Preface

PES College of Engineering, Mandya, started in the year 1962, has become autonomous in the academic year 2008-09. Since, then it has been doing the academic and examination activities successfully. The college is running Eight undergraduate and Eight Postgraduate programs. It consists of Six M.Tech programs, which are affiliated to VTU. Other postgraduate programs are MBA and MCA.

India has recently become a Permanent Member by signing the Washington Accord. The accord was signed by the National Board of Accreditation (NBA) on behalf of India on 13th June 2014. It enables not only the mobility of our degree globally but also establishes equivalence to our degrees with that of the member nations such as Taiwan, Hong Kong, Ireland, Korea, Malaysia, New Zealand, Russia, Singapore, South Africa, Turkey, Australia, Canada and Japan. Among other signatories to the international agreement are the US and the UK. Implementation of Outcome
Based Education (OBE) has been the core issue for enabling the equivalence and of Indian degrees and their mobility across the countries.

Our Higher Educational Institution has adopted the CBCS based semester structure with OBE scheme and grading system.

The credit based OBE semester system provides flexibility in designing curriculum and assigning credits based on the course content and hours of teaching.

The OBE, emphasize setting clear standards for observable, measurable outcomes of programs in stages. There lies a shift in thinking, teaching and learning processes moving towards Students Centric from Teacher Centric education. OBE standards focus on mathematics, language, science, attitudes, social skills & moral values.

The key features which may be used to judge, if a system has implemented an outcome based education system is mainly Standard based assessments that determines whether students have achieved the stated standard. Assessments may take any form, so long as the process actually measure whether the student knows the required information or can perform the required task. Outcome based education is a commitment that all students of all groups will ultimately reach the same minimum standards. Outcome Based Education is a method or means which begins with the end in mind and constantly emphasizes continuous improvement.

Choice Based Credit System (CBCS) provides choice for students to select from the prescribed courses (core, Foundation, Foundation Elective, elective, open elective and minor or soft skill courses). The CBCS provides a ‘cafeteria’ type approach in which the students can Choose electives from a wide range of courses of their choice, learn at their own pace, undergo additional courses and acquire more than the required credits, adopt an interdisciplinary approach to learning which enables integration of concepts, theories, techniques, and, perspectives from two or more disciplines to advance fundamental understanding or to solve problems whose solutions are beyond the scope of a single discipline. These greatly enhance the skill/employability of students.

In order to increase the Industry/Corporate readiness, many Soft Skills and Personality Development modules have been added to the existing curriculum of the academic year 2015-16. Industry Interactions have been made compulsory to enhance the field experience. In order to enhance creativity and innovation Mini Project and Industrial visit & Interaction are included in all undergraduate programs.

Dr. Umesh D.R.  
Deputy Dean (Academic)  
Associate Professor, 
Dept. of Computer Science & Engg.  
Dr. Girish.R  
Dean (Academic)  
Professor,  
Dept. of Computer Science & Engg.  

P.E.S.COLLEGE OF ENGINEERING, MANDYA-571 401  
(An Autonomous Institution under VTU, Belagavi)

DEPARTMENT OF ELECTRICAL & ELECTRONICS ENGINEERING

Profile

Department of Electrical & Electronics Engineering Programme has been accredited by NBA for 6 Academic years (2017-18 to 2022-23).

The Department of Electrical and Electronics Engineering was established right from the inception of the institute in the year 1962. The various programs offered by the
Department are B.E., M.Sc., (Engg.) by research and research leading Ph.D affiliated to Visvesvaraya Technological University (VTU), Belagavi. Also, Department is affiliated for Ph.D program with University of Mysore, Mysore and Kuvempu University, Shimoga. About 100 research papers have been published by the Department faculty members in various International & National journals and conferences.

The Department emphasizes towards imparting quality education, rigorous teaching-learning, hands-on expertise and helping students to shape their all-round personality. The Department with its strong pool of faculty, well-developed laboratories, latest software and hardware facilities, contributes to develop life-long learning skills to its students and producing worthy researchers by offering doctoral research program.

The academic programs are designed and updated keeping in view the constantly changing industrial needs, skills and challenges emerging out of new research. The academic programs are well received by the industry and academia. The department has always exerted the best of its effort to meet the objectives of achieving technical excellence in the areas of Electrical and Electronics Engineering such as High Voltage Engineering, Power Electronics & Drives, Control Systems, Power Systems, Energy Systems, Analog and Digital Electronics, Signal Processing, PLC & SCADA and Microcontrollers.

The Department regularly organizes industrial visits, Technical lectures by experts from industries and institutes in contemporary areas to bridge the gap between syllabi and current developments.
VISION
The department of E & E would endeavour to create a pool of Engineers who would be technically competent, ethically strong also fulfill their obligation in terms of social responsibility.

MISSION
- Adopt the best pedagogical methods and provide the best facility, infrastructure and an ambience conducive to imbibe technical knowledge and practicing ethics.
- Group and individual exercises to inculcate habit of analytical and strategic thinking to help the students to develop creative thinking and in still team skills.
- MOUs and Sponsored projects with industry and R & D organizations for Collaborative learning
- Enabling and encouraging students for continuing Education and moulding them for life-long learning process

PROGRAM EDUCATIONAL OBJECTIVES (PEOs)
PEO1: Excel in professional career and/or higher education by acquiring knowledge in mathematical, computing and Electrical & Electronics engineering principles
PEO2: Analyze real life problems and Design Electrical & Electronics Engineering system with appropriate solutions that are technically sound, economically feasible and socially acceptable
PEO3: Exhibit professionalism, ethical attitude, communications kills, team work in their profession and adapt to current trends by engaging in lifelong learning.

PROGRAMME OUTCOMES (POs)
PO-1: Graduates will apply the knowledge of mathematics, Physics, chemistry and allied engineering subjects to solve problems in Electrical and Electronics Engineering.
PO-2: Graduates will Identify, formulate and solve Electrical and Electronics Engineering problem.
PO-3: Graduates will design Electrical and Electronics systems meeting the given specifications for different problems taking safety and precautions into consideration.
PO-4: Graduates will design, conduct experiments, analyze and interpret data
PO-5: Graduates will use modern software tools to model and analyze problems, keeping in view their limitations.
PO-6: Graduates will understand the impact of local and global issues / happenings on Electrical Engineers.
PO-7: Graduates will provide sustainable solutions for problems related to Electrical and Electronics Engineering and also will understand their impact on environment.

PO-8: Graduates will have knowledge of professional ethics and code of conduct as applied to Electrical Engineers.

PO-9: Graduates will work effectively as an individual and as a member or leader in diverse teams and in multi-disciplinary settings.

PO-10: Graduates will communicate effectively in both verbal and written form.

PO-11: Graduates will plan, execute and complete projects

PO-12: Graduates will have the ability for self-education and lifelong learning

PROGRAMME SPECIFIC OUTCOMES (PSOs)

PSO1: To understand the concept in Electrical and Electronics Engineering and apply them to develop modules analyze assess the performance of various power system equipment, generation, transmission, utilization and protection mechanisms.

PSO2: Design, develop, analyze and test electrical and electronics system: Deploy control strategies for electrical dives, power system networks, power electronics, high voltage and other related applications.
### VII Semester B.E Electrical & Electronics Engineering

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### VIII Semester B.E Electrical & Electronics Engineering

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#### Professional Elective – IV

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<td>2.</td>
<td>P18EE822</td>
<td>Energy Auditing &amp; Demand Side Management</td>
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<td>3.</td>
<td>P18EE823</td>
<td>Power system operation and control</td>
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Course Title: Computer Techniques In Power Systems

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Prerequisites: The student should have undergone the course on Power system Analysis, transmission and distribution and A.C. machines

Course Learning Objectives (CLOs)

This course aims to:
1. Form the bus admittance matrix for the given power system network by singular transformation method.
2. Develop general power flow equations (PFE) or Load flow analysis (LF) equations for an n-bus power system.
3. Solve PFE (LFA) using algorithms such as Gauss-Seidel and Newton-Raphson methods.
4. Analyze or Design a power system for a given operation conditions.
5. To allocate the total demand of a power system by optimizing the overall operating costs.
6. Determine the transient stability of a power system.

Relevance of the Course
This course covers the analysis of large power systems by using computers. For large power system networks, it is not possible use conventional methods that employ manual calculations. Hence, it is necessary to go for the computer oriented techniques which are based on numerical methods. In this course students are thought how to do Load flow analysis, stability analysis of power system, and perform economic operation of power system.

Course Content

Unit - I

Self-study: program to calculate incidence matrices using software

10 Hrs

Unit - II
Network Matrices: Introduction, Formation of Ybus – by method of inspection, by method of singular transformation (YBUS = At[y]A); Formation of Bus Impedance Matrix with(3x3) and without mutual coupling elements. Problems on Ybus and Zbus formation

Self-study: Program to form Ybus and Zbus matrices.

10 Hrs

Unit – III
Load Flow Studies: Introduction, Power flow equations, Classification of buses, Operating constraints, Data for load flow, Gauss - Seidal Method – Algorithm and flow chart for PQ and PV buses (numerical problem for one iteration only), Acceleration of convergence; Newton Raphson Method – Algorithm and flow chart for NR method in polar coordinates (numerical problem for one iteration only), Decoupled load flow, Fast Decoupled Load flow (Excluding Problems), Comparison of load flow studies.

Self-study: Program for power flow studies using software

12 Hrs
Unit - IV


10 Hrs

**Self-study:** Iterative technique to solve economic dispatch problems.

Unit-V

**Transient Stability Studies:** Equal Area Criterion, Swing equation, Numerical solution of Swing Equation – Point-by-point method, Modified Euler’s method, Runge -Kutta method, Milne’s predictor corrector method, Representation of power system for transient stability studies.

10 Hrs

**Self-study:** Program for Power-angle equation using software

**Text Books:**

**Reference Books:**

**Course Outcomes**

*After learning all the units of the course, the student is able to*

- **CO1:** Apply the network topology to obtain different types of incidence matrices.
- **CO2:** Apply the different methods to construct network matrices - Y bus and Z bus.
- **CO3:** Examine load flow studies using different algorithms.
- **CO4:** Analyze the economic generation schedule considering pre-specified constraints
- **CO5:** Analyze the transient stability of a power system using a variety of techniques.
# Course Articulation Matrix

| Course Outcome (CO)                                                                 | Program Outcomes | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PO 13 | PO 14 | PO 15 | PO 16 | PO 17 | PO 18 | PO 19 | PO 20 |
|------------------------------------------------------------------------------------|------------------|------|------|------|------|------|------|------|------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| 1. Apply the knowledge of network topology to obtain different types of incidence matrices. |                  | 3    | 3    | -    | -    | -    | -    | -    | -    | -     | -     | 2     | -     | -     | -     | -     | -     | -     | -     | -     | -     |
| 2. Apply the different methods to construct network matrices-Y bus and Z bus.     |                  | 3    | 3    | -    | -    | -    | -    | -    | -    | -     | -     | 2     | -     | -     | -     | -     | -     | -     | -     | -     | -     |
| 3. Examine load flow studies using different algorithms.                           |                  | 3    | 3    | -    | -    | 2    | -    | -    | -    | -     | -     | 2     | -     | -     | -     | -     | -     | -     | -     | -     | -     |
| 4. Analyze the economic generation schedule considering pre-specified constraints |                  | 3    | 3    | -    | -    | -    | -    | -    | -    | -     | -     | 2     | -     | -     | -     | -     | -     | -     | -     | -     | -     |
| 5. Analyze the transient stability of a power system using a variety of techniques. |                  | 3    | 3    | -    | -    | 2    | -    | -    | -    | -     | -     | 2     | -     | -     | -     | -     | -     | -     | -     | -     | -     |

- **PO 1**: High
- **PO 2**: Medium
- **PO 3**: Low

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**Electrical and Electronics Engineering**

VII & VIII Semester Syllabus 2020-2021  Page 10
Prerequisites: The student should have undergone the course on High Voltage Engineering

Course Learning Objectives

1. Students will understand the Breakdown phenomenon in gaseous, solids and liquid Dielectrics.
2. Students will learn basic need to generate high voltages such as HVAC, HVDC, Impulse Voltages and Impulse Currents in the laboratory.
3. Students gain the fundamental knowledge of physical phenomena of breakdown in insulating media and students will know the importance of insulating media and their applications in various fields.
4. Students will learn how to measure the high voltages in the laboratory
5. Students will know importance of testing and learn procedure of testing different insulating media for accessing their condition

Course Content

Unit-I

Introduction: Introduction to HV technology, Need for generating high voltages in laboratory. Important applications of high voltage.


Self-Study: Breakdown in electro-negative gases

Unit-II

Generation of HVAC and HVDC Voltages: HVAC - HV transformer; Need for cascade connection and working of transformer units connected in cascade, Series resonant circuit, Tesla coil. HVDC -, Cockcroft- Walton type high voltage DC set. Regulation, Ripple and Optimum number of stages.

Self-Study: Voltage doubler circuit

Unit-III


Self-Study: Triggering of impulse generator by three electrode gap arrangement

Unit-IV

Measurement of High Voltages: Electrostatic voltmeter - principle, construction and limitation; Chubb and Fortescue method for HVAC measurement, Generating voltmeter-Principle & Construction; Series resistance micro ammeter for HVDC measurements,
Standard sphere gap measurements for HVAC, HVDC and Impulse voltages; Factors 
affecting the measurements: Potential dividers - Resistance dividers, Capacitance dividers ,
Mixed RC potential dividers;
**Self-Study:** Surge current measurement - Klydanograph and Magnetic link.

**Unit-V**

**Non-destructive Insulation Testing Techniques:** Dielectric loss and loss angle 
measurements using Schering Bridge, Transformer ratio arms bridge; Need for discharge 
detection, PD measurements – aspects, factors affecting the discharge detection; Discharge 
detection methods - Straight and Balanced methods.

**High Voltage Tests on Electrical Apparatus:** Tests on Circuit breakers and Transformers.

**Self-Study:** Tests on Cables and Insulators

**Text Books:**

**Reference books:**

**Course Outcomes (CO)**

After learning all the units of the course, The Students will be able to

**CO1:** Apply the knowledge of the Phenomena of Breakdown in different Dielectrics

**CO2:** Analyze the HVAC and HVDC voltage generation processes

**CO3:** Examine the concepts regarding generation of HVAC, HVDC, and impulse voltages.

**CO4:** Illustrate how HVAC, HVDC, and impulse voltages are measured.

Voltage Tests on Electrical Apparatus.

**CO5:** Analyze the concepts of Non-destructive Insulation Testing Techniques and High
### Course Articulation Matrix

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<th>Course Outcomes (CO)</th>
<th>Program outcomes</th>
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<td>Apply the knowledge of the Phenomena of Breakdown in different Dielectrics</td>
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<td>Analyze the HVAC and HVDC voltage generation processes</td>
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<tr>
<td>Examine the concepts regarding generation of HVAC, HVDC, and impulse voltages.</td>
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<tr>
<td>Illustrate how HVAC, HVDC, and impulse voltages are measured.</td>
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<tr>
<td>Analyze the concepts of Non-destructive Insulation Testing Techniques and High Voltage Tests on Electrical Apparatus.</td>
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1 – Low 2 – Moderate 3 – High
Course Title: AC and DC Drives

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Course Learning Objectives:
1. To study and understand the basics of drive system and their control with their operating regions.
2. To learn the operating principles of different types of drive systems and their speed control like dc shunt/separately excited motor drive system using single phase & three phase controlled rectifiers.
3. To learn the operating principle, performance characteristics and speed control of induction motor drive system, synchronous motor drive system.
4. To understand the principles of some energy recovery schemes for performance improvement of IM drive system.
5. To understand the various processes in manufacturing industries and the different types of motors used in different stages.
6. Design and analyze simple drive systems and also to carry out mini-project in teams for a given set of specifications.

Course Content

Unit – I

**Introduction:** Electric Drives, Advantages of Electrical Drives, Parts of Electrical Drives, Choice of Electrical Drives, Status of DC &AC Drives.

**Rectifier controlled dc drives:** Speed torque characteristics, speed control techniques of shunt/separately excited dc motor (theory only), Half & Fully controlled rectifier fed dc drives, (separately &series dc motors) under continuous and discontinuous current mode, Ward Leonard drives.  

**Self-study:** Controlled rectifier fed dc drives

Unit – II

**Converter fed Drives:** Three phase half controlled rectifier control of dc separately exited motor,

,Three phase fully controlled rectifier control of dc separately exited motor converter fed dc drives, dual converter fed drives, multi quadrant operation of dc separately exited motor fed from fully controlled rectifier.

**Chopper controlled dc drives:** Chopper controlled dc drives – Chopper Control Of Separately exited Dc motor,(motoring and braking operation, multi-quadrant operation of chopper)Chopper control of series motor(motoring and braking operation).  

**Self-study:** Control of fractional HP motor.

Unit – III

**Closed loop control of DC Drives:** Introduction, Open loop transfer function, closed loop transfer function, closed loop position control, Phase locked loop, Microcomputer control of DC drives.

**Concept of dc motor braking:** Methods of braking - regenerative, dynamic braking & plugging

**Self-study:** Closed loop speed control of Multi-motor drivers
Unit – IV

AC Drives: Introduction to three phase Induction Motor drives, Analysis and Performance, Speed and Torque control methods: Stator voltage control, rotor voltage control, Stator frequency control, Voltage and frequency control, VSI fed IM drive, closed loop speed control and converter rating for VSI and Cycloconverter Induction motor drives, CSI fed IM drive, closed loop control of CSI drives, Static Kramer drive, Static Scherbius drive and braking of IM. 12Hrs

Self-study: Eddy current drives

Unit – V


Self-study: Starting large synchronous machines. 10Hrs

Text Books:

Reference Books:

Course Outcomes:
At the end of the course students will be able to:
1. Analyze the various types of electric drives with their operating characteristics.
2. Analyze the various types of converter and chopper fed drives for different quadrant operation.
3. Describe the concepts of open and closed loop drives to assess the braking operation of Induction motor.
5. Analyze various motor drive control scheme for industrial applications.
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<td>2. Analyze the various types of converter and chopper fed drives for different quadrant operation.</td>
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<td>3. Analyze the braking operation of open and closed loop drives.</td>
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<td>4. Apply different methods of speed control for induction motor drive.</td>
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<td>5. Analyze various motor drive control scheme for industrial applications.</td>
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1-Low 2-Medium 3-High
Course Title: Flexible AC Transmission Systems (FACTS)

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<th>Credits – 3</th>
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</thead>
</table>

Contact period : Lecture: 52Hrs, Exam 3 Hrs | Weightage : CIE:50 SEE:50

Course Content

Unit – I

FACTS Concepts and General System Configuration: Transmission interconnection, Power flow in AC system, Power flow and dynamic stability consideration of a transmission interconnection, relative importance of controllable parameters, Basic types and Brief Description of FACTS Controller. 12 Hrs

Self-study: Benefits from FACTS

Unit – II

Voltage sourced converters: Basic concepts, single phase full wave bridge converter operation, single phase-Leg operation, Square wave voltage harmonics for a single phase bridge, Three phase full wave bridge converter, Transformer connection for 12 Pulse Operation. 10 Hrs

Self-study: Transformer connection for 24 pulse operation

Unit – III

Self and Line Commutated Current Source Converter: Basic concepts, 3-phase full wave diode rectifier, Thyristor based converter; rectifier, inverter operation & commutation failures, Current sourced converter with turn-off devices, Current source versus voltage source converters. 10 Hrs

Self-Study: Diode Rectifier

Unit – IV

Static Shunt Compensator SVC and STATCOM: Objective of shunt compensation, Methods of controllable Var generation; TCR & TSR, TSC; Static Var compensator, SVC and STATCOM; VI & VQ curves & transient stability enhancement 10 Hrs

Self-study: Voltage control of SVC

Unit – V

Static Series Compensators GCSC, TSSC, TCSC and SSSC: Objectives of series compensation; capacitive compensation, transcendent stability improvement & power oscillation damping, Variable impedance type of series compensation, switching converter type series compensation; SSSC. 10 Hrs

Self-Study: The need for variable-series compensation

Text Book:

Reference Books:

**Course Outcomes**

**CO1:** Describe and analyze the Transmission, Power flow and dynamic stability in FACTS controllers.

**CO2:** Analyze the different types of voltage converts in FACTS

**CO3:** Analyze the different types of current converts in FACTS

**CO4:** Examine the SVC and SATCOM shunt compensators in FACTS

**CO5:** Examine the different series compensators in FACTS

### Course Articulation Matrix

<table>
<thead>
<tr>
<th>Course Outcome – CO</th>
<th>Program Outcome</th>
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</thead>
<tbody>
<tr>
<td></td>
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<tr>
<td>5 Examine the different series compensators in FACTS</td>
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</tbody>
</table>

1-Low 2-Medium 3-High
## Course Content

### Unit-I

**TRANSFORMERS:** **Specifications:** Power and distribution transformers as per BIS standards.  
**Installation:** Location, site, selection, foundation details (like bolts size, their number, etc), code of practice for terminal plates, polarity & phase sequence, oil tanks, drying of windings and general inspection.  
**Commissioning tests:** Following tests as per national & International Standards, volt ratio test, earth resistance, oil strength, Bucholz & other relays, tap changing gear, fans & pumps, insulation test, impulse test, polarizing index, load & temperature rise test.  
**Specific Tests:** Determination of performance curves like efficiency, regulation etc, and determination of mechanical stress under normal & abnormal conditions.  
**Self-study:** Different types of transformer oil tanks  

12Hrs

### Unit-II

**SYNCHRONOUS MACHINES:** **Specifications:** As per BIS standards.  
**Installation:** Physical inspection, foundation details, alignments, excitation systems, cooling and control gear, drying out.  
**Commissioning Tests:** Insulation, Resistance measurement of armature & field windings,  
**Performance tests:** Various tests to estimate the performance of generator operations, Slip test maximum lagging current, maximum reluctance power tests, sudden short circuit tests, transient & sub transient parameters, measurements of sequence impedances, capacitive reactance, separation of losses, temperature rise test, retardation tests, Various abnormal conditions and the respective Protection  

10Hrs

**Self-study:** Selection of motor

### Unit-III

**Induction Motors:** Specifications for different types of motors, Duty, I.P. protection.  
**Installation:** Location of the motors (including the foundation details) & its control apparatus, shaft & alignment for various coupling, fitting of pulleys & coupling, drying of windings.  
**Commissioning Test:** Mechanical tests for alignment, air gap symmetry, tests for bearings, vibrations & balancing.  
**Electrical Tests:** Insulation test, earth resistance, high voltage test, starting up, failure to speed up to take the load, type of test, routine test, factory test and site test (in accordance with ISI code,  
**Self-study:** Maintenance of motor  

10Hrs

### Unit-IV

**SWITCH GEAR & PROTECTIVE DEVICES:** Standards, types, specification, installation, commissioning tests, maintenance schedule, type & routine tests.
Current transformer and Voltage transformer: Specifications, procurement, testing of CT, Specifications, procurement, testing of PT, Specifications and testing of cable.

Self-study: Rating of circuit breakers

Unit-V

Safety Management: Objectives of safety management, seven principles of safety management, work permit system, safety clearance and creepages, Safety procedures in eclectic plant, First aid, Electric shock, touch potential and step potential, recommended safety precautions against electric shock in small buildings, shops, and small LV installations Live line working (Hot line Maintenance), safety management during O and M.

Self-study: First aid

10Hrs

TEXT BOOKS:

REFERENCE BOOKS:
1. Relevant Bureau of Indian Standards

Course Outcomes

CO1: Examine the specifications, installation procedure, and commissioning process of transformers

CO2: Analyze the specification, installation procedure and commissioning process of synchronous machine.

CO3: Analyze the specification, coupling and alignment process of Induction motor for installation.

CO4: Analyze and test the protective devices for CT and PT.

CO5: Illustrate the safety management and safety measures.
## Course Articulation Matrix

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<td>Analyze and test the protective devices for CT and PT</td>
<td>2 2</td>
</tr>
<tr>
<td>Illustrate the safety management and safety measures</td>
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</table>

1-Low 2-Medium 3-High
Course Title: Electrical Power Utilization

Course Code: P18EE743  Semester: VII  L-T-P-H: 2-2-0-4  Credits – 3
Contact period : Lecture: 52Hrs, Exam 3 Hrs  Weightage: CIE:50  SEE:50

Course Content

Unit – I

**Heating and Welding:** Introduction, mode of heat transfer, advantages and methods of electric heating, resistance heating, induction heating, the arc furnaces, vertical core type furnace, Indirect core type furnace, Induction furnace, coreless Induction furnace, Dielectric heating, electric welding and their types.  
**Self-Study:** Control device and electric equipment  

12Hrs

Unit – II

**Illumination:** Laws of illumination, light schemes, Design of lighting scheme, different types of lamps, construction and working of Incandescent, sodium vapour lamp, mercury vapour lamp, fluorescent lamp, and CFL and LED  
**Self-Study:** Recommended levels of Illumination  

10Hrs

Unit – III

**Electric Traction:** Introduction, requirement of an ideal traction system scheme of traction and merits and demerits, types of electric traction, electric trains, tramways, trolley buses, systems of electrification for traction purposes: direct current, 1 phase AC system, Three phase as system, composite system.  
**Self-Study:** Diesel electric traction  

10Hrs

Unit – IV

**Speed-Time Characteristics:** Analysis of speed-time curve for electric train, Mechanism of train movement, tractive effort for propulsion of train, specific energy output, various factors affecting energy consumption  
**Self-Study:** Types of railway systems  

10Hrs

Unit – V

**Traction Motors:** Introduction, selection of traction motors, methods of speed control - energy saving by series-parallel method, AC series motor, characteristics, electric braking-plugging, rheostatic braking, regenerative breaking on A C series motor  
**Self-Study:** linear induction motor and their use  

10Hrs

Text Books:
3. Utilization of Electrical power by R K Rajput, Laxmi publication

Reference books:
2. Utilization of Electrical power by Dr. Ramesh L Chakrasali, 2014
### Course Outcomes

After learning all the units of the course, the student is able to:

**CO1:** Discuss different types of heating and welding  
**CO2:** Describe different Lighting scheme and types of lamps.  
**CO3:** Analyze different schemes, types and applications of Electric traction.  
**CO4:** Analyze the speed-time characteristics of Electric train  
**CO5:** Analyze the different traction motors and their applications.

### Course Articulation Matrix

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<td>Analyze the different traction motors and their applications.</td>
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1-Low 2-Medium 3-High
**Course Title:** Artificial Neural Networks & Artificial Intelligence  

<table>
<thead>
<tr>
<th>Course Code: P18EE744</th>
<th>Semester: VII</th>
<th>L-T-P-H: 2-2-0-4</th>
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**Course Learning Objectives (CLOs)**

This course aims to:

1. Understand the different terminologies used in Artificial Neural Network.
2. Study the different learning rules in ANN.
3. Understand the architecture and algorithm of various neural networks.

**Course Content**

**Unit-I**

**Introduction to ANN:**  

**Fundamental models of ANN & Learning Processes:**  

**Self-Study:** Generate AND, NOT function using MP neural net by MATLAB.  

**Unit-II**

**Architecture and Algorithms of ANN:**  

**Adaline and Madline networks**- Adaline networks-Architecture, algorithm, Application procedure (Excluding problems) and Madline networks Architecture, algorithm, and Application procedure (Excluding problems).

**Self-Study:** Develop MATLAB program for AND & OR function by using perceptron and adaline net.  

10Hrs

**Unit-III**


Self-Study: Develop a MATLAB program for approximating a two 2-dimensional functions using back propagation in batch mode.

Unit-IV


Adaptive Resonance Theory (ART): ART fundamentals, Basic architecture, Basic operation, Learning in ART. Basic training steps. ART1 - Architecture, training algorithms (Excluding problems).

Self-Study:ART2 - Architecture, training algorithms

Unit-V

Introduction to Artificial Intelligence:
Artificial Intelligence, Goals of AI, AI Technique, Applications of AI, Types of Intelligence, Working of Speech and Voice Recognition Systems, AI - Agents & Environments, Agent Terminology, Types of Agents- Rational Agent, Simple and Model based Reflex Agents, Goal Based Agents, Utility Based Agents, Properties of Environment, different AI- Search Terminology (Meaning only).

Artificial Intelligence – Robotics:

Self-Study: Brute-Force Search Strategies, Informed (Heuristic) Search Strategies

Text books:

Reference books:

**Course outcomes**

After completion of this course students shall be well versed with the following information:

**CO1:** Apply the knowledge of allied engineering to analyze the different terminologies used in Artificial Neural Network

**CO2:** Analyze the different learning rules in Artificial Neural Network.

**CO3:** Examine the architecture and algorithm of various neural networks.

**CO4:** Apply the knowledge of feedback and feed forward network to analyze architecture and algorithm back propagation and Hopfield networks.

**CO5:** Analyze the architecture and algorithm of Learning vectors and self organizing maps.

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1-Low 2-Medium 3-High
Course Title: Utilization of Electrical Power

<table>
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<th>Semester: VII</th>
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Course Learning Objectives (CLOs)

This course aims to:

1. Understand the different types of heating and welding
2. Understand the different Lighting scheme and types of lamps.
3. To study about Electric traction
4. To get the knowledge of speed-time characteristics of Electric train.

Course Content

Unit – I

**Heating and Welding:** Introduction, mode of heat transfer, advantages and methods of electric heating, resistance heating, induction heating, the arc furnaces, vertical core type furnace, Indirect core type furnace, Induction furnace, coreless Induction furnace, Dielectric heating, electric welding and their types. **11Hrs**

**Self-Study:** Control device and electric equipment.

Unit – II

**Illumination:** Laws of illumination, light schemes, Design of lighting scheme, different types of lamps, construction and working of Incandescent, sodium vapour lamp, mercury vapour lamp, fluorescent lamp, and CFL. **10Hrs**

**Self Study:** Recommended levels of Illumination

Unit – III

**Electric Traction:** Introduction, requirement of an ideal traction system scheme of traction and merits and demerits, types of electric traction, electric trains, tramways, trolley buses, systems of electrification for traction purposes: direct current, 1 phase AC system, three phase as system, composite system. **11Hrs**

**Self-Study:** Diesel electric traction

Unit – IV

**Speed-Time Characteristics:** Analysis of speed-time curve for electric train, Mechanism of train movement, tractive effort for propulsion of train, specific energy output, various factors affecting energy consumption. **10Hrs**

**Self-Study:** Types of railway systems

Unit – V

**Traction Motors:** Introduction, selection of traction motors, methods of speed control - energy saving by series-parallel method, AC series motor, characteristics, electric braking-plugging, rheostatic braking, regenerative breaking on A C series motor. **10Hrs**

**Self-Study:** linear induction motor and their use.
Text Books:
3. Utilization of Electrical power by R K Rajput, Laxmipublication

Reference books:
4. Utilization of Electrical power by Dr. Ramesh L Chakrasali, 2014

Course Outcomes

After learning all the units of the course, the student is able to:

CO1: Discuss different types of heating and welding

CO2: Describe different Lighting scheme and types of lamps.

CO3: Analyze different schemes, types and applications of Electric traction.

CO4: Analyze the speed-time characteristics of Electric train

CO5: Analyze the different traction motors and their applications.

Course Articulation Matrix

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<td>2</td>
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</tbody>
</table>

1-Low 2-Medium 3-High
Course Learning Objectives

After going through the course, the students should be able to:

1. Appreciate the importance of various types of energy sources and understand the need for studying renewable energy sources.
2. Understand the various types of conversion methods of solar radiations into heat and know the various types of solar collectors and applications.
3. Know the significance of wind energy and understand the basic principles and its applications.
4. Understand the need for biomass energy and to know the various types of biomass conversion technologies.
5. Understand the relevance of various types of ocean and tidal energy conversion systems and to know the different types of arrangements and application.

Course Content

Unit-I

Self-Study: Solar Thermal Energy Applications.

08 Hrs

Unit-II

Self-Study: Applications of Solar Cell Systems.

12 Hrs

Unit-III


**Self-Study:** Sources and Types of Waste, Recycling of Plastics.  \( \text{12 Hrs} \)

**Unit-IV**


**Self-Study:** Advantages and Disadvantages of Tidal Power, Problems Faced in Exploiting Tidal Energy.  \( \text{12 Hrs} \)

**Unit-V**


**Self-Study:** Application of OTEC in Addition to Produce Electricity,  \( \text{12 Hrs} \)

**TextBook**


**Reference Books:**

1. Khan BH, Non-conventional energy resources, TMH, New Delhi, 2006.

**Course outcomes**

After completion of this course students shall be well versed with the following information:

**CO1:** Discuss various types of energy sources
**CO2:** Analyze solar energy applications to thermal and electric system.

**CO3:** Describe wind energy conversion system for power generation.

**CO4:** Depict Biomass conversion technology to produce the biogas and bio fuel.

**CO5:** Analyze various principles to extract energy from ocean.

### Course Articulation Matrix

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| 3-High | 2-Medium | 1-Low |
Course Title: Hybrid Electric Vehicles

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</table>

Course Content

Unit-I

**Introduction:** Sustainable Transportation, A Brief History of HEVs, Why EVs Emerged and Failed, Architectures of HEVs, Interdisciplinary Nature of HEVs, State of the Art of HEVs, Challenges and Key Technology of HEVs.


Self-Study:-Wheel Slip Dynamics. 12Hrs

Unit-II

**Plug-in Hybrid Electric Vehicles:** Introduction to PHEVs, PHEV Architectures, Equivalent Electric Range of Blended PHEVs, Fuel Economy of PHEVs, Power Management of PHEVs, PHEV Design and Component Sizing, Component Sizing of EREVs, Component Sizing of Blended PHEVs, HEV to PHEV Conversions, Other Topics on PHEVs.

Self-Study:- Vehicle-to-Grid Technology. 10 Hrs

Unit-III

**Power Electronics in HEVs:** Introduction, Principle of Power Electronics, Rectifiers Used in HEVs, Buck Converter Used in HEVs, Non-isolated Bidirectional DC–DC Converter, Voltage Source Inverter, Current Source Inverter, Isolated Bidirectional DC–DC Converter, PWM Rectifier in HEVs, EV and PHEV Battery Chargers, Modelling and Simulation of HEV Power Electronics, Emerging Power Electronics Devices, Thermal Management of HEV Power Electronics.

Self-Study :- Circuit Packaging 12Hrs

Unit-IV

**Electric Machines and Drives in HEVs:** Introduction, Permanent Magnet Motor Drives, Switched Reluctance Motors, Doubly Salient Permanent Magnet Machines, Design and Sizing of Traction Motors, Thermal Analysis and Modeling of Traction Motors. 8Hrs

Self-Study :- Induction Motor Drives

Unit-V

Batteries, Ultra capacitors, Fuel Cells, and Controls: Introduction, Battery Characterization, Comparison of Different Energy Storage Technologies for HEVs, Modelling Based on Equivalent Electric Circuits, Battery Charging Control, Charge Management of Storage

**Self-Study:** Hydraulic Energy Storage System **10Hrs**

**Text Book:**

1. Hybrid Electric Vehicles principles and Applications with Practical Perspectives Chris Mi.MAbulMasrur, Davi D Wenzhog Gao

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**Course outcomes**

After completion of this course students shall be well versed with the following information:

**CO1:** Understanding the knowledge of different types of hybrid electric vehicles.

**CO2:** To get knowledge of Plug-in hybrid electric vehicles.

**CO3:** To study and analyze the different converters used in HEV’s

**CO4:** Get a basic knowledge of types of motors used in HEV’s

**CO5:** To get knowledge of batteries and batteries management systems.

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<table>
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**Program Outcome (ABET/NBA-(3a-k))**

P O 1 2 3 4 5 6 7 8 9 10 11 12

**L-Low, M-Moderate, H-High**
Course Title: Automation Engineering

<table>
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Course Content

Unit 1

**Need and benefits of automation, PLC system:** applications of PLC, PLC modules, I/O module, Communication module, PID module, Input analog and digital devices, Output analog and digital devices.

**Self-Study:** List the forms and specifications of PLCs available from various manufacturers 10 Hrs

Unit 2

PLC registers, PLC timer function, PLC counter function, PLC simple arithmetic and logical functions, PLC ladder logic diagram, Advanced PLC functions like SKIP, MASTER CONTROL RELAY, JUMP with non-return, jump with return, Sequencer function 12 Hrs

**Self-Study:** Master control internal relay

Unit 3

**PLC applications:** Bottling filling plant, Material handling elevator, 2-axis robot with sequencer control, Level control, Trouble shooting

**Self-Study:** Case study of a real time SCADA Application 10 Hrs

Unit 4

Introduction to DCS, concept of DCS, hierarchy of DCS, function of each level of DCS, Introduction to supervisory Control and Data Acquisition system (SCADA), SCADA Architecture, Interfacing SCADA with PLC 10 Hrs

**Self-Study:** Examples of Commercial Network systems

Unit 5

**Induction motor drive:** V/F Control, Direct torque control, Stepper motor drives, AC and DC Servo motor drives, DC motor drives

**Self-Study:** Retentive timer, Timer/counter sequencer 10 Hrs

**Text Books:**

1. Webb John W. and Reis A. Ronald, “Programmable Logic Controllers Principles and applications” PHI, New Delhi, Latest edition
2 Bolton W, “Programmable Logic Controllers” Elsevier India Pvt. Ltd. New Delhi


Reference Books:


COURSE OUTCOMES:

CO1: To Understanding basics of automation.
CO2: To study about PLC programming and instructions.
CO3: To analyze the applications of PLC
CO4: To get the basic knowledge of DCS & SCADA
CO5: Understand the basic of motor drives.

Course Articulation Matrix (CAM)

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<td>L4 M H L - - L - - M H H</td>
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L- Low, M- Moderate, H-High
Course Title : Relay and High Voltage Laboratory

Course Code : P18EEL76  |  Semester : VII  |  L- T- P-H : 0 - 0 -3-3  |  Credits:1.5
Contact Period: Lecture: 36 Hrs, Exam: 3 Hrs  |  Weightage: CIE:50  |  SEE:50

Course Learning Objectives (CLOs)

This course aims

To conduct practical experiments on Relay and High voltage equipment; IDMT directional/non-directional relay, differential relay, over voltage relay, feeder protection, Spark over characteristics of air (HVAC/HVDC), impulse generator & Partial Discharge analysis for different insulation at different pressure.

**List of Experiments**

A. RELAY LAB

1. Over current relay:
   - (a) IDMT non-directional characteristics
   - (b) Directional features
   - (c) IDMT directional characteristics
2. DMT Characteristics of over voltage or under voltage relay.

B. HIGH VOLTAGE LAB

1. Spark over characteristics of air insulation subjected to HVAC & HVDC for uniform and non-uniform fields
3. To determine 50% probability flashover voltage using impulse generator
4. Partial Discharge characteristics at low pressures using vacuum system and high pressure chamber.
5. Breakdown characteristics of gaseous/liquid insulation using power/high frequency voltage generator.

C. Self-study experiment

Course Outcomes

Student will be able to

1. Conduct experiments to analyze the operation of relays and protection scheme for generator
2. Analyze the characteristics of HVAC, HVDC, impulse generators, and partial discharges by conducting experiments.
3. Ability to communicate effectively in a team/as an individual s to conduct experiments
<table>
<thead>
<tr>
<th>Course Outcome (CO)</th>
<th>Program Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conduct experiments to analyze the operation of relays and protection scheme for</td>
<td>PO1  PO2  PO3  PO4  PO5  PO6  PO7  PO8  PO9  PO10  PO11  PO12</td>
</tr>
<tr>
<td>generator</td>
<td>3     3     3     3     -     -     -     -     -     -     -     2     2</td>
</tr>
<tr>
<td>Analyze the characteristics of HVAC, HVDC, impulse generators, and partial</td>
<td>PO1  PO2  PO3  PO4  PO5  PO6  PO7  PO8  PO9  PO10  PO11  PO12</td>
</tr>
<tr>
<td>discharges by conducting experiments</td>
<td>3     3     3     3     -     -     -     -     -     -     -     2     2</td>
</tr>
<tr>
<td>Ability to communicate effectively in a team/as an individual s to conduct</td>
<td>-     -     -     -     -     -     -     -     -     1     3     3     -     -</td>
</tr>
<tr>
<td>experiments</td>
<td></td>
</tr>
</tbody>
</table>

**L- Low**  **M- Medium**  **H-High**

**Topic learning objective:**
1. IDMT directional & non directional characteristics of over current relay
2. DMT Characteristics of over voltage or under voltage relay
3. Merz-Price- protection scheme
4. Feeder protection for different faults
5. Motor protection scheme-fault studies
6. Spark over characteristics of air in HVAC for uniform & non uniform fields
7. Spark over characteristics of air in HVDC for uniform & non uniform fields
8. Measurement of HVAC
9. Measurement of HVDC
10. 50% probability flashover voltage using impulse generator
11. Partial Discharge characteristics at low & high pressure using vacuum system chamber.
12. Breakdown characteristics of gaseous/liquid insulation using power/high frequency
Course Title : Power System Simulation Lab

<table>
<thead>
<tr>
<th>Course Code : P18EEL77</th>
<th>Semester : VII</th>
<th>L-T-P-H: 0-0-3-3</th>
<th>Credits : 1.5</th>
<th>Weightage: CIE:50 SEE:50</th>
</tr>
</thead>
</table>

Contact Period: Lecture: 36 Hr, Exam: 3 Hr

Course Learning Objectives (CLOs)

This course aims
To simulate the experiments to form formation of Y bus by inspection method and singular transformation method, find the bus currents bus voltages, and line flow of the specified system. Find the different faults of a transmission line and study the load flow analysis.

List of Experiments

2. (i)Y-Bus formation for power systems by inspection method.(ii) Determination of bus currents, bus power and line flows for a specified system with given bus voltage profile.
3. Bus admittance matrix (Y – Bus) formation for power systems with and without mutual Coupling, by singular transformation.
4. To determine fault currents and voltages in a single transmission line system with a specified location for SLG fault, LL fault, and LLG (DLG) fault.
6. To determine I) Swing curve II) Critical clearing time for a single machine connected to Infinite bus through a pair of identical transmission lines.
7. Determination of optimal generator scheduling for thermal plants.
9. Self-Study experiment viz. Analysis of typical power system (problems) by using software package or MATLAB programs.
10. Self-study experiment / simulation

Course Outcomes

Student will be able to

1. Apply the knowledge of power systems for formation of Y bus with and without mutual coupling using MATLAB Programming
2. Conduct experiments to execute programs to study load flow, different faults and stability of the power system.
3. Ability to communicate effectively in a team/as an individuals to conduct experiments
## Course Articulation Matrix

<table>
<thead>
<tr>
<th>Course Outcome (CO)</th>
<th>Program Outcome</th>
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<tbody>
<tr>
<td><strong>Apply the knowledge of power systems for formation of Y bus with and without mutual coupling using MATLAB Programming</strong></td>
<td><strong>P O</strong> 3 3 - 3 - - - - - - 2 -</td>
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<tr>
<td><strong>Conduct experiments to execute programs to study load flow, different faults and stability of the power system.</strong></td>
<td><strong>P O</strong> 3 3 - 3 - - - - - - 2 -</td>
</tr>
<tr>
<td><strong>Ability to communicate effectively in a team/as an individual s to conduct experiments</strong></td>
<td><strong>P O</strong> - - - - - 1 3 3 - - -</td>
</tr>
</tbody>
</table>

**I- Low** **M- Medium** **H-High**
### Course Title: Project Work Phase – I and Project Seminar

<table>
<thead>
<tr>
<th>Course Code: P18EE78</th>
<th>Semester: VII</th>
<th>L:T:P:H: 0:0:0:4</th>
<th>Credits :02</th>
</tr>
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<tbody>
<tr>
<td></td>
<td></td>
<td>Weight age: CIE:100</td>
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</tbody>
</table>

Project Work: The Project Work (Phase I + Phase II) carries 8 credits (2 credits+6 credits) and spreads over TWO semesters, i.e. during 7th and 8th semesters.

I. Project Phase – I and Project seminar Comprises of Literature Survey, Problem identification, Objectives and Methodology. CIE marks shall be based on the report covering Literature Survey, Problem identification, Objectives and Methodology and seminar presentation skill.

II. The Assessment marks (CIE) in the case of Project Work - Phase I, shall be based on the evaluation at the end of the 7th semester by a committee consisting of Head of the concerned department, two senior faculty members of the department, one of them may be the internal guide. The work may be evaluated by the committee for award of Assessment marks (CIE) based on a Report [comprising of synopsis, Introduction, Literature survey, Objective and Methodology], presentation and viva voce.

III. The project work shall be carried out by candidate(s) independently/in a group (maximum of four) during the seventh and eighth semester under the guidance of one of the faculty members of the Department of study. If the project work is of inter-disciplinary nature, a co-guide shall be taken from the same or any other relevant Department. If a project work has to be carried out in any industry / factory / organization, outside the campus, the permission for the same and the name of co-guide at any of these organizations shall be intimated to the authorities at the beginning of seventh semester by the Head of the Department.
Course Title: Renewable Energy Sources

<table>
<thead>
<tr>
<th>Course Code: P18EE81</th>
<th>Semester: VIII</th>
<th>L-T-P-H: 4-0-0-4</th>
<th>Credits –04</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contact period : Lecture: 52Hrs, Exam 3</td>
<td>Weightage : CIE:50% SEE:50%</td>
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</table>

Course Learning Objectives

After going through the course, the students should be able to:

1. Appreciate the importance of various types of energy sources and understand the need for studying renewable energy sources.
2. Understand the various types of conversion methods of solar radiations into heat and know the various types of solar collectors and applications.
3. Know the significance of wind energy and understand the basic principles and its applications.
4. Understand the need for biomass energy and to know the various types of biomass conversion technologies.
5. Understand the relevance of various types of ocean and tidal energy conversion systems and to know the different types of arrangements and application.

UNIT-1

Energy Sources: Introduction, Importance of energy consumption as measure of prosperity, per capita energy consumption, Classification of energy resources; Conventional energy resources-availability and their limitations, non-conventional energy resources-Classifications, advantage, limitations; world energy scenario; Indian energy Scenario.

5Hrs


5Hrs

Self-Study: Comparison of conventional and non-conventional energy resources.

UNIT-2

Solar Thermal System: Solar water heater (Flat plate collectors) solar cookers-box type, concentrating dish type, solardriers, still furnaces, green houses.


10Hrs

Self-Study: Principle of conversion of solar radiation into heat.

UNIT-3
**Wind Energy:** Introduction, history of wind energy, scenario – world & India. Basic principle of Wind energy conversion system (WECS), classifications of WECS, part of a WECS. Derivation of power in the wind, electrical power output & capacity factor of WECS, wind site selection consideration, advantages & disadvantages of WECS

10Hrs  
**Self-Study:** Wind & its property

**UNIT-4**

**Biomass Energy:** Introduction, Biomass fuel, biomass conversion technologies, urban waste to energy conversion, Biomass gasification, biomass to ethanol production, Biogas production from the waste biomass, factors affecting Biogas generation, types of Biogas plants – KVIC & Janata Model; Biomass programme in India.

10Hrs  
**Self-Study:** Photosynthesis process

**UNIT-5**

**Energy From Ocean:** Components of tidal power plant (TPP), classification of tidal power plant, estimation of energy - single Basin & Double Basin type TTP (no derivation, simple numerical problems), Advantages & Limitation of TTP. Ocean thermal Energy Conversion (OTEC) - principle of OTEC System, method of OTEC power generation - open cycle (Claude Cycle), closed cycle (Anderson cycle) & Hybrid cycle (Block diagram description only).

Introduction to Grid integration

12Hrs  
**Self-Study:** Principle of Tidal power, Tidal energy

**Text Book:**


**Reference Books:**

1. Khan BH, Non-conventional energy resources, TMH, New Delhi, 2006.

**Course outcomes**

After completion of this course students shall be well versed with the following information:

**CO1:** Discuss various types of energy sources  
**CO2:** Analyze solar energy applications to thermal and electric system.  
**CO3:** Describe wind energy conversion system for power generation.  
**CO4:** Depict Biomass conversion technology to produce the biogas and bio fuel.  
**CO5:** Analyze various principles to extract energy from ocean.
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<tr>
<td>Discuss various types of energy sources</td>
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<td>Analyze various principles to extract energy from ocean.</td>
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3-High 2-Medium 1-Low
Course Title: HVDC Power Transmission

Course Code: P18EE821
Semester: VIII  L-T-P-H: 2-2-0-4  Credits –03

Course Learning Objectives

1. Comparison of DC transmission with respect to AC transmission
2. Analysis of converters – assumptions, characteristics & Properties
3. Analysis of Greatez circuit (rectification & inversion)
4. To study the control strategies involved in DC Transmission
5. To know about the role of protection, harmonics & filters in DC transmission

Course content

Unit – I
General Aspects of DC Transmission and Comparison of it with AC Transmission:
Historical sketch, Types of DC links, Comparison of AC and DC transmission, Description of
DC transmission systems, Principal applications of DC transmission, Modern Trends in
HVDC Technology, Planning for HVDC Transmission. 10Hrs
Self-study : HVDC transmission based on VSC

Unit –II
Converter circuits: Valve characteristics, Properties of converter circuits, Assumptions,
Single phase converters, Pulse number, Three phase converters; one way and two way (6
pulse)converters, Twelve pulse cascade of two bridges (Characteristics and analysis are
excluded), Choice of best circuit for HVDC converter 10Hrs
Self-study : Additional six pulse converter circuits

Unit -III
Analysis of Three phase bridge converter: Analysis with grid control without overlap;
current and phase relations, Analysis with grid control and overlap less than 60˚; voltage
reduction due to commutation overlap, Mode 1, Mode 2 and Mode 3 operation, Vd-Id
Characteristics of Converter, Inversion. 10Hrs
Self-study : Series and parallel arrangements of valves, anodes or bridges

Unit –IV
Control strategies: Basic means of control, Power reversal, Limitations of manual control,
Constant voltage versus constant current control, desired features of control, Actual control
characteristics, Constant minimum ignition angle control, Constant current control, Stability
of control, Power control and current limits, MTDC systems (configurations only)12Hrs
Self-study : Constant extinction angle control, Tap changer control, power control and
current limits

Unit –V
Protection: General, Prevention of consequent commutation failures, Converter faults, DC
Circuit breakers, Clearing line faults and re-energizing the line.
**Harmonics and Filter**: Characteristic and Uncharacteristic harmonics, Telephone interference, Troubles caused by harmonics, Means of reducing harmonics, Harmonic filters.

**10Hrs**

**Self-study**: DC reactors

**Text Book**: 

**Reference Books**: 

**Course Outcomes**: 

**CO1**: Apply the knowledge of transmission and distribution system to study AC transmission & DC transmission.  
**CO2**: Analyze various converter circuits used in HVDC transmission.  
**CO3**: Apply the concept of power electronics to study three phase Bridge Converter.  
**CO4**: Examine different HVDC transmission control strategies.  
**CO5**: Analyze the concept of Protection in HVDC transmission.

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<tr>
<td>Course Outcome (CO)</td>
<td>P O 1 P O 2 P O 3 P O 4 P O 5 P O 6 P O 7 P O 8 P O 9 P O 10 P O 11 P O 12 PSO 1 PSO 2</td>
</tr>
<tr>
<td>Apply the knowledge of transmission and distribution system to study AC transmission &amp; DC transmission.</td>
<td>3 2 - - - - - - - - - - - - - - - - - - - - -</td>
</tr>
<tr>
<td>Analyze various converter circuits used in HVDC transmission.</td>
<td>2</td>
</tr>
<tr>
<td>Apply the concept of power electronics to study three phase Bridge Converter.</td>
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</tr>
<tr>
<td>Examine different HVDC transmission control strategies.</td>
<td>2</td>
</tr>
<tr>
<td>Analyze the concept of Protection in HVDC transmission.</td>
<td>2</td>
</tr>
</tbody>
</table>

3-High 2-Medium 1-Low
Course Title: Energy Auditing & Demand Side Management

Course Code: P18EE822  Semester: VIII  L-T-P-H: 2-2-0-4  Credits –03

Contact period : Lecture: 52Hrs, Exam 3 Hrs  Weightage : CIE:50% SEE:50%

Course Learning Objectives

The course will enable the students to understand:
1. Energy situation in the world and in India, Time value of money concept, Developing cash flow models, Payback analysis, taxes and tax credits, concept of ABT.
2. Energy audit, presentation of energy audit results, measurements in energy audit.
3. Power factor correction, energy efficient motors and lighting basics.
4. Concept of DSM, benefits of DSM, Different techniques of DSM. awareness program for Energy conservation and load management

Course Content

Unit 1


Energy Economic Analysis: The time value of money concept, Interest, Types of interest- simple interest, compound interest, nominal interest, effective interest, present worth, future worth. Developing cash flow models, payback analysis, advantages and disadvantages of payback analysis, depreciation, methods of depreciation, Concept of ABT, broad features of ABT design and numerical problem. 12Hrs

Self-Study: Taxes and tax-credit

Unit 2

Energy Auditing: Introduction, Definition & objectives of Energy Management, Principles of management, Energy management strategy, Elements of energy audits, energy audit: types and methodology, preliminary audit and detailed audit, role of energy management team, energy audit reporting format, energy use profiles, Audits required to construct the energy use profiles: envelop audit, functional audit, process audit, transportation audit, utility audit, measurements in energy audits, presentation of energy audit results, energy audit instruments: combustion analyzer, fuel efficiency monitor, fyrite, contact thermometer, infrared thermometer, pitot tube and manometer, water flow meter, speed measurements, leak detectors, lux meters. 12Hrs

Self-Study: Electrical System Optimization

Unit 3

Electrical Equipment and power factor correction: Power factor improvement-Power factor, causes of low power factor, advantages of high power factor, disadvantages of low power factor, Power factor improvement equipment-static capacitors, synchronous condenser, and phase advancers. Calculation of power factor correction, importance of power.
factor improvement, most economical power factor, location & sizing of capacitors, energy efficient motors, Numerical on power factor correction.  

Self-Study: Lighting basics  

10Hrs

Unit4

Demand Side Management: Introduction to DSM, concept of DSM, benefits of DSM, DSM planning and implementation, different techniques of DSM–time of day pricing and metering, multiutility power exchange model, load management, Load priority technique-direct load control technique, local load control technique, distributed load control technique.  

08Hrs

Self-Study: Energy efficient technology in electrical system.

Unit5

Load management: Peak clipping, load shifting, valley filling, strategic energy conservation, strategic load growth, flexible load shape, energy efficiency improvement, Different time zones, Tariff option for DSM- time of day tariff, seasonal tariff, curtailable tariff, End use energy conservation, customer acceptance of DSM, DSM implementation issues, DSM implementation strategies, Management and Organization of Energy Conservation awareness Programs- Plant level, Division level, corporate level.  

10Hrs

Self-Study: Energy efficient lighting controls and Integrated energy policy.

Text Books:-

Reference Books:-
2. Hand book on energy auditing - TERI (Tata Energy Research)

Course Outcomes

CO1: Explain Energy situation in India and World, Concept of Time value of money concept and ABT.

CO2: Conduct energy audits and determine energy use profiles by applying knowledge of power generation.

CO3: Analyze location & sizing of capacitors and energy efficient motors.

CO4: Illustrate the concept Demand Side Management along with its benefits. Also different techniques of DSM.

CO5: Explain Load Management, DSM implementation issues and Strategies
<table>
<thead>
<tr>
<th>Course Articulation Matrix</th>
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<tbody>
<tr>
<td><strong>Course Outcome (CO)</strong></td>
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<tr>
<td>Analyze the energy situation in India and around the world</td>
</tr>
<tr>
<td>Conduct energy audits and determine energy use profiles by applying knowledge of power generation.</td>
</tr>
<tr>
<td>Analyze the sizing and location of capacitors with low electrical consumption.</td>
</tr>
<tr>
<td>Illustrate the concept of Demand Side Management.</td>
</tr>
<tr>
<td>Explain Load Management, DSM implementation issues and Strategies.</td>
</tr>
<tr>
<td>3-High</td>
</tr>
</tbody>
</table>
Course Title: Power System Operation And Control

Course Code: P18EE823  |  Semester: VIII  |  L-T-P-H: 2-2-0-4  |  Credits:03
Contact Period: Lecture: 52Hrs  Exam 3 Hrs  |  Weightage: CIE:50% SEE:50%

Course Learning Objectives (CLOs)

This course aims is to:

1. To get the overview of computer control centers for power systems.
2. To understand the methods of controlling power generation
3. To study the methods of controlling load-frequency
4. To study the need of Unit commitment
5. To understand about power system security

Course Content

Unit – I
Control center operation of power systems: Introduction to Computer Control center, digital computer configuration, Automatic generation control, Area control error, Operation without central computers, Expression for tie-line flow and frequency deviation, Parallel operation of generators, problems on tie-line frequency.

10Hrs
Self-study: Area lumped dynamic model

Unit – II
Automatic Generation Control: Automatic control loops of generators: AGC and AVR. Automatic Load Frequency Control (ALFC/LFC) of single area systems-turbine speed governing system, turbine model, generator- load model, steady state analysis, dynamic response, concept of control area, load frequency control of -two area systems, Automatic voltage regulator

10Hrs
Self-study: state space model of two area load frequency control

Unit – III
Control of voltage and Reactive Power: Introduction, sending and receiving end voltages in terms of power and reactive power, generation and absorption of reactive power, relation between voltage, power and reactive power at a node, methods of voltage control-Injection of Reactive Power: shunt capacitors and reactors, series capacitor, synchronous compensator, static VAR compensator and STATCOMs, Tap-Changing Transformers, Voltage stability and Voltage collapse.

Self-study: Voltage control in Distribution Network

12 Hrs

Unit –IV
Unit Commitment: Statement of the problem, need and importance of unit commitment, constraints in unit commitment: spinning reserve, Thermal unit constraints, other constraints problems on priority list method, Methods of Unit commitment -priority lists method.

10Hrs
Self-study: Dynamic programming solution

Unit –V

**Power System Security:** Introduction, factors affecting power system security, Power system contingency analysis, Detection of network problems, network sensitivity methods, calculation of network sensitivity factor, contingency ranking. **10Hrs**

Self-study: Concentric relaxation

**Text Books:**

**Reference Books:**

**Course Outcomes**

After learning all the units of the course, the student is able to:

**CO1:** Apply the knowledge of power system to study the control center operation of Power System.

**CO2:** Analyze the different methods of automatic generation control.

**CO3:** Examine the various methods of controlling voltage and reactive power.

**CO4:** Illustrate the different methods to find solution of Unit commitment.

**CO5:** Analyze different power system security issues in order to solve network problems.
<table>
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<tr>
<th>Course Outcomes</th>
<th>Program Outcomes</th>
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<tbody>
<tr>
<td><strong>1.</strong> Apply the knowledge of power system to study the control center operation of Power System.</td>
<td>PO 1: 3, PO 2: 2, PO 10: 2</td>
</tr>
<tr>
<td><strong>2.</strong> Analyze the different methods of automatic generation control</td>
<td>PO 3: 2, PO 4: 3, PO 11: 2</td>
</tr>
<tr>
<td><strong>3.</strong> Examine the various methods of controlling voltage and reactive power.</td>
<td>PO 5: 2, PO 6: 2, PO 12: 2</td>
</tr>
<tr>
<td><strong>4.</strong> Illustrate the different methods to find solution of Unit commitment.</td>
<td>PO 7: 2, PO 8: 2, PO 1: 2</td>
</tr>
<tr>
<td><strong>5.</strong> Analyze different power system security issues in order to solve network problems</td>
<td>PO 9: 2, PO 10: 2</td>
</tr>
</tbody>
</table>

- **3-High**
- **2-Medium**
- **1-Low**
Course Title: Smart Grid

Course Code: P18EE824  
Semester: VIII  
L-T-P-H: 2-2-0-4  
Credits –03

Contact period: Lecture: 52Hrs, Exam 3 Hrs  
Weightage: CIE:50%; SEE:50%

Course Content

Unit-I


**Performance Analysis Tools for Smart Grid Design:** Introduction to Load Flow Studies, Challenges to Load Flow in Smart Grid and Weaknesses of the Present Load Flow Methods, Load Flow State of the Art: Classical, Extended Formulations, and Algorithms, Congestion Management Effect, Load Flow for Smart Grid Design, DSOPF Application to the Smart Grid, Static Security Assessment (SSA) and Contingencies, Contingencies and Their Classification. **12Hrs**

**Self-study:** Microgrid and Smart Grid Comparison, Contingency Studies for the Smart Grid.

Unit-II


**Self-study:** Assessment, State Estimation.

Unit-III

Pathways for Designing Smart Grid Using Advanced Optimization and Control Techniques for Selection Functions, General Level Automation, Bulk Power Systems Automation of the Smart Grid at Transmission Level, Distribution System Automation Requirement of the Power Grid, End User/Appliance Level of the Smart Grid. **12Hrs**

**Self-study:** Applications for Adaptive Control and Optimization

**Unit-IV**


**Self-study:** Cyber Security and Possible Operation for Improving Methodology for Other Users.

**10 Hrs**

**Unit-V**

**Research, Education, and Training for the Smart Grid:** Introduction, Research Areas for Smart Grid Development, Research Activities in the Smart Grid, Multidisciplinary Research Activities, Smart Grid Education, Training and Professional Development. **Case Studies and Test beds for the Smart Grid:** Introduction, Demonstration Projects, Advanced Metering, Microgrid with Renewable Energy, Power System Unit Commitment (UC) Problem, ADP for Optimal Network Reconfiguration in Distribution Automation, Case Study of RER Integration, Test beds and Benchmark Systems.

**Self-study:** Challenges of Smart Transmission, Benefits of Smart Transmission. **10Hrs**


**Course Outcomes**

After learning all the units of the course, the student is able to:

**CO1:** Analyze the performance of different smart grid architecture.

**CO2:** Analyze the stability of the smart grid system.

**CO3:** Analyze the different computational tools used for smart grid.

**CO4:** Understand the renewable energy usage and storage.

**CO5:** Analyze the research area and different trainings or smart grid
Guidelines for Internship:

I. Internship is of minimum eight weeks duration and to be completed between the vacation period of VI & VII semester and VII & VIII semester.

II. The internship can be carried out in any industry/ R & D Organization/ Research/ Institute/ Educational institute of repute/ Internshala (ACITE MoU Internship).

III. The Department/college shall nominate staff member/s to facilitate, guide and supervise students under internship.

IV. The Internal Guide has to visit place of internship at least once during the student’s internship.

V. The students shall report the progress of the internship to the guide in regular intervals and seek his/her advice.

VI. After the completion of Internship, students shall submit a report with completion and attendance certificates to the Head of the Department with the approval of both internal and external guides.

VII. There will be 50 marks CIE (Seminar: 25, Internship report: 25) and 50 marks for Viva Voce conducted during Semester End Examination (SEE) of VIII Semester. For the conduction of Internship Semester End Examination following instructions are issued:
   a. The Semester End Examination (SEE) for 50 marks shall be conducted similar to final semester project work / lab examination.
   b. Internal & External Examiners shall be appointed by the BoE – Chairperson in consultation with HoD and approval of the same by the Principal & Controller of Examination.
   c. External Examiner may be from the Industry. If the external examiner from the industry is not available, alternative arrangement shall be made by the BoE - Chairperson by appointing a faculty from out of the available faculty in the department, wherein the student is studying.

VIII. The students are permitted to carry out the internship anywhere in India or abroad. The Institution will not provide any kind of financial assistance to any student for carrying out the Internship.

IX. Failing to undergo Internship: Internship is one of the head for obtaining degree, therefore completion of internship is mandatory.
Project Work: The Project Work (Phase I + Phase II) carries 8 credits (2 credits+6 credits) and spreads over TWO semesters, i.e. during 7th and 8th semesters.

I. Project Phase – I and Project seminar Comprises of Literature Survey, Problem identification, Objectives and Methodology. CIE marks shall be based on the report covering Literature Survey, Problem identification, Objectives and Methodology and seminar presentation skill.

II. The Assessment marks (CIE) in the case of Project Work - Phase I, shall be based on the evaluation at the end of the 7th semester by a committee consisting of Head of the concerned department, two senior faculty members of the department, one of them may be the internal guide. The work may be evaluated by the committee for award of Assessment marks (CIE) based on a Report [comprising of synopsis, Introduction, Literature survey, Objective and Methodology], presentation and viva voce.

III. The project work shall be carried out by candidate(s) independently/in a group (maximum of four) during the seventh and eighth semester under the guidance of one of the faculty members of the Department of study. If the project work is of inter-disciplinary nature, a co-guide shall be taken from the same or any other relevant Department. If a project work has to be carried out in any industry / factory / organization, outside the campus, the permission for the same and the name of co-guide at any of these organizations shall be intimated to the authorities at the beginning of seventh semester by the Head of the Department.

IV. The weekly progress of the Project work shall be monitored and reviewed by the Project Guide assigned by DUGC. The method of evaluation, including intermediate assessment shall be evolved by the pertinent DUGC.

V. A candidate shall submit N+3 (No. of candidates+3) copies of the Report of the Project Work to Head, DUGC on or before the specified date. The report shall be in the format prescribed by the Institute. The candidate shall submit a report of the project work (dissertation) duly approved by the guide and co-guide. The project report shall be countersigned by the guide, co-guide (if any) and the Head of the Department.

VI. The last date for the submission of Report shall be Two weeks before the closure of the semester in which the project work credits have been registered for and is expected to be completed or as announced by the COE. The date of submission of the dissertation may be extended up to a maximum of eight academic years, from the date of commencement of the first semester in which the candidate has taken admission to the course.

VII. The final evaluation (CIE & SEE) for Project Work - Phase II is done by a Project Work Evaluation Committee (PWEC) constituted by the pertinent DUGC. There shall be an open seminar followed by a viva – voce examination as part of the final evaluation. After the final evaluation, appropriate letter grade is awarded.

VIII. If in the opinion of the PWEC, the Project Report is acceptable with minor modifications for the minimum passing grade 'E'(Fair) in the case of project, the PWEC shall value and instruct the candidate suitably to incorporate the
necessary modifications and to resubmit it to the Chairman, PWEC. After such resubmission, the Chairman, PWEC will certify that the necessary modification has been incorporated.

IX. The Assessment marks in case of Project Work - Phase II and seminar shall be based on the evaluation, as per the guidelines, at the end of the 8th semester by a committee consisting of Head of the concerned department, two senior faculty members of the department (one of them may be the internal guide).

X. The Assessment marks sheet shall bear the signature of all those concerned, along with the date and seal of the Principal.
In the Self-Study course & Seminar, the student has to choose & study the courses related to the program discipline with her/his own efforts under the guidance of a Course Instructor/Project guide, using study materials available in open sources i.e. Massive Open Online Course (MOOC) NPTEL Courses. The intention of the course is to encourage the habit of self-learning.

Further, in addition to the above, the department has to release the pool of courses from the list of available 8 weeks NPTEL online courses. The student has to register for the course from the available pool during VII / VIII Semester and the same will be reflected in the Grade Card of the VIII Semester. The 50 marks CIE assessment is based on the final NPTEL score (i.e. Online assignments: 25% + Proctored exam: 75%). The NPTEL score will be mapped directly to the CIE marks as per the calculation below only if he /she has completed the NPTEL course (i.e. Certification).

\[
\text{CIE} = \frac{\text{NPTEL Score} \times 1.5}{2} = \text{Maximum CIE should be 50 Marks} \\
\text{Ex. - 1: If NPTEL Score is 60 then the CIE will be } = \frac{60 \times 1.5}{2} = 45 \\
\text{Ex. - 2: If NPTEL Score is 80 then the CIE will be } = \frac{80 \times 1.5}{2} = 50 \text{ (Max. CIE should be 50 Marks)}
\]

If the student fails to complete the NPTEL course at the end of the VIII Semester, then the department has to constitute a committee consisting of the Head of the department, two senior faculty members of the department, one of them may be the internal guide. The evaluation is based on a Report, Presentation, and Viva-Voce and the assessment is a relative evaluation in context to the student completed NPTEL course Certification (i.e. the CIE Score should be less than the score of the student cleared NPTEL Course).