage and current distortion - harmonic indices, Devices for controlling harmonic distortion - passive and active filters, IEEE and IEC standards.

## UNIT-IV

**Power Quality Monitoring and Distributed Generation:** Power Quality Monitoring - Industry requirements - standards, Power Quality Measurement Equipment: Power line disturbance analyser, Harmonic analyser-Spectrum analyser, Flicker meters and Disturbance analyser.

**Introduction to DG Technologies**: Interface to the Utility System-Power Quality issues, Site study for Distributed Generation-Interconnection standards, Issue on Power Quality in Smart Grids and Micro Grids

**REFERENCES:**


1. Roger C. Dugan, Mark McGranaghan, Surya Santoso, H.Wayne, H. Wayne Beaty, “Electrical Power Systems Quality”, Tata McGraw Hill, Third edition, 2012.
2. J. Arrillaga, N.R. Watson, S. Chen, “Power System Quality Assessment”, Wiley, 2011.
3. Dash.S.S, Rayaguru.N.K, “Power Quality Management”, 2nd Edition, Vijay Nicole Publishers, 2016.
4. Jos Arrillaga, Neville R. Watson, “Power System Harmonics”, 2nd Edition, Wiley Publishers, 2015.
5. ArindamGhosh ,“Power Quality Enhancement Using Custom Power Devices”, Kluwer Academic Publishers, 2002.
6. G.T. Heydt, “Electric Power Quality”, 2nd edition, Stars in a Circle Publications, 1994.

**Course Articulation Matrix:**

| Course/Course Code: Power Quality (**PE/EE/15-T**) | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
| CO1 | 3 | 1 | 2 | 1 | 1 | 1 | 1 | - | - | - | 1 | 1 | 3 | 1 | 1 |
| CO2 | 3 | 2 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 1 |
| CO3 | 3 | 2 | 2 | 1 | 1 | - | - | - | 1 | 1 | 1 | 1 | 3 | 2 | 1 |
| CO4 | 3 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 2 | 1 |
| CO5 | 3 | 1 | 2 | 3 | 2 | 1 | 1 | - | 1 | 1 | 2 | 2 | 2 | 2 | 2 |
| CO6 | 3 | 2 | 3 | 2 | 3 | 3 | 3 | 2 | 2 | 1 | 3 | 3 | 2 | 2 | 2 |

**Correlation level:** **1**- Slight /Low **2-** Moderate/ Medium **3**- Substantial/High

# SMART GRID TECHNOLOGIES

**General Course Information:**

| | |
|---|---|
| Course Code: **PE/EE/16-T**<br>Course Credits: 3.0<br>Mode: Lecture (L)<br>Type: Program Elective<br>Teaching Schedule L T P: 3 0 0<br>Examination Duration: 3 hours | **Course Assessment Methods; Max. Marks: 100 (Internal: 30; External: 70)**<br>Three minor tests, each of 20 marks, will be conducted. The third minor will be conducted in open book mode by the Course Coordinator. No date sheet will be issued for the third minor at the level of the Departments. For the purpose of internal assessment, the average of the highest marks obtained by a student in any two minor examinations will be considered. All the minor examination question papers will be prepared and evaluated by following the Outcome Based Education framework. Class Performance will be measured through percentage of lectures attended (4 marks) Assignments (4 marks) and class performance (2 marks).<br><br>The end semester examination will be of 70 marks. For the end semester examination, nine questions are to be set by the examiner. Question number one will be compulsory and based on the entire syllabus. It will contain seven short answers type questions. Rest of the eight questions is to be given by setting two questions from each of the four units of the syllabus. A candidate is required to attempt any other four questions selecting one from each of the four units. All questions carry equal marks. |

**Prerequisites: PCC-EE206-T, PCC-EE302-T**

**Course Outcomes**

| Sr. No. | Course outcomes<br>At the end of the course students will be able to: | RBT* Level |
|---|---|---|
| CO1. | Recall the basics of Power system and its design aspects. | **L1(Remembering)** |
| CO2. | Describe the structure of smart grid on the basis of traditional grid with the role of automation in transmission and distribution. | **L2(Understanding)** |
| CO3. | Demonstrate the operation, scheduling and economics using evolutionary algorithms for smart grid and maximum utilization of renewable energy resources. | **L3(Apply)** |
| CO4. | Compare its performance with conventional grid and analyze the role of frequency for the control of grid. | **H1(Analysis)** |
| CO5. | Judge and evaluate the efficiency of system on the basis of supply of electricity with its economic indices. | **H2 (Evaluating)** |
| CO6. | Formulate algorithm or automation so that maximum consumer can be benefitted and losses of the system can be minimized. | **H3 (Creating)** |

***Revised Bloom's Taxonomy Action verbs/Level**

## Course Content

### UNIT-I

**Introduction to Smart Grid:** Smart Grid, Need of Smart Grid, Working definitions of Smart Grid and associated concepts, Smart Grid Functions, Traditional Power Grid and Smart Grid, New

Technologies for Smart Grid, Advantages, Whole sale energy market in smart grid, Indian Smart Grid, Key Challenges for Smart Grid.

## UNIT-II

**Smart Grid Architecture:** Components and Architecture of Smart Grid Design, Review of the proposed architectures for Smart Grid, Fundamental components of Smart Grid designs, Transmission Automation, Distribution Automation, Renewable Integration, Energy Management in smart grid.

## UNIT-III

**Tools and Distribution Generation Technologies:** Introduction to Renewable Energy Technologies, Micro grids, Storage Technologies, Electric Vehicles and plug-in hybrids, Environmental impact and Climate Change, Economic Issues, Advanced metering infrastructure.

## UNIT-IV

**Communication Technologies and Smart Grid:** Introduction to Communication Technology, Synchro Phasor Measurement Units (PMUs), Wide Area Measurement Systems (WAMS).
**Control of Smart Power Grid System:** Load Frequency Control (LFC) in Micro Grid System – Voltage Control in Micro Grid System, Reactive Power Control in Smart Grid, Case Studies for the Smart Grids.

**REFERENCES:**


1. James Momoh, "Smart Grid - fundamentals of design and analysis", John Wiley and Sons, 2012.
2. Janaka Ekanayake, "Smart Grid -Technology and Applications", John Wiley and Sons, 2012.
3. Stuart Borlase, "Smart Grids, Infrastructure, Technology and Solutions", CRC Press, 2013.
4. Gil Masters, "Renewable and Efficient Electric Power System", Wiley-IEEE Press, 2004.
5. A.G. Phadke and J.S. Thorp, "Synchronized Phasor Measurements and their Applications", Springer Edition, 2010.
6. T. Ackermann, "Wind Power in Power Systems", Hoboken, NJ, USA, John Wiley, 2005.

**Course Articulation Matrix:**

| Course/Course Code: Smart Grid Technologies (**PE/EE/16-T**) Semester: VIII | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
| CO1 | 3 | 2 | 2 | 1 | 1 | - | - | - | - | 1 | 1 | 1 | 3 | 2 | 1 |
| CO2 | 3 | 2 | 3 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 3 | 2 | 1 |
| CO3 | 3 | 2 | 2 | 1 | 2 | 2 | 2 | 1 | 2 | 1 | 2 | 2 | 3 | 2 | 1 |
| CO4 | 3 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 3 | 2 | 1 |
| CO5 | 3 | 2 | 2 | 1 | 1 | 1 | 2 | 1 | 1 | 1 | 2 | 2 | 3 | 2 | 2 |
| CO6 | 3 | 3 | 3 | 2 | 3 | 3 | 3 | 2 | 2 | 1 | 3 | 3 | 3 | 3 | 3 |

**Correlation level:** **1**- Slight /Low **2-** Moderate/ Medium **3**- Substantial/High

# Detailed Syllabus

# of

# B. Tech. (EE)

# VIII Semester

## Program Elective Course-V

# EHV AC AND DC TRANSMISSION

## General Course Information:

| | |
|---|---|
| Course Code: **PE/EE/17-T**<br>Course Credits: 3.0<br>Mode: Lecture (L)<br>Type: Program Elective<br>Teaching Schedule L T P: 3 0 0<br>Examination Duration: 3 hours | **Course Assessment Methods; Max. Marks: 100 (Internal: 30; External: 70)**<br>Three minor tests, each of 20 marks, will be conducted. The third minor will be conducted in open book mode by the Course Coordinator. No date sheet will be issued for the third minor at the level of the Departments. For the purpose of internal assessment, the average of the highest marks obtained by a student in any two minor examinations will be considered. All the minor examination question papers will be prepared and evaluated by following the Outcome Based Education framework. Class Performance will be measured through percentage of lectures attended (4 marks) Assignments (4 marks) and class performance (2 marks).<br><br>The end semester examination will be of 70 marks. For the end semester examination, nine questions are to be set by the examiner. Question number one will be compulsory and based on the entire syllabus. It will contain seven short answers type questions. Rest of the eight questions is to be given by setting two questions from each of the four units of the syllabus. A candidate is required to attempt any other four questions selecting one from each of the four units. All questions carry equal marks. |

## Course outcomes:

| Sr. No. | Course outcomes<br>At the end of the course students will be able to: | RBT* Level |
|---|---|---|
| CO1. | Elicit the major components, advantages, limitations and applications of EHV AC and DC transmission Systems | **L1(Remembering)** |
| CO2. | Recapitulate the fundamental aspects of Extra High Voltage A.C and DC transmission design and analysis | **L2(Understanding)** |
| CO3. | Apply the remedial measures against the problems associated with EHVAC and DC transmission such as Corona, AN, RI, Over-voltages, Ferro-resonance, Harmonics in converters | **L3(Apply)** |
| CO4. | Perform in-depth analysis of various control techniques for controlling the power flow through a dc link and multi-terminal operation of HVDC | **L4(Analysis)** |
| CO5. | Critically evaluate AC and DC transmission system with respect to all aspects | **L5( Evaluating)** |

***Revised Bloom's Taxonomy Action verbs/Levels**

## Course Content

### UNIT- I

**Introduction**: Need of EHV transmission, standard transmission voltage, Power handling capacity, Comparison of EHV AC & DC transmission systems and their applications & limitations, Bundled conductors, Surface voltage gradients in conductor, Distribution of voltage gradients on sub-conductors, mechanical considerations of transmission lines, modern trends in EHV AC & DC transmission.

## UNIT- II

**EHV AC Transmission**: Corona, Corona loss formulae, corona current, Audible noise- generation and characteristics corona pulses their generation and properties, Radio interference (RI) effects, Over voltage due to switching, Ferro-resonance, reduction of switching surges on EHV system, principle of half wave transmission**.**

## UNIT- III

**Components of EHV D.C.:** Converter circuits, Rectifier and inverter valves, Reactive power requirements, Harmonics generation, Adverse effects, Classification, Remedial measures to suppress, Filters, Ground return, Converter faults & protection harmonics, misoperation, Commutation failure, Multi-terminal D.C. lines.

## UNIT- IV

**Control of EHV D.C.:** Desired features of control, control characteristics, Constant current control, Constant extinction angle control. Ignition Angle control, Parallel operation of HVAC & DC system, Problems & advantages.

**REFERENCES:**


1. R.D. Begamudre, "EHV AC Transmission Engineering", Wiley Eastern Press, 2011
2. S. S. Rao, "EHV AC & DC Transmission", Khanna publishers, 2008
3. E. Kimbark, "HVDC Transmission", John Wiley and Sons, 1971
4. J. Arrillaga, "HVDC Transmission", 2nd Edition, IEEE Press, 1998
5. K. R. Padiyar, "HVDC Transmission, New Age International", 2nd edition, 2012
6. P. Kundur, "Power System Stability and Control", Tata McGraw Hill, 1994

**Course Articulation Matrix:**

| Course/Course Code: EHVAC and DC Transmission (**PE/EE/17-T**), Semester: VIII | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
| CO1 | 3 | 1 | 2 | 1 | 1 | 1 | - | 1 | 1 | - | 2 | 2 | 3 | 2 | 1 |
| CO2 | 3 | 1 | 2 | 1 | 1 | 1 | - | 1 | 1 | - | 2 | 2 | 3 | 2 | 1 |
| CO3 | 3 | 2 | 2 | 2 | 1 | 1 | - | 1 | 1 | - | 2 | 1 | 2 | 2 | 1 |
| CO4 | 2 | 3 | 2 | 2 | 1 | 1 | - | 1 | 1 | - | 2 | 1 | 2 | 2 | 1 |
| CO5 | 2 | 3 | 2 | 2 | 1 | 1 | - | 1 | 1 | - | 2 | 1 | 2 | 2 | 1 |

**Correlation level:** **1**- Slight /Low **2-**Moderate/ Medium **3-** Substantial/High

# RESTRUCTURED POWER SYSTEM

## General Course Information:

| | |
|---|---|
| Course Code: **PE/EE/18-T**<br>Course Credits: 3.0<br>Mode: Lecture (L)<br>Type: Program Elective<br>Teaching Schedule L T P: 3 0 0<br>Examination Duration: 3 hours | **Course Assessment Methods; Max. Marks: 100 (Internal: 30; External: 70)**<br>Three minor tests, each of 20 marks, will be conducted. The third minor will be conducted in open book mode by the Course Coordinator. No date sheet will be issued for the third minor at the level of the Departments. For the purpose of internal assessment, the average of the highest marks obtained by a student in any two minor examinations will be considered. All the minor examination question papers will be prepared and evaluated by following the Outcome Based Education framework. Class Performance will be measured through percentage of lectures attended (4 marks) Assignments (4 marks) and class performance (2 marks).<br><br>The end semester examination will be of 70 marks. For the end semester examination, nine questions are to be set by the examiner. Question number one will be compulsory and based on the entire syllabus. It will contain seven short answers type questions. Rest of the eight questions is to be given by setting two questions from each of the four units of the syllabus. A candidate is required to attempt any other four questions selecting one from each of the four units. All questions carry equal marks. |

**Prerequisites: PCC-EE206-T, PCC-EE302-T**

## Course Outcomes

| Sr. No. | Course outcomes<br>At the end of the course students will be able to: | RBT* Level |
|---|---|---|
| CO1. | Recall the basics of Power system and its design aspects. | **L1(Remembering)** |
| CO2. | Describe the structure of restructured power system on the basis of conventional power system design. | **L2(Understanding)** |
| CO3. | Demonstrate the operation, scheduling and economics of with an emphasis on recent research in this area. | **L3(Apply)** |
| CO4. | Compare its performance with conventional (bundled) power system. | **H1(Analysis)** |
| CO5. | Judge and evaluate the efficiency of system on the basis of supply of electricity with its economic indices. | **H2 (Evaluating)** |
| CO6. | Design can be formulated so that maximum consumer can be benefitted. | **H3 (Creating)** |

***Revised Bloom's Taxonomy Action verbs/Level**

## Course Content

### UNIT-I

**Introduction:** Measures for Energy Conservation, History of Electrical Power Generation, Laws, Efficient Transmission Arrangements, Measures for Energy Conservation, History of Electrical Power Generation, The Laws, Challenges and Issues in Competition Market, Competition in Generation, Efficient Transmission Arrangements. Role of different Authorities in Power Sectors.

## UNIT-II

**Power Trading**: Term-Ahead Market (TAM), Short-Term Open Access in Inter-state Transmission, (Collective Transaction/Pool Transaction),Present Practice,Market Clearing Process (MCP), Linear Bid Market, Determination of MCP for Single Sided Linear Bid Market

## UNIT-III

**Load Frequency control**: Power Industry Scenario, Introduction to AVR and ALFC Loops, review of modeling of an Isolated Generating System, Model for a Vessel, Reheat Type Steam Turbine Model, Complete Block Diagram Representation of LFC of an Isolated Area , Indian Power Industry Restructuring, Challenges in Load Frequency Control, Disco Participation Matrix (DPM),ACE Participation Factors, Transaction During Contract Violation/Pool Based Transaction, Mathematical Modeling of AGC with Restructuring

## UNIT-IV

**Available Power Transfer Capability**: Fundamentals and Importance of ATC, Algorithm for ATC Determination, Methods of ATC Determination, Power Transfer Distribution Factors Based on D.C. Load Flow Approach, Static ATC Determination Using A.C. Power Transfer Distribution Factor.

**REFERENCES:**


1. L. L. Lai, "Power System Restructuring and Deregulation", John Wiley& Sons Inc., New York, HRD Edition, 2001.
2. S. K. Gupta, "Restructuring Electric Power Systems", I K International Publishing House.
3. Kankar Bhattacharya, Math H.J.Bollen and Jaap E. Daalder, "Operation of Restructured Power Systems", USA: Kluwer Academic Publishers, 2001.
4. Mohammad Shahidehpour, Hatim Yamin, "Market Operations in Electric Power Systems", John Wiley & Sons Inc., 2002.
5. Lorrin Philipson, H. Lee Willis, "Understanding Electric Utilities and Deregulation", Taylor & Francis, New York, 2nd Edition, 2006.
6. Mohammad Shahidehpour, Muwaffaq Alomoush, "Restructured Electrical Power Systems", Marcel Dekker, INC., New York, 1st Edition, 2001.
7. Overview of Power Sector in India 2005: Indian Core Publishing.

**Course Articulation Matrix:**

| Course/Course Code: Restructured Power System (**PE/EE/18-T**) Semester: VIII | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
| CO1 | 3 | 1 | 2 | 1 | 1 | 2 | 1 | 2 | 2 | 1 | 1 | 1 | 3 | 3 | 1 |
| CO2 | 3 | 2 | 3 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 3 | 2 | 1 |
| CO3 | 3 | 1 | 2 | 1 | 2 | 2 | 2 | 1 | 2 | 1 | 2 | 2 | 3 | 2 | 1 |
| CO4 | 3 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 3 | 2 | 1 |
| CO5 | 3 | 1 | 2 | 1 | 1 | 1 | 2 | 1 | 1 | 1 | 2 | 2 | 3 | 2 | 2 |
| CO6 | 3 | 2 | 3 | 2 | 3 | 3 | 3 | 2 | 2 | 1 | 3 | 3 | 3 | 2 | 3 |

**Correlation level:** **1**- Slight /Low **2-** Moderate/ Medium **3-** Substantial/High

# HIGH VOLTAGE ENGINEERING

**General Course Information:**

| | |
|---|---|
| Course Code: **PE/EE/19-T**<br>Course Credits: 3.0<br>Mode: Lecture (L)<br>Type: Program Elective<br>Teaching Schedule L T P: 3 0 0<br>Examination Duration: 3 hours | **Course Assessment Methods; Max. Marks: 100 (Internal: 30; External: 70)**<br>Three minor tests, each of 20 marks, will be conducted. The third minor will be conducted in open book mode by the Course Coordinator. No date sheet will be issued for the third minor at the level of the Departments. For the purpose of internal assessment, the average of the highest marks obtained by a student in any two minor examinations will be considered. All the minor examination question papers will be prepared and evaluated by following the Outcome Based Education framework. Class Performance will be measured through percentage of lectures attended (4 marks) Assignments (4 marks) and class performance (2 marks).<br><br>The end semester examination will be of 70 marks. For the end semester examination, nine questions are to be set by the examiner. Question number one will be compulsory and based on the entire syllabus. It will contain seven short answers type questions. Rest of the eight questions is to be given by setting two questions from each of the four units of the syllabus. A candidate is required to attempt any other four questions selecting one from each of the four units. All questions carry equal marks. |

**Course outcomes:**

| Sr. No. | Course outcomes<br>At the end of the course students will be able to: | RBT* Level |
|---|---|---|
| CO1. | Describe the Knowledge about high voltage generation | **L1(Remembering)** |
| CO2. | Discuss the testing methods of High Voltage Equipment | **L2(Understanding)** |
| CO3. | Find the problem occur in high voltage generation | **L3(Apply)** |
| CO4. | Test various apparatus and their measurement method for generating high voltages. | **L4(Analysis)** |
| CO5. | Select the reasons of overvoltage in power system and protection methods against them. | **L5( Evaluating)** |
| CO6. | Formulate the incidence, network matrices and model of the power system components. | **L6(Creating)** |

***Revised Bloom's Taxonomy Action verbs/Levels**

**Course Content**

**UNIT- I**

**Break Down Mechanism of Gaseous Materials:** Mechanism of Breakdown of gases, Townsend's first Ionization Co-efficient, Townsend's second Ionization Co-efficient, Townsend's Breakdown Mechanism, and Streamer Theory of Breakdown in gases, Paschen's law.

**UNIT-II**

**Breakdown in Liquid and Solid Dielectrics:** Suspended Particle Theory, Cavity Breakdown, Electro- convection Breakdown, Breakdown in solid Dielectrics, Intrinsic Breakdown,

Electromechanical Breakdown, Breakdown due to Treeing and Tracking, Thermal Breakdown, Electrochemical Breakdown

## UNIT-III

**Generation of High Dc and Ac Voltages:** Introduction, Rectifier circuits, Cockcroft- Walton voltage multiplier circuit, electrostatic generator, generation of high ac voltages by cascaded transformers, series resonant circuit.

## UNIT-IV

**High Voltage Testing & Measurement:** Sphere-Gap, Uniform field Spark gap, Rod Gap, Electrostatic Voltmeter, Generating Voltmeter, Impulse Voltage Measurement using Voltage divider, Measurement of high DC, AC and Impulse Current., Testing of line Insulator, Testing of Cable, Testing of Bushings, Testing of Power Capacitor, Testing of Power Transformers, Testing of Circuit Breaker.

**REFERENCES:**


1. M.S. Naidu & V. Kamaraju, “High Voltage Engineering”, Publication TMH
2. S Kamakshaiah/V Kamaraju, “HVDC Transmission,” McGraw Hill
3. Rakos Das Begamudre, “Extra EHV A.C Transmission” PHI Publication.
4. C.L Wadhwa, “High Voltage Engineering”, New Age International Ltd.
5. Ravindra Arora & Wolfgang Mosch, “High voltage Insulation Engineering”, New Age International Publishers, 2011.
6. E. Kuffel, W.S. Zaengl, J. Kuffel,"High voltage Engineering Fundamentals”, Newnes Publishers, 2011.
7. M.S. Naidu & Kamaraju, “High voltage Engineering Fundamentals”, TMH, 2008.

**Course Articulation Matrix:**

| Course/Course Code: High Voltage Engineering(**PE/EE/19-T**), Semester: VIII | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
| CO1 | 2 | 3 | 2 | 1 | 2 | 1 | 1 | - | - | - | 1 | 1 | 3 | 2 | 1 |
| CO2 | 3 | 2 | 2 | 2 | 1 | 2 | 1 | - | - | - | 2 | 1 | 2 | 1 | 1 |
| CO3 | 2 | 2 | 2 | 3 | 2 | 1 | - | - | - | - | 1 | 1 | 3 | 3 | 1 |
| CO4 | 2 | 2 | 1 | 2 | 3 | 2 | 1 | - | - | - | - | - | 2 | 2 | 1 |
| CO5 | 3 | 3 | 2 | 1 | 1 | 3 | 1 | - | - | - | 2 | 1 | 2 | 1 | 1 |
| CO6 | 2 | 2 | 3 | 2 | 1 | 3 | 1 | - | - | - | 1 | 2 | 2 | 2 | 1 |

**Correlation level:** **1**- Slight /Low **2-**Moderate/ Medium **3-** Substantial/High

# BIG DATA ANALYSIS

## General Course Information:

| | |
|---|---|
| Course Code: **PE/EE/20-T**<br>Course Credits: 3.0<br>Mode: Lecture (L)<br>Type: Program Elective<br>Teaching Schedule L T P: 3 0 0<br>Examination Duration: 3 hours | **Course Assessment Methods; Max. Marks: 100 (Internal: 30; External: 70)**<br>Three minor tests, each of 20 marks, will be conducted. The third minor will be conducted in open book mode by the Course Coordinator. No date sheet will be issued for the third minor at the level of the Departments. For the purpose of internal assessment, the average of the highest marks obtained by a student in any two minor examinations will be considered. All the minor examination question papers will be prepared and evaluated by following the Outcome Based Education framework. Class Performance will be measured through percentage of lectures attended (4 marks) Assignments (4 marks) and class performance (2 marks).<br><br>The end semester examination will be of 70 marks. For the end semester examination, nine questions are to be set by the examiner. Question number one will be compulsory and based on the entire syllabus. It will contain seven short answers type questions. Rest of the eight questions is to be given by setting two questions from each of the four units of the syllabus. A candidate is required to attempt any other four questions selecting one from each of the four units. All questions carry equal marks. |

## Course outcomes:

| Sr. No. | Course outcomes<br>At the end of the course students will be able to: | RBT* Level |
|---|---|---|
| CO1. | Explain different issues involved in the design and implementation of a database system | **L1(Remembering)** |
| CO2. | Explain the physical and logical database designs & modeling and Big Data and its Business Implications. | **L2(Understanding)** |
| CO3. | Knowledge the algorithms for dealing with big data. | **L3(Apply)** |
| CO4. | Analysis of number of Clusters and its diagnostics. | **L4(Analysis)** |
| CO5. | Evaluating the job Execution in Hadoop Environment. | **L5( Evaluating)** |
| CO6. | Formulate optimization problems and obtain an optimal solutions | **L6(Creating)** |

***Revised Bloom's Taxonomy Action verbs/Levels**

## Course Content

### UNIT- I

**DATABASE SYSTEM ARCHITECTURE**: Data Abstraction, Data Independence, Data Definition Language (DDL), Data Manipulation Language (DML).
**DATA MODELS**: Entity-relationship model, network model, relational and object oriented data models, integrity constraints, data manipulation operations

### UNIT- II

**RELATIONAL QUERY LANGUAGES**: Relational algebra, Tuple and domain relational calculus, SQL3, DDL and DML constructs, Open source and Commercial DBMS – MYSQL.
**RELATIONAL DATABASE DESIGN**: Domain and data dependency, Armstrong's axiom, Normal forms, Dependency preservation, Lossless design.
**QUERY PROCESSING AND OPTIMIZATION**: Evaluation of relational algebra expressions, Query equivalence, Join strategies, Query optimization algorithms..

## UNIT- III

**INTRODUCTION TO BIG DATA AND HADOOP**: Introduction to Big Data, Big Data Analytics, History of Hadoop, Apache Spark, Analysing Data with Hadoop.
**HDFS (HADOOP DISTRIBUTED FILE SYSTEM)**: Design of HDFS, Command Line Interface, Hadoop file system interfaces, Data flow, Data Ingest with Flume and Scoop and Hadoop archives, Hadoop I/O: Compression and Serialization.

## UNIT- IV

**MAP REDUCE & CLASSIFICATION METHODS:**
**MAP REDUCE:** Anatomy of a Map Reduce Job Run, Failures, Job Scheduling, Shuffle and Sort, Task Execution, Map Reduce Types and Formats, Map Reduce Features.
**Overview of Clustering** – K-means: Use Cases–Overview of the Method, Determining the Number of Clusters, Diagnostics – Reasons to Choose and Cautions, Classification: Decision Trees Introduction to streams concepts and NoSQL databases.

**TEXT BOOKS:**


1. Database System Concepts", 6th Edition by Abraham Silberschatz, Henry F. Korth, S. Sudarshan, McGraw-Hill.
2. "Principles of Database and Knowledge – Base Systems", Vol 1 by J. D. Ullman, Computer Science Press.
3. "Fundamentals of Database Systems", 5th Edition by R. Elmasri and S. Navathe, Pearson Education
4. "Foundations of Databases", Reprint by Serge Abiteboul, Richard Hull, Victor Vianu, Addison-Wesley
5. Seema Acharya, Subhasini Chellappan, "Big Data Analytics" Wiley 2015.
6. Michael Berthold, David J. Hand, "Intelligent Data Analysis", Springer, 2007
7. Jay Liebowitz, "Big Data and Business Analytics" Auerbach Publications,CRC press, 2013.


**REFERENCE BOOKS:**


1. Anand Rajaraman and Jef rey David Ulman, "Mining of Massive Datasets", Cambridge University Press, 2012.
2. Glen J. Myat, "Making Sense of Data", John Wiley & Sons, 2007.
3. Arvind Sathi, "Big Data Analytics: Disruptive Technologies for Changing the Game", MC Press, 2012

**Course Articulation Matrix:**

| Course/Course Code: Big Data Analysis (**PE/EE/20-T**), Semester: VIII | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
| CO1 | 3 | 1 | 2 | 1 | 1 | 2 | 1 | - | - | - | 3 | 3 | 1 | 2 | 1 |
| CO2 | 3 | 2 | 2 | 1 | 2 | 2 | 1 | - | - | - | 3 | 3 | 1 | 2 | 1 |
| CO3 | 2 | 2 | 2 | 2 | 3 | 2 | 1 | - | - | - | 3 | 2 | 2 | 2 | 1 |
| CO4 | 2 | 3 | 2 | 2 | 2 | 2 | 1 | - | - | - | 3 | 2 | 2 | 3 | 1 |
| CO5 | 3 | 3 | 2 | 2 | 2 | 2 | 1 | - | - | - | 3 | 2 | 2 | 3 | 1 |
| CO6 | 3 | 3 | 2 | 2 | 2 | 2 | 1 | - | - | - | 3 | 2 | 3 | 3 | 1 |

**Correlation level:** **1**- Slight /Low **2-**Moderate/ Medium**3-** Substantial/High

# Detailed Syllabus
# of
# B. Tech. (EE)
# VIII Semester
# (Full Semester Industrial Training)

**Policy Document for providing exemptions in attendance to the B.Tech. students of the University for undertaking various internships/trainings during their final/penultimate semester**

## 1. Background:

It has been realized that the students pursuing B. Tech. programmes offered by the University/affiliated Institutes/Colleges are facing challenges as under:

4. Students selected in industry during their programme are asked to join the industry for internship/training of duration up to one semester.
5. The provision is not there in these programmes to allow the students to join the internship by way of getting the required attendance of semester from internship/training.
6. So, students are not able to join such internship/training consequential to two-fold loss:
   (c) Job opportunity.
   (d) Skill development in industry environment.

But, presently, in the B. Tech. Programmes run by the University, there is no provision for the students to join the industry for such internship/training of/for more than 6–8-week duration. To facilitate the students for joining longer duration internships/trainings, a need for framing a policy document was felt.

Keeping in view the above challenges/statutory position and to avoid hardship to students and to improve the employability of the students, Ch. Devi Lal University, Sirsa has framed a policy to accord exemptions in attendance to students undertaking various internships/trainings during their final/penultimate semester of the B. Tech. Programmes.

## 2. Applicability of the policy with following Provisions:

The policy is applicable to the students studying in the final semester/ penultimate semester of B. Tech. programmes.

### 2.1 Provisions:

Student covered as per section title 'Applicability of the Policy' will be governed by the following provisions:

6. The student will be allowed to join the organization for internship/training in the final semester/ penultimate semester of the course for a period of up to one semester only if he/she must be passed/ cleared in all courses/subjects in all the semester examination whose results have been declared.
7. The student will earn his attendance from the organization during the period of internship.
8. Attendance will be certified by the organization, failing which student will be debarred from appearing in the University examinations of that semester.
9. The student will have to give an undertaking that he/she will appear in all the internal/external examination/practical as per requirements of the Programme and as per Schedule of the University examination for that programme. For this he/she will have to

do the necessary preparation by himself/herself and Institute/department will not be responsible for the same.

10. If the student is selected in a company/industry/organization etc., and is asked to join the organization in the final semester/ penultimate semester for a period of upto one semester; then formally constituted Internship Facilitation Committee (IFC) will examine and give its recommendation as deemed fit.

## 2.2 Composition of Internship Facilitation Committee (IFC):

The composition of IFC will be as under:

6. Dean, Faculty of Engg. & Tech./Director/ Principal (or Nominee) (Chairperson)
7. Chairperson/Head/ In-charge of the concerned Department/Branch (Member)
8. In-Charge Academic Branch/Academic In-charge of Institute (Member)
9. Senior most faculty of the department other than Chairperson/ Director/Head of the Department/Branch (Member)
10. Training and Placement officer/ In-Charge TPO of the Institute /College/Department (Member Secretary)

Any offer by the organisations providing internship on demanding charges from a student will be discouraged by the Internship Facilitation Committee (IFC). Member Secretary of the IFC will schedule the meeting and maintain all the records.

## 3. Conclusion:

The students can only be allowed to join the internship/training in company/ industry/ organization etc. with exemptions in attendance on the final recommendation of Internship Facilitation Committee (IFC) of the Institute / Department and permission given by the Department/Institute/College authority.

**List of Common Courses:**

BSC

| Course Code | Definition / Category |
|---|---|
| BSC | Basics Science Courses |
| ESC | Engineering Science Courses |
| HSMC | Humanities and Social Sciences Including Management Courses |
| MC | Mandatory Courses |
| PC | Program Courses |
| PE | Program Core |
| OE | Open Elective Courses |
| EEC | Employability Enhancement Courses (Project Work/ Summer Training/ Industrial Training/ Practical Training/ Internship/ Seminar, etc.) |

| # | Course Title | Course Code (T) | Course Code(P) | Credit |
|---|---|---|---|---|
| 1. | Physic | BSC/1-T(i-vii) | BSC/1-P | |
| 2. | Chemistry | BSC/2-T | BSC/2-P | |
| 3. | Mathematics-I | BSC/3-T | | |
| 4. | Mathematics-II | BSC/4-T | | |
| 5. | Mathematics-I (CSE/IT) | BSC/5-T | | |
| 6. | Mathematics-II (CSE/IT) | BSC/6-T | | |
| 7. | Mathematics-III | BSC/7-T | | |
| 8. | Introduction to Food Biotechnology | BSC/8-T | BSC/8-P | |

ESC

| # | Course Title | Course Code (T) | Course Code(P) | Credit |
|---|---|---|---|---|
| 1. | Basics Electrical Engineering | ESC/1-T | ESC/1-P | |
| 2. | Engineering Graphics and Design Lab | - | ESC/2-P | |
| 3. | Programming for Problem Solving | ESC/3-T | ESC/3-P | |
| 4. | Workshop/ Manufacturing Practices | ESC/4-T | ESC/4-P | |
| 5. | Analog Electronics Circuit | ESC/5-T | | |
| 6. | Engineering Properties of Food | ESC/6-T | | |
| 7. | Civil Engineering Mats Testing Evaluation-I Lab | - | ESC/7-P | |
| 8. | Civil Engineering Mats Testing Evaluation-II Lab | - | ESC/8-P | |
| 9. | Engineering Mechanics | ESC/9-T | | |
| 10. | Workshop Technology-II Lab | | ESC/10-P | |
| 11. | Basics of Machine Drawing | | ESC/11-P | |

HSMC

| # | Course Title | Course Code (T) | Course Code(P) | Credit |
|---|---|---|---|---|
| 1. | English | HSMC/1-T | HSMC/1-P | |
| 2. | Human Values & Personality Development | HSMC/2-T | | |
| 3. | Fundamentals of Management for Engineers | HSMC/3-T | | |
| 4. | Economics for Engineers | HSMC/4-T | | |
| 5. | Industrial Physiology | HSMC/5-T | | |

MC

| # | Course Title | Course Code (T) | Course Code(P) | Credit |
|---|---|---|---|---|
| 1. | Induction Training | MC/1 | | |
| 2. | Environmental Sciences | MC/2-T | | |
| 3. | Indian Constitution | MC/3-T | | |
| 4. | Essence of Indian Traditional Knowledge | MC/4-T | | |
| 5. | Technical Presentation | | MC/5-P | |
| 6. | Entrepreneurship | MC/6-T | | |
| 7. | Disaster Preparedness & Planning Management | MC/7-T | | |
| 8. | General Proficiency | | MC/8-P | |

# The Curriculum Book

# Bachelor of Technology

## 4-YEAR FULL TIME PROGRAMME

## 3rd YEAR (ELECTRICAL ENGINEERING)

## Choice Based Credit System with

## Learning Outcomes based Curriculum Framework (LOCF)

## For Batch: 2022-23


**FACULTY OF ENGINEERING AND TECHNOLOGY**

**CHAUDHARY DEVI LAL UNIVERSITY**

**SIRSA-125055**



**SESSION: 2024-2025**

# OPEN ELECTIVES COURSES

Offered for

# B. Tech. Programme

# (2022-23 Scheme)

Chaudhary Devi Lal University
Sirsa, Haryana (India) - NAAC Accredited Univesity
(Established by the State Legislature Act 9 of 2003)

# Open Elective Courses offered for various B.Tech. Programmes
# (2022-23 Scheme)

## Open Elective Course-I for B.Tech. V Semester

| Sr. No. | Course Code | Course Nomenclature | Offered By | Credits |
|---|---|---|---|---|
| 1 | OE/EE/1-T | Utilization of Electrical Energy | Electrical Engineering | 3 |
| 2 | OE/EE/2-T | Wind and Solar Energy System | | 3 |
| 3 | OE/EE/3-T | Electrical and Hybrid Vehicles | | 3 |
| 4 | OE/EE/4-T | Introduction to Electrical Machines | | 3 |

## Open Elective Course-II for B.Tech. VI Semester

| Sr. No. | Course Code | Course Nomenclature | Offered By | Credits |
|---|---|---|---|---|
| 1 | OE/EE/5-T | Renewable Energy Resources | Electrical Engineering | 3 |
| 2 | OE/EE/6-T | Special Electrical Machines | | 3 |
| 3 | OE/EE/7-T | Smart Grid Technologies | | 3 |
| 4 | OE/EE/8-T | Electrical Measurements and Instruments | | 3 |

## Open Elective Course-III for B.Tech. VII Semester

| Sr. No. | Course Code | Course Nomenclature | Offered By | Credits |
|---|---|---|---|---|
| 1 | OE/EE/9-T | Energy Management and Auditing | Electrical Engineering | 3 |
| 2 | OE/EE/10-T | Power Plant Engineering | | 3 |
| 3 | OE/EE/11-T | Transducers and Sensors | | 3 |
| 4 | OE/EE/12-T | EHV AC and DC Transmission | | 3 |

**Note:** ***Student can opt, for any open electives other than open Elective offered by his/her own department.***

# Detailed Syllabus
# of
# B. Tech. (EE)
# V Semester
## Open Elective Course-I

Chaudhary Devi Lal University
Sirsa, Haryana (India) – NAAC Accredited Univesity
(Established by the State Legislature Act 9 of 2003)

# Open Elective Course-I for B.Tech. V Semester

| Sr. No. | Course Code | Course Nomenclature | Offered By | Credits |
|---|---|---|---|---|
| 1 | OE/EE/1-T | Utilization of Electrical Energy | Electrical Engineering | 3 |
| 2 | OE/EE/2-T | Wind and Solar Energy System | | 3 |
| 3 | OE/EE/3-T | Electrical and Hybrid Vehicles | | 3 |
| 4 | OE/EE/4-T | Introduction to Electrical Machines | | 3 |

# UTILIZATION OF ELECTRICAL ENERGY

*(Students from Department of Electrical Engineering cannot opt this subject as Open Elective)*

## General Course Information:

| | |
|---|---|
| Course Code: **OE/EE/1-T**<br>Course Credits: 3<br>Mode: Lecture (L)<br>Type: Open Elective<br>Teaching Schedule L T P: 3 0 0<br>Examination Duration: 03 hours. | **Course Assessment Methods; Max. Marks: 100 (Internal: 30; External: 70)**<br>Three minor tests, each of 20 marks, will be conducted. The third minor will be conducted in open book mode by the Course Coordinator. No date sheet will be issued for the third minor at the level of the Departments. For the purpose of internal assessment, the average of the highest marks obtained by a student in any two minor examinations will be considered. All the minor examination question papers will be prepared and evaluated by following the Outcome Based Education framework. Class Performance will be measured through percentage of lectures attended (4 marks) Assignments (4 marks) and class performance (2 marks).<br><br>The end semester examination will be of 70 marks. For the end semester examination, nine questions are to be set by the examiner. Question number one will be compulsory and based on the entire syllabus. It will contain seven short answers type questions. Rest of the eight questions is to be given by setting two questions from each of the four units of the syllabus. A candidate is required to attempt any other four questions selecting one from each of the four units. All questions carry equal marks. |

**Course outcomes:**

| Sr. No. | Course outcomes<br>At the end of the course students will be able to: | RBT* Level |
|---|---|---|
| CO1. | List and describe the various conventional and renewable energ resources and technologies | **L1 (Remembering)** |
| CO2. | Recognize the impact of renewable energy utilization on society and environment | **L2 (Understanding)** |
| CO3. | Interpret and apply the concepts of renewable energy sources for electricity generation and grid integration | **L3 (Applying)** |
| CO4. | Make comparisons among renewable energy resources and technologies | **L4(Analyzing)** |
| CO5. | Assess and select the options among renewable energy resources and technologies | **L5 (Evaluating)** |
| CO6. | Do the basic design of various renewable energy systems for different requirements | **L6 (Creating)** |

***Revised Bloom's Taxonomy Action verbs/Levels**

**Course Content**

### UNIT–I

**Illumination and Refrigeration:** Illumination – Terminology; laws of illumination, Photometry, lighting, calculations. Electric lamps — Different types of lamps, LED lighting and Energy efficient lamps, Design of lighting schemes –factory lighting; flood lighting, street lighting.

Refrigeration: Domestic refrigerator and water coolers, Air-Conditioning, Various types of air conditioning system and their applications, smart air conditioning units.

### UNIT-II

**Domestic utilization of electrical energy:** House wiring, Induction based appliances, Online and Offline UPS, Batteries, Power quality aspects, nonlinear and domestic loads, Earthing; domestic, industrial and sub-station. Energy Efficient motors: Standard motor' efficiency, need for more efficient motors, Motor life cycle, direct savings and payback analysis, efficiency evaluation factor.

## UNIT-III

**Electric Heating and Electrolytic Processes:** Types of heating and applications, Electric Furnaces-Resistance, Inductance and Arc Furnace. Electric welding and sources of welding, Electrolytic Processes: Definition of various terms used in Electrolysis, Faradays[1] laws of Electrolysis, Extraction of Metals, Refining of metals, Electro-Deposition

## UNIT–IV

**Traction system-** Requirement of an ideal traction system, power supply, traction drives, electric braking, Train movement (speed time curve, simplified speed time curve, average speed and schedule speed), Electric traction motors & their control, Speed control and braking

**Recommended Readings:**


1. R.K. Rajput, 'Utilization of Electrical Power', Laxmi Publications,1st edition,2006.
2. S.L. Uppal and S. Rao, 'Electrical Power Systems', Khanna Publishers, New Delhi,1V Edition,2014.
3. J. B. Gupta, 'Utilization of Electrical Energy and Electric Traction, S.K. Kataria and Sons, 10th edition, 2012.
4. N. V. Suryanarayana, Utilization of Electrical Power, New Age International Publishers, reprinted 2005.
5. C.L. Wadhwa, Generation, Distribution and Utilization of Electrical Energy, New Age International Publishers, 4th edition,2011.
6. H. Partab, Modern Electric Traction, Dhanpat Rai & Co., 3rd edition,2012.
7. Energy Efficiency in Electrical Utilities, BEE Guide Book,2010.

**Course Articulation Matrix:**

| Course/Course Code: Utilization of Electrical Energy (**OE/EE/1-T**), Semester: V | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
| CO1 | 2 | 2 | 1 | 1 | - | - | - | - | - | - | - | 1 | 1 | 1 | - |
| CO2 | 1 | 1 | - | 1 | - | - | - | - | - | - | - | 1 | 1 | 1 | 1 |
| CO3 | 2 | 1 | 1 | - | - | - | 1 | - | - | - | - | 1 | 1 | 1 | - |
| CO4 | 3 | 2 | 2 | 1 | 2 | - | - | - | - | 1 | - | - | 2 | 1 | 1 |
| CO5 | 2 | 2 | 3 | - | - | - | - | - | - | - | - | - | 3 | 1 | - |
| CO6 | 2 | 3 | 1 | - | - | - | - | - | - | 1 | - | 1 | 1 | 1 | 1 |

**Correlation level:** **1**- Slight /Low **2-**Moderate/ Medium **3**- Substantial/High

# WIND AND SOLAR ENERGY SYSTEMS

*(Students from Department of Electrical Engineering cannot opt this subject as Open Elective)*

## General Course Information:

| | |
|---|---|
| Course Code: **OE/EE/2-T**<br>Course Credits: 3<br>Mode: Lecture (L)<br>Type: Open Elective<br>Teaching Schedule L T P: 3 0 0<br>Examination Duration: 03 hours. | **Course Assessment Methods; Max. Marks: 100 (Internal: 30; External: 70)**<br>Three minor tests, each of 20 marks, will be conducted. The third minor will be conducted in open book mode by the Course Coordinator. No date sheet will be issued for the third minor at the level of the Departments. For the purpose of internal assessment, the average of the highest marks obtained by a student in any two minor examinations will be considered. All the minor examination question papers will be prepared and evaluated by following the Outcome Based Education framework. Class Performance will be measured through percentage of lectures attended (4 marks) Assignments (4 marks) and class performance (2 marks).<br><br>The end semester examination will be of 70 marks. For the end semester examination, nine questions are to be set by the examiner. Question number one will be compulsory and based on the entire syllabus. It will contain seven short answers type questions. Rest of the eight questions is to be given by setting two questions from each of the four units of the syllabus. A candidate is required to attempt any other four questions selecting one from each of the four units. All questions carry equal marks. |

## Course outcomes:

| Sr. No. | Course outcomes<br>At the end of the course students will be able to: | RBT* Level |
|---|---|---|
| CO1. | Understanding the energy scenario and the consequent growth of the power generation from renewable energy sources | **L1 (Remembering)** |
| CO2. | Understanding the basic physics of wind and solar power generation. | **L2 (Understanding)** |
| CO3. | Applications of power electronic interfaces for wind and solar generation. | **L3 (Applying)** |
| CO4. | Evaluating the issues related to the grid-integration of solar and wind energy systems. | **L4(Analyzing)** |
| CO5. | To create and design the Network Integrating Systems of Wind and Solar Systems | **L6 (Creating)** |

***Revised Bloom's Taxonomy Action verbs/Levels**

## Course Content

### UNIT-I

Physics of Wind Power: History of wind power, Indian and Global statistics, Wind physics, Betz limit, Tip speed ratio, stall and pitch control, Wind speed statistics-probability distributions, Wind speed and power-cumulative distribution functions.

Solar thermal power generation: Technologies, Parabolic trough, central receivers, parabolic dish, Fresnel, solar pond, elementary analysis.

### UNIT-II

Wind generator topologies: Review of modern wind turbine technologies, Fixed and Variable speed wind turbines, Induction Generators, Doubly-Fed Induction Generators and their characteristics, Permanent Magnet Synchronous Generators, Power electronics converters. Generator-Converter 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, monocrystalline, polycrystalline; V-I characteristics of a PV cell, PV module, array, Power Electronic Converters for Solar Systems, Maximum Power Point Tracking (MPPT) algorithms. Converter Control.

## 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.

**Text / References:**


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.
3. S. P. Sukhatme, “Solar Energy: Principles of Thermal Collection and Storage”, McGraw Hill, 1984.
4. H. Siegfried and R. Waddington, “Grid integration of wind energy conversion systems” John Wiley and Sons Ltd., 2006.
5. G. N. Tiwari and M. K. Ghosal, “Renewable Energy Applications”, Narosa Publications, 2004.

**Course Articulation Matrix:**

| Course/Course Code: Wind and Solar Energy Systems (**OE/EE/2-T**), Semester: V | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
| CO1 | 2 | 1 | 2 | 1 | - | - | - | - | - | - | - | 1 | 1 | 1 | - |
| CO2 | 1 | 1 | 1 | 2 | 1 | - | - | - | - | - | - | 1 | 1 | 1 | - |
| CO3 | 2 | 1 | 1 | - | - | - | 1 | - | - | - | - | - | 1 | 1 | - |
| CO4 | 3 | 2 | 2 | - | 1 | - | - | - | - | - | - | - | 2 | 1 | - |
| CO5 | 2 | 2 | 2 | - | - | - | - | - | - | - | - | - | 3 | 1 | - |
| CO6 | 2 | 3 | 1 | - | - | 1 | - | - | 1 | 1 | - | 1 | 1 | 1 | 2 |

**Correlation level:** **1**- Slight /Low **2-**Moderate/ Medium **3**- Substantial/High

# ELECTRICAL & HYBRID VEHICLES

*(Students from Department of Electrical Engineering cannot opt this subject as Open Elective)*

## General Course Information:

| | |
|---|---|
| Course Code: **OE/EE/3-T**<br>Course Credits: 3<br>Mode: Lecture (L)<br>Type: Open Elective<br>Teaching Schedule L T P: 3 0 0<br>Examination Duration: 03 hours. | **Course Assessment Methods; Max. Marks: 100 (Internal: 30; External: 70)**<br>Three minor tests, each of 20 marks, will be conducted. The third minor will be conducted in open book mode by the Course Coordinator. No date sheet will be issued for the third minor at the level of the Departments. For the purpose of internal assessment, the average of the highest marks obtained by a student in any two minor examinations will be considered. All the minor examination question papers will be prepared and evaluated by following the Outcome Based Education framework. Class Performance will be measured through percentage of lectures attended (4 marks) Assignments (4 marks) and class performance (2 marks).<br><br>The end semester examination will be of 70 marks. For the end semester examination, nine questions are to be set by the examiner. Question number one will be compulsory and based on the entire syllabus. It will contain seven short answers type questions. Rest of the eight questions is to be given by setting two questions from each of the four units of the syllabus. A candidate is required to attempt any other four questions selecting one from each of the four units. All questions carry equal marks. |

**Course outcomes:**

| Sr. No. | Course outcomes<br>At the end of the course students will be able to: | RBT* Level |
|---|---|---|
| CO1. | Understand the basic concept and history of EV and HEV | **L1 (Remembering)** |
| CO2. | Understand the models to describe hybrid vehicles and their performance. | **L2 (Understanding)** |
| CO3. | Analysis of different possible ways of energy storage. | **L3 (Applying)** |
| CO4. | Analysis of the different strategies related to energy management systems | **L4(Analyzing)** |
| CO5. | Study of design of Vehicle to grid technology. | **L5(Evaluating)** |
| CO6. | Study that includes construction, principle of operation of electrical AC generators and motors, methods of starting, speed control. | **L6(Creating)** |

***Revised Bloom's Taxonomy Action verbs/Levels**

## Course Content

### UNIT-I

Introduction: History of hybrid and electric vehicles, social and environmental importance of hybrid and electric vehicles, impact of modern electric vehicles on energy supplies. Electric Vehicle Composition and Configurations, Basic concept of hybrid Electric vehicle, HEV configuration types – series, parallel, series-parallel and complex hybrid, Power flow control.

### UNIT-II

Electric Propulsion: major requirements of EV motor drive, characteristics and control of DC motor, Induction motor, Switched Reluctance motor and Permanent Magnet motor, power converters devices/topology, control hardware, software and strategy vehicle, power source characterization, transmission characteristics.

## UNIT-III

Energy Storage: Introduction to energy storage requirements in Hybrid and Electric Vehicles, Energy sources, Battery based energy storage and its analysis, Fuel fell based energy storage and its analysis, super capacitor based energy storage and its analysis, Flywheel based energy storage and its analysis.

## UNIT-IV

Energy Management Strategies: Introduction to energy management strategies used in hybrid and electric vehicles, classification of different energy management strategies, comparison of different energy management strategies, implementation issues of energy management strategies. Plug-in electric vehicles, Vehicle to grid (V2G) and Grid to vehicle (G2V) fundamentals

**Text / References:**


1. C. Mi, M. A. Masrur and D. W. Gao, "Hybrid Electric Vehicles: Principles and Applications with Practical Perspectives", John Wiley & Sons, 2011.
2. S. Onori, L. Serrao and G. Rizzoni, "Hybrid Electric Vehicles: Energy Management Strategies", Springer, 2015.
3. M. Ehsani, Y. Gao, S. E. Gay and A. Emadi, "Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals, Theory, and Design", CRC Press, 2004.
4. T. Denton, "Electric and Hybrid Vehicles", Routledge, 2016.

| Course/Course Code: Electrical &Hybrid Vehicles (**OE/EE/3-T**), | | | | | | | | | | | | | | | Semester: V |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
| CO1 | 2 | 1 | - | - | - | - | - | - | - | - | - | 1 | 1 | - | 1 |
| CO2 | 1 | 1 | - | 2 | - | - | - | - | - | - | - | 1 | 1 | 1 | 1 |
| CO3 | 2 | 1 | 1 | - | - | 1 | 1 | - | - | - | - | - | 1 | 1 | - |
| CO4 | 3 | 2 | 2 | 2 | - | - | - | - | - | - | - | - | 2 | 1 | - |
| CO5 | 2 | 2 | 2 | 1 | - | - | - | - | - | - | - | - | 3 | 1 | 1 |
| CO6 | 2 | 3 | 1 | 2 | - | - | - | - | 1 | 1 | 1 | 1 | 1 | 2 | - |

**Course Articulation Matrix:**

**Correlation level:** **1**- Slight /Low **2-**Moderate/ Medium **3-** Substantial/High

# INTRODUCTION TO ELECTRICAL MACHINES

***(Students from Department of Electrical Engineering cannot opt this subject as Open Elective)***

**General Course Information:**

| | |
|---|---|
| Course Code: **OE/EE/4-T**<br>Course Credits: 3<br>Mode: Lecture (L)<br>Type: Open Elective<br>Teaching Schedule L T P: 3 0 0<br>Examination Duration: 03 hours. | **Course Assessment Methods; Max. Marks: 100 (Internal: 30; External: 70)**<br>Three minor tests, each of 20 marks, will be conducted. The third minor will be conducted in open book mode by the Course Coordinator. No date sheet will be issued for the third minor at the level of the Departments. For the purpose of internal assessment, the average of the highest marks obtained by a student in any two minor examinations will be considered. All the minor examination question papers will be prepared and evaluated by following the Outcome Based Education framework. Class Performance will be measured through percentage of lectures attended (4 marks) Assignments (4 marks) and class performance (2 marks).<br><br>The end semester examination will be of 70 marks. For the end semester examination, nine questions are to be set by the examiner. Question number one will be compulsory and based on the entire syllabus. It will contain seven short answers type questions. Rest of the eight questions is to be given by setting two questions from each of the four units of the syllabus. A candidate is required to attempt any other four questions selecting one from each of the four units. All questions carry equal marks. |

**Course outcomes:**

| Sr. No. | Course outcomes<br>At the end of the course students will be able to: | RBT* Level |
|---|---|---|
| CO1. | Fundamental knowledge of magnetic circuits and electromechanical energy conversion devices. | **L1 (Remembering)** |
| CO2. | Understanding of the construction and principle operation of Single phase and three phase transformers. | **L2 (Understanding)** |
| CO3. | Analysis of different types of 3-phase transformers, phase conversion and other phenomenon | **L3 (Applying)** |
| CO4. | Study of DC machines with their suitability for specific industrial applications. | **L4(Analyzing)** |
| CO5. | Study of design of Vehicle to grid technology. | **L5(Evaluating)** |
| CO6. | Study that includes construction, principle of operation of electrical AC generators and motors, methods of starting, speed control. | **L6(Creating)** |

***Revised Bloom's Taxonomy Action verbs/Levels**

## Course Content

### UNIT-I

**Transformers**: Principle, construction of core, winding and tank, operation, equivalent circuit, phasor diagram, parameters determination, , losses: core loss and copper loss, testing of transformers: open circuit and short circuit test, efficiency, Principle of Auto-Transformers, construction, comparison with 2-winding Transformer, application. Basics of three phase transformer

### UNIT-II

**DC. Machines**: Elementary DC machine, construction,

**DC Generator:** working principle, EMF equation, ,types of D.C. generator: Separately and self-excited, Applications, **DC Motor: working p**rinciple, Significance of back emf, Torque Equation, Types and Characteristics of DC Motors, Need of Starter, three

point starter, four point starter, Speed Control (armature resistance, flux control, armature voltage), Ward-Leonard system, Losses and efficiency, Applications.

## UNIT-III

**Poly Phase Induction Motors:** Construction details of three-phase induction motor, Rotating magnetic field, principle of operation, slip, Equivalent circuit, expression for torque, full load torque, maximum torque, starting torque and output power, torque-slip and torque-speed characteristics, no load and blocked rotor test, Applications.

**Single Phase Induction & Special Motors:** Single Phase Induction Motor: Construction & types, Shaded Pole Motor, Double revolving field theory, Stepper Motor, Brushless DC motor, Servomotors, , Reluctance Motor, Hysteresis Motor, Repulsion Motor, Schrage Motor, Linear Induction Motor.

## UNIT-IV

**Synchronous Machines: Alternators**: Construction features and types, EMF equation of alternators, armature reaction in alternators, circuit model and phasor diagram, Voltage regulation, Salient pole synchronous machine, two-reaction theory, Applications. **Motors:** Principle of operation, Methods of starting, Torque and power equations, 'V' and inverted 'V' curves, Hunting and its suppression, Applications.

**Text / References:**


1. P.S. Bhimbra, 'Electrical Machinery', Khanna Publications.
2. I.J. Nagarath and D.P. Kothari, "Electric Machines", T.M.H. Publishing Co Ltd., New Delhi, 4th Edition 2010.
3. R. K. Rajput, "Electric Machines", Laxmi Publications.
4. B. L. Thareja, "A Text Book of Electrical Technology", Volume II, S. Chand Publications
5. Fitzgerald Kingsley and Umans, "Electric Machinery" McGraw HillBooks co., New Delhi, VII Edition, 2013.
6. J. B. Gupta., "Theory and Performance of Electrical Machines", Kataria and Sons, 14th edition 2009.
7. A.S. Langsdorf, "Theory of AC Machinery", Tata McGraw Hill.
8. P.S. Bhimbra, "Generalized Theory of Electrical Machines", Khanna Publications.
9. Ashfaq Husain, "Electrical Machines", Dhanpat Rai Publications.

**Course Articulation Matrix:**

| Course/Course Code: Electrical &Hybrid Vehicles (**OE/EE/4-T**), | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
| CO1 | 2 | 1 | 1 | 1 | - | - | - | - | - | - | - | 1 | 1 | - | - |
| CO2 | 1 | 1 | 1 | 1 | - | - | - | - | - | - | - | 1 | 1 | 1 | 1 |
| CO3 | 2 | 1 | 1 | 2 | - | - | 1 | - | - | - | - | - | 1 | 1 | - |
| CO4 | 3 | 2 | 2 | - | - | - | - | - | - | - | - | - | 2 | 1 | - |
| CO5 | 2 | 2 | 1 | 2 | - | - | - | - | - | 2 | - | - | 3 | 1 | - |
| CO6 | 2 | 3 | 1 | - | - | - | 1 | 2 | - | 1 | - | 1 | 1 | 1 | - |

**Correlation level:** **1**- Slight /Low **2-**Moderate/ Medium **3-** Substantial/High

# Detailed Syllabus
# of
# B. Tech. (EE)
# VI Semester
## Open Elective Course-II

Chaudhary Devi Lal University
Sirsa, Haryana (India) – NAAC Accredited Univesity
(Established by the State Legislature Act 9 of 2003)

# Open Elective Course-II for B.Tech. VI Semester

| Sr. No. | Course Code | Course Nomenclature | Offered By | Credits |
|---|---|---|---|---|
| 1 | OE/EE/5-T | Renewable Energy Resources | Electrical Engineering | 3 |
| 2 | OE/EE/6-T | Special Electrical Machines | | 3 |
| 3 | OE/EE/7-T | Smart Grid Technologies | | 3 |
| 4 | OE/EE/8-T | Electrical Measurements & Instruments | | 3 |

# RENEWABLE ENERGY RESOURCES

*(Students from Department of Electrical Engineering cannot opt this subject as Open Elective)*

## General Course Information:

| | |
|---|---|
| Course Code: **OE/EE/5-T**<br>Course Credits: 3<br>Mode: Lecture (L)<br>Type: Open Elective<br>Teaching Schedule L T P: 3 0 0<br>Examination Duration: 03 hours. | **Course Assessment Methods; Max. Marks: 100 (Internal: 30; External: 70)**<br>Three minor tests, each of 20 marks, will be conducted. The third minor will be conducted in open book mode by the Course Coordinator. No date sheet will be issued for the third minor at the level of the Departments. For the purpose of internal assessment, the average of the highest marks obtained by a student in any two minor examinations will be considered. All the minor examination question papers will be prepared and evaluated by following the Outcome Based Education framework. Class Performance will be measured through percentage of lectures attended (4 marks) Assignments (4 marks) and class performance (2 marks).<br><br>The end semester examination will be of 70 marks. For the end semester examination, nine questions are to be set by the examiner. Question number one will be compulsory and based on the entire syllabus. It will contain seven short answers type questions. Rest of the eight questions is to be given by setting two questions from each of the four units of the syllabus. A candidate is required to attempt any other four questions selecting one from each of the four units. All questions carry equal marks. |

## Course outcomes:

| Sr. No. | Course outcomes<br>At the end of the course students will be able to: | RBT* Level |
|---|---|---|
| CO1. | List and describe the various conventional and renewable energ resources and technologies | **L1 (Remembering)** |
| CO2. | Recognize the impact of renewable energy utilization on society and environment | **L2 (Understanding)** |
| CO3. | Interpret and apply the concepts of renewable energy sources for electricity generation and grid integration | **L3 (Applying)** |
| CO4. | Make comparisons among renewable energy resources and technologies | **L4(Analyzing)** |
| CO5. | Assess and select the options among renewable energy resources and technologies | **L5 (Evaluating)** |
| CO6. | Do the basic design of various renewable energy systems for different requirements | **L6 (Creating)** |

***Revised Bloom's Taxonomy Action verbs/Levels**

## Course Content

### UNIT-I

**Introduction:** Over view of conventional & renewable energy sources, Limitations of conventional energy sources, need & development of alternate energy sources, basic schemes and applications of direct energy conversion types of renewable energy systems, Future of Energy Use, Global and Indian Energy scenario, Potential of renewable energy sources, renewable electricity and key elements, Global climate change, CO2 reduction potential of renewable energy, concept of Hybrid systems.

## UNIT-II

**Solar and Wind Energy**:
Solar radiation spectra, solar geometry, Earth Sun angles, observer Sun angles, solar day length, Estimation of solar energy availability, Photovoltaic effect, characteristics of photovoltaic cells, conversion efficiency, solar batteries and applications, Design of standalone PV system, Solar energy in India, solar collectors, solar furnaces & applications, Design of solar water heater,
History of wind power, wind generators, theory of wind power, wind energy conversion system, wind speed and power, scope in India, advantages and limitations.

## UNIT-III

**Thermo-electric and MHD Generators:** Seeback effect, Peltier effect, Thomson effect, Thermo-electric convertors, Brief description of the construction of thermoelectric generators, Applications and economic aspects.
Hall Effect, Basic principles of MHD generator, Different types of MHD generators, Conversion effectiveness, Practical MHD generators, Applications and economic aspects.

## UNIT-IV

**Fuel Cells and Miscellaneous Sources:** Principle of action, Gibbs free energy, general description of fuel cells, types, construction, operational characteristics and applications, Geo-thermal system, characteristics of geothermal resources, Low head hydro-plants, Network Integration Issues: Overview of grid code technical requirements, Power system interconnection experiences in the world

**TEXT AND REFERENCE BOOKS:**


1. G.D. Rai, Non-Conventional sources of Energy, Khanna Publishers, 2009
2. G.S. Sawhney, Non-Conventional Energy Resources, PHI Learning,2012
3. B.H Khan., Non-Conventional Energy Resources, Tata McGrawHill,2009
4. R.A.Coobe, An Introduction to Direct Energy Conservation, Pitman,1968
5. M.A.Kettani, Direct Energy Conversion, Addison-Wesley Educational Publishers Inc,1970
6. Robert L. Loftness, Energy Hand book, Van Nostrand Reinhold, 1984
7. S. S. Rao, B. B. Parulekar, Energy Technology, Khanna Publishers, 1994
8. G. N. Tiwari and M. K. Ghosal, "Renewable Energy Applications", Narosa Publications, 2004
9. S. A. Abbasi. and N. Abbasi, Renewable Energy Sources and Their Environmental Impact, Prentice Hall of India, 2001

**Course Articulation Matrix:**

| Course/Course Code: Renewable Energy Resources (**OE/EE/5-T**), | | | | | | | | | | | | | | | Semester: VI |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
| CO1 | 1 | 1 | - | - | - | - | - | - | - | - | - | 1 | 1 | 1 | - |
| CO2 | 1 | 1 | 1 | 1 | - | - | - | - | - | - | - | 1 | 1 | 1 | - |
| CO3 | 2 | 1 | 1 | 1 | - | - | 1 | - | - | - | - | - | 1 | 1 | 1 |
| CO4 | 3 | 2 | 2 | - | - | - | - | - | - | - | - | - | 2 | 1 | - |
| CO5 | 2 | 2 | 1 | - | 1 | - | - | - | - | - | - | - | 3 | 1 | 1 |
| CO6 | 2 | 3 | 1 | - | 1 | - | 1 | - | - | 1 | - | 1 | 1 | - | - |

**Correlation level:** **1**- Slight /Low **2-**Moderate/ Medium **3**- Substantial/High

# SPECIAL ELECTRICAL MACHINES

*(Students from Department of Electrical Engineering cannot opt this subject as Open Elective)*

## General Course Information:

| | |
|---|---|
| Course Code: **OE/EE/6-T**<br>Course Credits: 3<br>Mode: Lecture (L)<br>Type: Open Elective<br>Teaching Schedule L T P: 3 0 0<br>Examination Duration: 03 hours. | **Course Assessment Methods; Max. Marks: 100 (Internal: 30; External: 70)**<br>Three minor tests, each of 20 marks, will be conducted. The third minor will be conducted in open book mode by the Course Coordinator. No date sheet will be issued for the third minor at the level of the Departments. For the purpose of internal assessment, the average of the highest marks obtained by a student in any two minor examinations will be considered. All the minor examination question papers will be prepared and evaluated by following the Outcome Based Education framework. Class Performance will be measured through percentage of lectures attended (4 marks) Assignments (4 marks) and class performance (2 marks).<br><br>The end semester examination will be of 70 marks. For the end semester examination, nine questions are to be set by the examiner. Question number one will be compulsory and based on the entire syllabus. It will contain seven short answers type questions. Rest of the eight questions is to be given by setting two questions from each of the four units of the syllabus. A candidate is required to attempt any other four questions selecting one from each of the four units. All questions carry equal marks. |

## Course outcomes:

| Sr. No. | Course outcomes<br>At the end of the course students will be able to: | RBT* Level |
|---|---|---|
| CO1. | Trained with the concepts and working of electrical machines | **L1(Remembering)** |
| CO2. | Enhance the knowledge and working of advanced electrical machines | **L2(Understanding)** |
| CO3. | Gain the knowledge of special motors and generators associated with no conventional energy resources | **L3(Apply)** |
| CO4. | Perform in-depth analysis of special motors and its applications in allied fields | **L4(Analysis)** |
| CO5. | Substantially prepared to take up prospective research related to special electrical machines | **L5(Evaluating)** |

***Revised Bloom's Taxonomy Action verbs/Levels**

## Course Content

### UNIT- I

Different types of Fractional Horse power (FHP) motors and uses in domestic & industrial application, Single phase induction motors, its constructions, operating principle, double field revolving theory and other related concepts, qualitative examination, starting methods and running performance of single-phase induction motors.

### UNIT- II

Linear Induction motor, its principle of operation, Linear Levitated Motors & its application, Maglev Motors, Hyperloop motors and its operation, Permanent magnet motors, High performance Energy Efficient motors and its need, Motor Life Cycle, Effect of E.M.F. injected into secondary circuits, qualitative study, Schrage motor,

## UNIT- III

Special Induction generators and its principle of operation, construction, brushless excitation systems for induction generators, Special motors and generators associated with Wind, Solar, Tidal, Biogas and other non-conventional Energy Resources & their applications.

## UNIT- IV

Synchronous motors (3-phase and 1-phase) and its operation, Series Universal motors, Stepper motors and its operation, its types, applications, features and advantages, Permanent Magnet AC motors, Switched Reluctance motors, Servomotors, principles, types and operation, Shaded-pole motors, Brush-less DC motors with salient features, construction, principle of operation & its applications

**REFERENCES:**


1. Dr. P.S. Bhimbra, "Generalized Electrical Machines", Khanna Publications.
2. O.E. Taylor, "The Performance & design of A.C. Commutator Motors", Wheeler.
3. M.G. Say, "Performance & Design of A.C. machines", Pitman Publishing.
4. T.J.E. Miller, "Brushless magnet and Reluctance motor drives", Claudon press, London, 1989.
5. R. Krishnan, "Switched Reluctance Motor drives", CRC press, 2001.
6. T. Kenjo, "Stepping motors and their microprocessor controls", Oxford University press, New Delhi, 2000.

**Course Articulation Matrix:**

| Course/Course Code: Special Electrical Machines(**OE/EE/6-T**), Semester: VI | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
| CO1 | 2 | 1 | 1 | 1 | - | - | - | - | - | - | - | 1 | 1 | - | 1 |
| CO2 | 1 | 1 | 1 | - | - | - | - | - | - | - | - | 1 | 1 | 1 | - |
| CO3 | 2 | 1 | 1 | - | - | - | 1 | - | - | 2 | - | - | 1 | 1 | - |
| CO4 | 3 | 2 | 2 | - | - | - | - | - | - | 1 | - | - | 2 | 1 | - |
| CO5 | 2 | 2 | 1 | 2 | - | - | - | - | - | - | - | - | 3 | 1 | - |
| CO6 | 2 | 3 | 1 | - | - | - | 1 | - | - | 1 | - | 1 | 1 | 1 | - |

**Correlation level:** **1**- Slight /Low **2-**Moderate/ Medium **3-** Substantial/High

# SMART GRID TECHNOLOGIES

*(Students from Department of Electrical Engineering cannot opt this subject as Open Elective)*

**General Course Information:**

| | |
|---|---|
| Course Code: **OE/EE/7-T**<br>Course Credits: 3.0<br>Mode: Lecture (L) and Tutorial (T)<br>Type: Open Elective<br>Teaching Schedule L T P: 3 0 0<br>Examination Duration: 3 hours | **Course Assessment Methods; Max. Marks: 100 (Internal: 30; External: 70)**<br>Three minor tests, each of 20 marks, will be conducted. The third minor will be conducted in open book mode by the Course Coordinator. No date sheet will be issued for the third minor at the level of the Departments. For the purpose of internal assessment, the average of the highest marks obtained by a student in any two minor examinations will be considered. All the minor examination question papers will be prepared and evaluated by following the Outcome Based Education framework. Class Performance will be measured through percentage of lectures attended (4 marks) Assignments (4 marks) and class performance (2 marks).<br><br>The end semester examination will be of 70 marks. For the end semester examination, nine questions are to be set by the examiner. Question number one will be compulsory and based on the entire syllabus. It will contain seven short answers type questions. Rest of the eight questions is to be given by setting two questions from each of the four units of the syllabus. A candidate is required to attempt any other four questions selecting one from each of the four units. All questions carry equal marks. |

**Course Outcomes**

| **Sr. No.** | **Course outcomes**<br>At the end of the course students will be able to: | **RBT* Level** |
|---|---|---|
| CO1. | Recall the basics of Power system and its design aspects. | **L1(Remembering)** |
| CO2. | Describe the structure of smart grid on the basis of traditional grid with the role of automation in transmission and distribution. | **L2(Understanding)** |
| CO3. | Demonstrate the operation, scheduling and economics using evolutionary algorithms for smart grid and maximum utilization of renewable energy resources. | **L3(Apply)** |
| CO4. | Compare its performance with conventional grid and analyze the role of frequency for the control of grid. | **H1(Analysis)** |
| CO5. | Judge and evaluate the efficiency of system on the basis of supply of electricity with its economic indices. | **H2 (Evaluating)** |
| CO6. | Formulate algorithm or automation so that maximum consumer can be benefitted and losses of the system can be minimized. | **H3 (Creating)** |

***Revised Bloom's Taxonomy Action verbs/Level**

**Course Content**

## UNIT-I

**Introduction to Smart Grid:** Smart Grid, Need of Smart Grid, Working definitions of Smart Grid and associated concepts, Smart Grid Functions, Traditional Power Grid and Smart Grid, New Technologies for Smart Grid, Advantages, Whole sale energy market in smart grid, Indian Smart Grid, Key Challenges for Smart Grid.

**UNIT-II**

**Smart Grid Architecture:** Components and Architecture of Smart Grid Design, Review of the proposed architectures for Smart Grid, Fundamental components of Smart Grid designs, Transmission Automation, Distribution Automation, Renewable Integration, Energy

Management in smart grid.

**UNIT-III**

**Tools and Distribution Generation Technologies:** Introduction to Renewable Energy Technologies, Micro grids, Storage Technologies, Electric Vehicles and plug-in hybrids, Environmental impact and Climate Change, Economic Issues, Advanced metering infrastructure.

**UNIT-IV**

**Communication Technologies and Smart Grid:** Introduction to Communication Technology, Synchro Phasor Measurement Units (PMUs), Wide Area Measurement Systems (WAMS).

**Control of Smart Power Grid System:** Load Frequency Control (LFC) in Micro Grid System – Voltage Control in Micro Grid System, Reactive Power Control in Smart Grid, Case Studies for the Smart Grids.

**REFERENCES:**


**1.** James Momoh, "Smart Grid - fundamentals of design and analysis", John Wiley and Sons, 2012.

**2.** Janaka Ekanayake, "Smart Grid -Technology and Applications", John Wiley and Sons, 2012.

**3.** Stuart Borlase, "Smart Grids, Infrastructure, Technology and Solutions", CRC Press, 2013.

**4.** Gil Masters, "Renewable and Efficient Electric Power System", Wiley-IEEE Press, 2004.

**5.** A.G. Phadke and J.S. Thorp, "Synchronized Phasor Measurements and their Applications", Springer Edition, 2010.

**6.** T. Ackermann, "Wind Power in Power Systems", Hoboken, NJ, USA, John Wiley, 2005.

**Course Articulation Matrix:**

| Course/Course Code: Smart Grid Technologies (**OE/EE/7-T**), | | | | | | | | | | | | Semester: VI | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
| CO1 | 2 | - | - | - | - | - | - | - | - | - | - | 1 | 1 | - | - |
| CO2 | 1 | 1 | 1 | - | - | - | - | - | - | - | - | 1 | 1 | 1 | - |
| CO3 | 2 | 1 | 1 | - | - | - | 1 | - | - | - | - | - | 1 | 1 | - |
| CO4 | 2 | 1 | 2 | - | - | - | - | - | - | - | - | - | 2 | 1 | - |
| CO5 | 2 | 2 | 3 | - | - | - | - | - | - | - | - | - | 3 | 1 | - |
| CO6 | 1 | 3 | 1 | - | - | - | 1 | - | - | 1 | - | 1 | 1 | - | - |

**Correlation level:** **1**- Slight /Low **2-**Moderate/ Medium **3-** Substantial/High

# ELECTRICAL MEASUREMENTS & INSTRUMENTS

*(Students from Department of Electrical Engineering cannot opt this subject as Open Elective)*

## General Course Information:

| | |
|---|---|
| Course Code: **OE/EE/8-T**<br>Course Credits: 3<br>Mode: Lecture (L)<br>Type: Open Elective<br>Teaching Schedule L T P: 3 0 0<br>Examination Duration: 03 hours. | **Course Assessment Methods; Max. Marks: 100 (Internal: 30; External: 70)**<br>Three minor tests, each of 20 marks, will be conducted. The third minor will be conducted in open book mode by the Course Coordinator. No date sheet will be issued for the third minor at the level of the Departments. For the purpose of internal assessment, the average of the highest marks obtained by a student in any two minor examinations will be considered. All the minor examination question papers will be prepared and evaluated by following the Outcome Based Education framework. Class Performance will be measured through percentage of lectures attended (4 marks) Assignments (4 marks) and class performance (2 marks).<br><br>The end semester examination will be of 70 marks. For the end semester examination, nine questions are to be set by the examiner. Question number one will be compulsory and based on the entire syllabus. It will contain seven short answers type questions. Rest of the eight questions is to be given by setting two questions from each of the four units of the syllabus. A candidate is required to attempt any other four questions selecting one from each of the four units. All questions carry equal marks. |

## Course outcomes:

| Sr. No. | Course outcomes<br>At the end of the course students will be able to: | RBT* Level |
|---|---|---|
| CO1. | To impart the knowledge of fundamentals of measuring instruments and their characteristics. | **L1 (Remembering)** |
| CO2. | Study of various types of instrumentation based on the principle, operation and measurements of various electrical quantities. | **L2 (Understanding)** |
| CO3. | Understand the working principle and construction of the measuring instruments like wattmeter, energy meter & frequency meter | **L3 (Applying)** |
| CO4. | Measurement of resistance and instruments required | **L4(Analyzing)** |
| CO5. | Study of measurement of inductance, capacitance with bridges & instruments. | **L6 (Creating)** |

***Revised Bloom's Taxonomy Action verbs/Levels**

## Course Content

### UNIT-I

**Units standards and errors**: S.I. units, Absolute, standards (International, Primary, Secondary & Working standards), True Value, Errors (Gross, Systematic & Random), State Characteristics of Instruments (Accuracy, Precision, Sensitivity, Resolution & threshold etc.).

**Measuring System fundamentals**: Classifications of measuring instruments (Absolute and Secondary) Instruments; Indicating, Recording & Integrating Instruments; Based on: Principle of operation, Generalized Instruments (Block diagram, description of blocks), three forces of Electromechanical Indicating Instruments (Deflecting, Controlling & Damping forces), Comparison between controlling methods

**UNIT-II**

**Measuring Instruments**: Construction and working principle of Electromechanical instruments, Torque equation, Shape of Scale, Use as Ammeter or as Voltmeter, Extension of range, Use as AC/DC or both, Advantages and Disadvantages of each type of measuring instruments, Errors in each instrument, PMMC type, Electro-dynamic type, Moving Iron Type (attraction, repulsion & combined types), Induction type, Hot wire type.

**UNIT-III**

**Wattmeters and Energy Meters**: Construction, operating principle, Torque equation, Shape of Scale, Errors, Advantages and Disadvantages of Electrodynamic & Induction type Wattmeters; & single phase induction type energy meters, Compensation and creep in energy meters, Electronic Energy meters.

**UNIT-IV**

**Low and High resistance measurements**: Wheat Stone bridge, its operating principle, Advantages & Limitations, Kelvin's Double bridge method, Measurement of high resistance and difficulties of its measurement, Direct method, loss of charge method, Magaohm bridge & Meggar.

**A.C. Bridges**: General balance equation of A.C. bridges, Circuit diagram, Phasor diagram, advantages and disadvantages, Applications of Maxwell's inductance , inductance-capacitance, Hay's bridge, Anderson's bridge, Owen's bridge, De-Sauty's bridge, Schering bridge & Wein's bridge etc.

**Text / References:**


1. A.K. Sawhney, "A Course in Electrical Measurement & Instrumentation", Khanna Publicaitons.
2. E.W. Golding, "Electrical Measurements".
3. J.B. Gupta, "Electronic & Electrical Measurement & Instrumentation", S.K. Kataria & Sons.
4. W.D. Cooper & A.D. Helfrick, "Electronic Instrumentation & Measuring Techniques".
5. E.O. Doeblin, "Measuring Systems", TMH.

**Course Articulation Matrix:**

| Course/Course Code: _Electrical Measurements & Instruments (**OE/EE/8-T**), | | | | | | | | | | | | | Semester: VI | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
| CO1 | 2 | 1 | - | 1 | - | - | - | - | - | - | - | 1 | 1 | - | - |
| CO2 | 1 | 1 | 1 | - | - | - | - | - | - | - | - | 1 | 1 | 1 | - |
| CO3 | 2 | 1 | 1 | - | - | - | 1 | - | - | - | - | - | 1 | 1 | - |
| CO4 | 3 | 2 | 1 | - | - | 1 | - | - | - | - | - | 1 | 2 | 1 | - |
| CO5 | 2 | 2 | 2 | - | - | - | - | - | - | - | - | - | 3 | 1 | - |
| CO6 | 2 | 3 | 1 | - | - | - | 1 | - | - | 1 | - | 3 | 1 | - | - |

**Correlation level:** **1**- Slight /Low **2**-Moderate/ Medium **3**- Substantial/High

# Detailed Syllabus
# of
# B. Tech. (EE)
# VII Semester
## Open Elective Course-III

Chaudhary Devi Lal University
Sirsa, Haryana (India) – NAAC Accredited Univesity
(Established by the State Legislature Act 9 of 2003)

# Open Elective Course-III for B.Tech. VII Semester

| Sr. No. | Course Code | Course Nomenclature | Offered By | Credits |
|---|---|---|---|---|
| 1 | OE/EE/9-T | Energy Management and Auditing | Electrical Engineering | 3 |
| 2 | OE/EE/10-T | Power Plant Engineering | | 3 |
| 3 | OE/EE/11-T | Transducers and Sensors | | 3 |
| 4 | OE/EE/12-T | EHV AC and DC Transmission | | 3 |

# ENERGY MANAGEMENT AND AUDIT

*(Students from Department of Electrical Engineering cannot opt this subject as Open Elective)*

## General Course Information:

| | |
|---|---|
| Course Code: **OE/EE/9-T**<br>Course Credits: 3<br>Mode: Lecture (L)<br>Type: Open Elective<br>Teaching Schedule L T P: 3 0 0<br>Examination Duration: 03 hours. | **Course Assessment Methods; Max. Marks: 100 (Internal: 30; External: 70)**<br>Three minor tests, each of 20 marks, will be conducted. The third minor will be conducted in open book mode by the Course Coordinator. No date sheet will be issued for the third minor at the level of the Departments. For the purpose of internal assessment, the average of the highest marks obtained by a student in any two minor examinations will be considered. All the minor examination question papers will be prepared and evaluated by following the Outcome Based Education framework. Class Performance will be measured through percentage of lectures attended (4 marks) Assignments (4 marks) and class performance (2 marks).<br><br>The end semester examination will be of 70 marks. For the end semester examination, nine questions are to be set by the examiner. Question number one will be compulsory and based on the entire syllabus. It will contain seven short answers type questions. Rest of the eight questions is to be given by setting two questions from each of the four units of the syllabus. A candidate is required to attempt any other four questions selecting one from each of the four units. All questions carry equal marks. |

**Course Outcomes**

| Sr. No. | Course outcomes<br>At the end of the course students will be able to: | RBT* Level |
|---|---|---|
| CO1. | Describe the present state of energy scenario | **L1(Remembering)** |
| CO2. | Describe the energy management and savings through the different levels during utilization | **L2(Understanding)** |
| CO3. | Solve the problems related with energy management and audit. | **L3(Apply)** |
| CO4. | Perform economic and energy efficiency analysis of various electrical devices on the behalf of their energy audit repot. | **H1(Analysis)** |
| CO5. | Create energy audit report for industrial, residential and commerci consumers | **H3 (Creating)** |

***Revised Bloom's Taxonomy Action verbs/Level**

## Course Content

### UNIT-I

**Energy Scenario:** Commercial and Non-Commercial Energy, Primary and Secondary Energy Resources, Conventional and non-conventional energy, Commercial Energy Production, Final Energy Consumption, Energy Needs of Growing Economy, Long Term Energy Scenario, Energy Pricing, Energy Sector Reforms, Energy and Environment: Air Pollution, Climate Change, Energy Security, Energy Conservation and its Importance, Energy Strategy for the Future

### UNIT-II

**Energy Management Functions:** Need for energy management, Energy management program, Organizational Structure, Energy Policy, Planning, Audit Planning, Educational Planning, Strategic Planning, Reporting

### UNIT-III

**Electrical Energy Management:** Electricity tariff, Electrical Load Management and Maximum Demand Control, Maximum demand controllers, Power Factor & Its importance, Automatic power factor controllers, Energy efficient motors, Soft starters with energy saver, Energy efficient transformers, Electronic ballast, Energy efficient lighting controls

## UNIT-IV

**Energy Audit:** Definition, Energy audit- need, Types of energy audit, Energy Auditing Services, Basic Components of an Energy Audit, Specialized Audit Tools, Industrial Audits, Commercial Audits, Residential Audits, Indoor Air Quality and basics of economic analysis.

**REFERENCES**:


1. Wayne C. Turner, Steve Doty, "Energy Management Hand book", The Fairmont Press, VIEdition, 2007
2. Amit K. Tyagi, "Handbook on Energy Audits and Management", Tata Energy Research Institute, 2nd reprint, 2003.
3. Barney L. Capehart, Wayne C. Turner, William J. Kennedy, "Guide to Energy Management", CRC Press.
4. www.bee-india.nic.in, BEE Reference book: no.1/2/3/4.

**Course Articulation Matrix:**

| Course/Course Code:- Energy Management and Audit (**OE/EE/9-T**), | | | | | | | | | | | | Semester: VII | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
| CO1 | 2 | - | - | 1 | - | - | - | - | - | - | - | 1 | 1 | - | - |
| CO2 | 1 | 1 | 1 | - | - | 1 | - | - | - | - | - | 1 | 1 | 1 | - |
| CO3 | 2 | 1 | 1 | - | - | - | 1 | - | - | - | - | - | 1 | 1 | 2 |
| CO4 | 3 | 2 | 1 | - | 1 | - | - | 1 | - | - | 1 | - | 2 | 1 | - |
| CO5 | 2 | 2 | 2 | - | - | - | - | - | - | - | - | - | 3 | 1 | 2 |
| CO6 | 2 | 3 | 1 | - | - | - | 1 | - | - | 1 | - | 3 | 1 | 1 | 2 |

**Correlation level:** **1**- Slight /Low **2-**Moderate/ Medium **3**- Substantial/High

# POWER PLANT ENGINEERING

*(Students from Department of Electrical Engineering cannot opt this subject as Open Elective)*

## General Course Information:

| | |
|---|---|
| Course Code: **OE/EE/10-T**<br>Course Credits: 3.0<br>Mode: Lecture (L)<br>Type: Open Elective<br>Teaching Schedule L T P: 3 0 0<br>Examination Duration: 3 hours | **Course Assessment Methods; Max. Marks: 100 (Internal: 30; External: 70)**<br>Three minor tests, each of 20 marks, will be conducted. The third minor will be conducted in open book mode by the Course Coordinator. No date sheet will be issued for the third minor at the level of the Departments. For the purpose of internal assessment, the average of the highest marks obtained by a student in any two minor examinations will be considered. All the minor examination question papers will be prepared and evaluated by following the Outcome Based Education framework. Class Performance will be measured through percentage of lectures attended (4 marks) Assignments (4 marks) and class performance (2 marks).<br><br>The end semester examination will be of 70 marks. For the end semester examination, nine questions are to be set by the examiner. Question number one will be compulsory and based on the entire syllabus. It will contain seven short answers type questions. Rest of the eight questions is to be given by setting two questions from each of the four units of the syllabus. A candidate is required to attempt any other four questions selecting one from each of the four units. All questions carry equal marks. |

### Course outcomes:

| Sr. No. | Course outcomes<br>At the end of the course students will be able to: | RBT* Level |
|---|---|---|
| CO1. | Describe and analyze different types of sources and mathematical expressions related to thermodynamics and various terms and factors involved with power plant operation. | **L1(Remembering)** |
| CO2. | Summarize the working and layout of steam power plants and discuss about its economic and safety impacts. | **L2(Understanding)** |
| CO3. | Illustrate the working principle and basic components of the nuclear power plant, diesel engine and the economic and safety principles involved with it. | **L3(Apply)** |
| CO4. | Examine the mathematical and working principles of different electrical equipment's involved in the generation of power. | **L4(Analysis)** |
| CO5. | Evaluate the different power generating systems | **L5(Evaluating)** |
| CO6. | Construct the model on the applications basis of power plant | **L6(Creating)** |

***Revised Bloom's Taxonomy Action verbs/Levels**

## Course Content

### UNIT- I

**Load and loading forecasting:** Load curves, maximum demand, load factor, diversity factor, capacity factor, utilization factor, types of loads, load forecasting.

**Power plant economics:** Choice of type of generation, size of generator and number of units, cost of electrical energy, depreciation of plant, effect of load factor on cost of electrical energy.

## UNIT- II

**Thermal power plants:** Choice of site, main and auxiliary equipment fuel gas flow diagram, water stream flow diagram, working of power plants and their layout, characteristics of turbo generators.
**Hydroelectric plants:** Choice of site, classification of hydroelectric plants, main parts and working of plants and their layouts, characteristics of hydro electric generators.

## UNIT- III

**Nuclear power plants:** Choice of site, classification of plants, main parts, layout and their working, associated problems.
**Diesel power plants:** Diesel plant equipment, diesel plant layout and its working, application of diesel plants.

## UNIT- IV

**Combined working of plants:** Advantages of combined operation plant requirements for base load and peak load operation. Combined working of run off river plant and steam plant.
**Tariffs and power factor improvement:** Different types of tariffs and methods of power factor improvement.

**REFERENCES:**


**1** P.K. Nag, "Power Plant Engineering", Tata McGraw Hill.
**2** F.T. Morse, "Power Plant Engineering", Affiliated East-West Press Pvt. Ltd, New Delhi/Madras.
**3** Kothari & Nagrath, "Power System Engineering", McGraw Hill.
**4** Granger and Stevenson, "Power System Analysis", McGraw Hill.
**5** Electric Power Generation operation and control, Wood and Wollenberg, Willey.
**6** R.K. Rajput, Power System Engineering, Laxmi Publication.

**Course Articulation Matrix:**

| Course/Course Code:- Power Plant Engineering (**OE/EE/10-T**), | | | | | | | | | | Semester: VII | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
| CO1 | 2 | - | 2 | - | - | - | - | 1 | - | 1 | - | 1 | 1 | - | - |
| CO2 | 1 | 1 | 1 | 2 | 1 | - | - | - | - | - | - | 1 | 1 | 1 | - |
| CO3 | 2 | 1 | 1 | - | - | - | 1 | - | - | 2 | - | - | 1 | 1 | - |
| CO4 | 3 | 2 | 1 | - | 2 | - | - | - | 2 | - | - | 1 | 2 | 1 | 1 |
| CO5 | 2 | 2 | 3 | - | - | - | - | - | - | - | 1 | - | 3 | 1 | - |
| CO6 | 2 | 3 | 1 | - | 2 | - | 1 | - | - | 1 | - | 3 | 1 | - | - |

**Correlation level:** **1**- Slight /Low **2-**Moderate/ Medium **3**- Substantial/High

# TRANSDUCERS AND SENSORS

*(Students from Department of Electrical Engineering cannot opt this subject as Open Elective)*

**General Course Information:**

| | |
|---|---|
| Course Code: **OE/EE/11-T**<br>Course Credits: 3.0<br>Mode: Lecture (L)<br>Type: Open Elective<br>Teaching Schedule L T P: 3 0 0<br>Examination Duration: 3 hours | **Course Assessment Methods; Max. Marks: 100 (Internal: 30; External: 70)**<br>Three minor tests, each of 20 marks, will be conducted. The third minor will be conducted in open book mode by the Course Coordinator. No date sheet will be issued for the third minor at the level of the Departments. For the purpose of internal assessment, the average of the highest marks obtained by a student in any two minor examinations will be considered. All the minor examination question papers will be prepared and evaluated by following the Outcome Based Education framework. Class Performance will be measured through percentage of lectures attended (4 marks) Assignments (4 marks) and class performance (2 marks).<br><br>The end semester examination will be of 70 marks. For the end semester examination, nine questions are to be set by the examiner. Question number one will be compulsory and based on the entire syllabus. It will contain seven short answers type questions. Rest of the eight questions is to be given by setting two questions from each of the four units of the syllabus. A candidate is required to attempt any other four questions selecting one from each of the four units. All questions carry equal marks. |

**Course outcomes:**

| Sr. No. | Course outcomes<br>At the end of the course students will be able to: | RBT* Level |
|---|---|---|
| CO1. | Understand about conventional transducers and select the suitable one for the given application. | **L1(Remembering)** |
| CO2. | Analyze and quantify the uncertainties in measurement data. | **L2(Understanding)** |
| CO3. | Design and develop customized smart sensors for different applications. | **L3(Apply)** |
| CO4. | Acquire a comprehensive knowledge of manufacturing techniques and design aspects of micro sensors and actuators. | **L4(Analysis)** |
| CO5. | Stability Analysis of a systems and design the controllers accordingly | **L5(Evaluating)** |
| CO6. | Applications of sensors for particular process control applications. | **L6(Creating)** |

***Revised Bloom's Taxonomy Action verbs/Levels**

## Course Content

### UNIT- I

Definition of transducer, Advantages of an electrical signal as output, Basic requirements of transducers, Primary and Secondary Transducer, Analog or digital types of transducers. Resistive, Inductive, capacitive, piezoelectric and Hall effect transducers, photovoltaic cells, semiconductor photodiode

**Measurement of Displacement:** Potentiometer resistance type transducers, inductive types transducers, differential transformer (L.V.D.T.), capacitive transducer, Hall Effect transducer

### UNIT- II

**Measurement of Pressure:** Manometer, Force Summing devices and electrical transducers
**Measurement of Flow:** Venturimeter, orifice meter, Pitot- static tube, rotameter, turbine flow meter,

ultrasonic flow meter, electromagnetic flow meter, hot wire anemometer.
**Measurement of Liquid Level:** Resistive method, Inductive methods, Capacitive methods

## UNIT- III

**Measurement of Temperature:** Metallic Resistance thermometers, semiconductor resistance sensors (Thermistors), thermo-electric sensors, Thermocouple.
**Measurement of Humidity:** Resistive, capacitive, aluminum oxide and crystal hygrometers.
**Measurement of Velocity:** variable reluctance pick up, electromagnetic tachometers, photoelectric transducer, toothed rotor tachometer generator.

## UNIT- IV

**Data Acquisition Systems and Conversion**: Introduction, Objectives and Configuration of Data Acquisition System, various types of Data Acquisition Systems, Data Conversion. Data acquisition in instrumentation systems.
**Smart Sensors**: Introduction to smart sensors, components of smart sensors, General architecture of smart sensors, Evolution of Smart Sensors, Advantages, standards for smart sensor interface, Industrial applications of smart sensors.

**Text Books**:
A.K.Sawhney, “A Course in Electrical and Electronics Measurement and Instrumentation,”Dhanpat Rai & Co.
D. Patranabis, “Sensors and Transducers,” PHI
B.C. Nakra, K.K. Chaudhary, “Instrumentation Measurement and Analysis”. Tata McGraw Hill Publishing Company Limited, New Delhi.

**REFRENCES**:

Data Acquisition and Signal Processing for Smart Sensors by Nikolay Kirianaki, Sergey Yurish, Nestor Shpak, Vadim Deynega, John Wiley & Sons Ltd.
D.V.S. Murty, “Transducers and Instrumentation”, Prentice Hall India.
Helfrick Albert D. and Cooper W. D., "Modern Electronic Instrumentation and Measurement Techniques", Prentice Hall India.
David A. Bell "Electronic Instrumentation and Measurements", PHI / Pearson Education.

**Course Articulation Matrix:**

| Course/Course Code:- Transducers and Sensors (**OE/EE/11-T**), Semester: VII | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
| CO1 | 2 | - | 1 | - | 1 | - | - | - | - | - | - | 1 | 1 | - | - |
| CO2 | 1 | 1 | 1 | 1 | - | 1 | - | - | - | - | - | 1 | 1 | 1 | 1 |
| CO3 | 2 | 1 | 1 | - | - | 1 | 1 | - | - | - | - | - | 1 | 1 | - |
| CO4 | 3 | 1 | 3 | - | 1 | - | - | - | - | - | 1 | - | 2 | 1 | 1 |
| CO5 | 2 | 2 | 2 | - | - | 1 | - | 1 | - | - | - | - | 3 | 1 | - |
| CO6 | 2 | 1 | 1 | - | - | - | 1 | - | - | 1 | - | 3 | 1 | - | - |

**Correlation level:** **1**- Slight /Low **2-**Moderate/ Medium **3**- Substantial/High

# EHV AC AND DC TRANSMISSION

*(Students from Department of Electrical Engineering cannot opt this subject as Open Elective)*

**General Course Information:**

| | |
|---|---|
| Course Code: **OE/EE/12-T**<br>Course Credits: 3.0<br>Mode: Lecture (L)<br>Type: Open Elective<br>Teaching Schedule L T P: 3 0 0<br>Examination Duration: 3 hours | **Course Assessment Methods; Max. Marks: 100 (Internal: 30; External: 70)**<br>Three minor tests, each of 20 marks, will be conducted. The third minor will be conducted in open book mode by the Course Coordinator. No date sheet will be issued for the third minor at the level of the Departments. For the purpose of internal assessment, the average of the highest marks obtained by a student in any two minor examinations will be considered. All the minor examination question papers will be prepared and evaluated by following the Outcome Based Education framework. Class Performance will be measured through percentage of lectures attended (4 marks) Assignments (4 marks) and class performance (2 marks).<br><br>The end semester examination will be of 70 marks. For the end semester examination, nine questions are to be set by the examiner. Question number one will be compulsory and based on the entire syllabus. It will contain seven short answers type questions. Rest of the eight questions is to be given by setting two questions from each of the four units of the syllabus. A candidate is required to attempt any other four questions selecting one from each of the four units. All questions carry equal marks. |

**Course outcomes:**

| Sr. No. | Course outcomes<br>At the end of the course students will be able to: | RBT* Level |
|---|---|---|
| CO1. | Elicit the major components, advantages, limitations and applications of EHV AC and DC transmission Systems | **L1(Remembering** |
| CO2. | Recapitulate the fundamental aspects of Extra High Voltage A.C and DC transmission design and analysis | **L2(Understandin** |
| CO3. | Apply the remedial measures against the problems associated with EHVAC and DC transmission such as Corona, AN, RI, Over-voltages, Ferro-resonance, Harmonics in converters | **L3(Apply)** |
| CO4. | Perform in-depth analysis of various control techniques for controlling the power flow through a dc link and multi-terminal operation of HVDC | **L4(Analysis)** |
| CO5. | Critically evaluate AC and DC transmission system with respect to all aspects | **L5(Evaluating)** |

***Revised Bloom's Taxonomy Action verbs/Levels**

## Course Content

### UNIT- I

**Introduction**: Need of EHV transmission, standard transmission voltage, Power handling capacity, Comparison of EHV AC & DC transmission systems and their applications & limitations, Bundled conductors, Surface voltage gradients in conductor, Distribution of voltage gradients on sub-conductors, mechanical considerations of transmission lines, modern trends in EHV AC & DC transmission.

### UNIT- II

**EHV AC Transmission**: Corona, Corona loss formulae, corona current, Audible noise- generation and characteristics corona pulses their generation and properties, Radio interference (RI) effects, Over voltage due to switching, Ferro-resonance, reduction of switching surges on EHV system, principle of half wave transmission**.**

## UNIT- III

**Components of EHV D.C.:** Converter circuits, Rectifier and inverter valves, Reactive power requirements, Harmonics generation, Adverse effects, Classification, Remedial measures to suppress, Filters, Ground return, Converter faults & protection harmonics, misoperation, Commutation failure, Multi-terminal D.C. lines.

## UNIT- IV

**Control of EHV D.C.:** Desired features of control, control characteristics, Constant current control, Constant extinction angle control. Ignition Angle control, Parallel operation of HVAC & DC system, Problems & advantages.

**REFERENCES:**


1. R.D. Begamudre, "EHV AC Transmission Engineering", Wiley Eastern Press, 2011
2. S. S. Rao, "EHV AC & DC Transmission", Khanna publishers, 2008
3. E. Kimbark, "HVDC Transmission", John Wiley and Sons, 1971
4. J. Arrillaga, "HVDC Transmission", 2nd Edition, IEEE Press, 1998
5. K. R. Padiyar, "HVDC Transmission, New Age International", 2nd edition, 2012
6. P. Kundur, "Power System Stability and Control", Tata McGraw Hill, 1994


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**Course Articulation Matrix:**

| Course/Course Code:- EHVAC and DC (**OE/EE/12-T**), Semester: VII | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
| CO1 | 2 | - | 1 | - | - | - | - | - | - | - | - | 1 | 1 | 1 | - |
| CO2 | 1 | 1 | 1 | - | - | - | - | - | - | - | - | 1 | 1 | 1 | - |
| CO3 | 2 | 1 | 1 | 2 | 1 | - | 1 | - | - | - | - | 1 | 1 | 1 | 1 |
| CO4 | 3 | 2 | 1 | - | - | - | - | 1 | - | 1 | - | - | 2 | 1 | - |
| CO5 | 2 | 2 | 3 | - | 1 | - | - | - | - | - | - | - | 3 | 1 | - |
| CO6 | 2 | 3 | 3 | - | - | - | 1 | - | - | 1 | - | 3 | 1 | - | 1 |

**Correlation level:** **1**- Slight /Low **2-**Moderate/ Medium **3**- Substantial/High