FACULTY OF ENGINEERING

Scheme of Instruction & Examination

and

Syllabi

B.E. V and VI Semester

of

Four Year Degree Programme

In

Electrical & Electronics Engineering

(With effect from the academic year 2018 – 2019)

Issued by

Dean, Faculty of Engineering
Osmania University, Hyderabad
July 2018
### SCHEME OF INSTRUCTION & EXAMINATION  
**B.E. V – Semester**  
**(ELECTRICAL AND ELECTRONICS ENGINEERING)**

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### Practical / Laboratory Courses

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<td>PE502EE</td>
<td>Electronic Instrumentation</td>
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<td>PE503EE</td>
<td>FACTS Devices</td>
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**MC:** Mandatory Course  
**PC:** Professional Course  
**HS:** Humanities and Sciences  
**L:** Lecture  
**T:** Tutorial  
**P:** Practical  
**D:** Drawing  
**CIE:** Continuous Internal Evaluation  
**SEE:** Semester End Examination (Univ. Exam)

**Note:** 1) Each contact hour is a Clock Hour  
2) The practical class can be of two and half hour (clock hours) duration as per the requirement of a particular laboratory.
Course Code | Course Title | Core / Elective
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PC501EE | Power Systems-II | Core

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**Course Objectives**
- The student able to learn and understand the performance analysis of transmission lines and cables.
- To be able to comprehend analysis of symmetrical and unsymmetrical faults in the power system.

**Course Outcomes**
At the end of the course students will be able to
- Acquire modeling of different short, medium and long transmission lines
- Understand the impact of different types of faults on overhead transmission lines and calculation of fault currents and their significance.
- Explain the reasons for voltage variation, importance of maintaining constant voltage in power system and different voltage control methods.
- Acquire the knowledge of natural impedance of transmission line and significance in the operation of power system network.

**UNIT-I**

*Transmission Line Theory:* Performance of short, medium, long lines - Line calculations - Tuned lines, Power circle diagram and their applications.
Corona - Causes - Disruptive and Visual critical voltages - Power loss - Minimization of corona effects.

**UNIT-II**

*Symmetrical Faults:* Use of per unit quantities in power systems, advantages of per unit system. Symmetrical Three-phase Faults, Transients in RL series circuits - Short circuit currents - Reactance’s of synchronous machines - Symmetrical fault calculations, Short circuit capacity of bus.

**UNIT-III**

*Unsymmetrical Faults:* Symmetrical components of unsymmetrical phasors - Power in terms of symmetrical components - Sequence impedance and sequence networks, Sequence networks of unloaded generators - Sequence impedances of circuit elements - Single line to ground, line to line and double line to ground faults on unloaded generator - Unsymmetrical faults of power systems, Open circuit faults.

**UNIT-IV**

*Voltage Control:* Phase modifiers, Induction Regulators - Tap changing Transformers, Series and Shunt Capacitors, Reactive Power requirement calculations, Static VAR compensators - Thyristor Controlled reactor, Thyristor switched capacitor.

**UNIT-V**

*Travelling Wave Theory:* Causes of over voltages - Travelling wave theory - Wave equation - Open circuited line - The short circuited line - Junction of lines of different
natural impedances - Reflection and Refraction Coefficients - Junction of cable and over head lines - Junction of three lines of different natural impedances- Bewley Lattice diagram.

**Suggested Readings:**
Course Code | Course Title            | Core / Elective
----------------|------------------------|------------------
PC502EE       | Electrical Machines – II | Core

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Course Objectives:

- To be able to understand in detail about transformers and induction machines. Construction, principle, performance characteristics and testing.
- To understand the construction, principle and performance characteristics of fractional HP motors.

Course Outcomes:

- Explain the rating, testing and applications of single phase, three phase transformers
- Acquire the knowledge of Rotating magnetic field theory, Double field revolving theory
- Develop equivalent circuit diagram of transformer, three phase induction motor and single phase induction motor.
- Develop Slip-torque characteristics of single phase and three phase induction motors
- Demonstrate knowledge of Starting methods, Speed control methods and applications of single and three phase induction motors.

UNIT-I

Single Phase Transformers: Constructional features of single phase transformers, principle of two winding transformer, ideal transformer - transformer on no load and on load - phasor diagrams• equivalent circuits, losses , Testing - Polarity test, OC and SC tests, Sumner's test, Regulation and efficiency, All day efficiency, separation of losses - Excitation phenomena in transformers, Auto transformer - Comparison with two winding transformer and applications.

UNIT-II

Three - Phase Transformers: Connections - Choice of transformer connections - Third harmonic voltages - Phase conversion - 3-phase to 2-phase transformation, Scott connection - constructional features of poly phase transformers - Tertiary winding, Parallel operation of transformers, phase shifting transformer, Tap changer.

UNIT-III

UNIT-IV


UNIT-V


Suggested Reading:

Faculty of Engineering, O.U  

With effect from Academic Year 2018 - 2019

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<td>PC503EE</td>
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Course Objectives
- To learn and understand the fundamental concepts, principle of operation and applications of various electrical measuring instruments.
- To understand various types of Bridges in measurement of resistance, inductance, capacitance and frequency.
- To understand the operation and applications of Ballistic Galvanometer, Flux meter and DC/AC Potentiometer.
- To understand the application of CRO for measurement of Amplitude, Phase and frequency of sinusoidal signals.

Course Outcomes
At the end of the course students will be able to
- Choose the suitable instrument like Ammeter, Voltmeter for AC/DC applications.
- Select suitable Bridge for measurement of electrical parameters and quantities.
- Use CRO for measurement of Amplitude, Phase and frequency of sinusoidal signals.

UNIT I
**Instruments:** indicating, Recording and Integrating instruments, Ammeter, Voltmeter, Expression for torque of moving coil, moving iron, Dynamometer, induction and electrostatic instruments.
Extension of range of instruments, Wattmeter Torque expression for dynamometer instruments, Reactive power measurement.

UNIT II
**Meters:** Energy meters, single phase and 3-phase, Driving torque and braking torque equations, Errors and testing compensation, Maximum demand indicator, Power factor meters, Frequency meters, Electrical resonance and Weston type of synchroscope.

UNIT III
**Bridge Methods and transducers:** Measurement of inductance, capacitance and resistance using Bridges, Maxwell’s, Hay’s, bridge, Anderson, Wein, Desauty’s, Schering’s bridges, Kelvin’s double bridge, Megger, Loss of charge method, Wagners earthing device, Transducers - Analog and digital transducers, Strain gauges and Hall effect transducers.

UNIT IV

7
Magnetic Measurements and instrument transformers: Ballistic galvanometer, Calibration by Hibbert’s magnetic standard flux meter, Lloyd-Fischer square for measuring iron loss, Determination of B-H curve and Hysteresis loop using CRO, Instrument transformers – Current and potential transformers, ratio and phase angle errors of CT’s and PT’s.

UNIT V
Potentiometers: Crompton’s DC and AC polar and coordinate types, Applications, Measurements of impedance, Calibration and ammeter voltmeter and wattmeters. Use of oscilloscope in frequency, phase and amplitude measurements

Suggested Reading:
4. U.A.Bakshi, A.V.Bakshi, Electrical and Electronic Instrumentation, Technical publications
Course Code | Course Title                                      | Core / Elective |
-------------|--------------------------------------------------|-----------------|
PC504EE      | Linear Control Systems (Common to EEE and EIE)   | Core            |

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Course Objectives
- To develop basic skills of utilizing mathematical tools needed to analyze and design classical linear control systems.
- To understand and develop the state space representation of control systems.

Course Outcomes
At the end of the course students will be able to
- Understand the concept of the terms control systems, feedback, Mathematical modeling of Electrical and Mechanical systems.
- Explain the time domain and frequency response analysis of control systems.
- Acquire the knowledge of various analytical techniques used to determine the stability of control systems.
- Able to understand the importance of design of compensators
- Able to demonstrate controllability and observability of modern control systems.

UNIT-I
Introduction to Control Systems: Classification of control systems. Feed-Back Characteristics, Effects of feedback - Mathematical modeling of Electrical and Mechanical systems - Transfer function - Transfer function of Potentiometer, synchro, AC servo motor, DC servo motor - Block diagram reduction technique - Signal flow graph, Mason's gain formula

UNIT-II

UNIT-III

UNIT-IV
Frequency Response Analysis: Introduction to frequency response - Frequency domain specifications - Bode plot - Stability analysis from Bode plots - Determination of transfer function from the Bode Diagram - Polar Plots, Nyquist Plots, Stability Analysis, Gain margin and phase margin


UNIT-V
State Space Analysis: Concepts of state, State variables and state model, Derivation of state models of linear time invariant systems - Controllable, Observable and Diagonal state models - State transition matrix - Solution of state equation - Concepts of Controllability and Observability.

Suggested Reading:
Faculty of Engineering, O.U

With effect from Academic Year 2018 - 2019

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<td>PC505EE</td>
<td>Digital signal processing and Applications (Common to EEE and EIE)</td>
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Course Objectives
- To be able to understand and apply classification: characterization, representation and analysis of signals and systems in time and frequency domain.
- To understand the principle and design of digital filters and to introduce digital signal processor and their architecture.

Course Outcomes
At the end of the course students will be able to
- Acquire the knowledge of - Classification of discrete time signals & discrete time systems , Properties of Z-transforms, Discrete time Fourier transform.
- Analyze the Characteristics of IIR digital filters, FIR digital filters.
- Explain the Advantages of Digital signal processors over conventional Microprocessors.

UNIT- I
Introduction to Digital Signal Processing: Sampling, Quantizing and coding - Classification of discrete time signals & discrete time systems - linear shift invariant systems - Stability and causality - Solution to Linear constant coefficient difference equations.

Z-transforms: Properties - Inverse z-transform- System function• Relation between s-plane and z-plane - Stability in Z-domain - Solution of difference equations using one sided z-transform.

UNIT - II
Frequency domain analysis: Discrete time Fourier transform (DTFT), Properties - Frequency domain representation of discrete time signals and systems - DFS, Properties-Frequency domain sampling OFT, Properties - circular convolution - Linear convolution using OFT - Fast Fourier transforms (FFT) - Radix-2 decimation in time(DIT) and decimation in frequency(DIF) FFT Algorithms, IDFT using FFT.

UNIT-III

UNIT- IV
**FIR digital filters:** Characteristics of FIR Digital Filters, frequency response. Design of FIR Digital filters using window techniques, Linear phase realization - Applications of digital signal processing to speech processing.

**Multirate signal processing:** Decimation, Interpolation, Sampling rate conversion, Implementation of sampling rate conversion.

**UNIT-V**

**Introduction to Digital Signal Processors:** Introduction to programmable DSPs - Advantages of Digital signal processors over conventional Microprocessors - Architecture of TMS 320C5X• introduction, Bus Structure, Central Arithmetic Logic Unit, Auxiliary Register, Index Register, Auxiliary Register Compare Register, Block Move Address Register, Parallel Logic Unit, Memory mapped registers, Program controller, Status registers, On-chip memory and On-chip peripherals

**Suggested Reading:**

Course Code | Course Title | Core / Elective
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PE501EE | Electrical Distribution System (Professional Elective – I) | Core

Prerequisite | Contact Hours per Week | CIE | SEE | Credits
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NIL | 3 | 30 | 70 | 3

**Course Objectives**
- To understand the concepts and Importance of different loads characteristics, Design of Sub-Transmission Lines, Sub-Stations and Feeders.
- To make the students understand about importance of Power Quality and Applications of capacitors in distribution systems.

**Course Outcomes**
At the end of the course students will be able to
- Understand the concept of different factors used in design of distribution system components.
- Explain the different types of secondary distribution systems and their performances.
- Acquire the knowledge of various components, functions and applications of distribution automation and SCADA.
- Able to design the optimal locations and ratings of shunt capacitors used in radial feeder for different loading conditions.

**UNIT-I**

**UNIT-II**
Design of Sub-transmission lines and distribution sub-stations. Substation bus schemes, rating of distribution substation, service area with multiple feeders, percent voltage drop Calculations.

**UNIT-III**

**UNIT-IV**
Voltage drop and power loss calculations, 3-phase, non 3-phase primary lines - Single phase two wire laterals with ungrounded neutral, single phase two wire ungrounded laterals. Voltage fluctuations, measures to reduce flickering.
UNIT-V
Application of capacitors to distribution systems. Effect of series and shunt capacitors, power factor correction, economic justification for capacitors. Best capacitor location-Algorithm. Distribution Automation: Definitions, Components of distribution SCADA.

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**Course Objectives**

- To be able to understand various electrical transducers and instrumentation, amplifiers operation and their characteristics.
- To understand in detail about digital instruments and recorders, oscilloscopes, signal conditioning and data conversion

**Course Outcomes**

At the end of the course the student will be able to:

- Understand various electrical transducers and instrumentation
- Understand in detail about digital instruments and recorders

**UNIT I**

**Transducers:** Classification of transducers-Pressure sensitive detectors-Temperature detectors-Types of Electrical Transducers-Analogue and Digital transducers-Strain gauges-Thermo-couple inductive transducer-Capacitive transducer-Piezoelectric transducers-Photo sensitive devices-Photo conductive cells-Photovoltaic cell-Selecting a transducer, Hall effect transducers.

**UNIT II**

**Instrumentation amplifiers:** Basic characteristics of instrumentation amplifiers-Direct coupled amplifiers-Operational amplifiers-Various function of operational amplifiers Difference amplifiers-Charge amplifiers-Logarithmic amplifier-Instrumentation amplifier with operational amplifier-Three amplifier configuration.

**UNIT III**

**Signal conditioning and Data conversion:** Types of signal conditioning-Amplification of amplitude modulation in instrumentation-Modulators-Demodulators-Filters-Types of filters-Signal circuits-Bridge as input Circuit-Filters as integrator and differentiator-(Analog to digital and Digital to analog conversion-Weighted resistance D/A converter-Analog to digital converters)-Sample and hold circuit-Flash type, Dual scope integrating type-Successive approx.method.
UNIT IV


UNIT V

**Oscilloscopes:** Block diagram-Electro static focusing-Cathode Ray Tube-Time base generator-Horizontal and Vertical deflection system-Deflection sensitivity and deflection factor, Frequency limitation-Delay line-Application of oscilloscope-Accessories of oscilloscope-Special oscilloscope-Digital storage oscilloscopes-Principle of operation.

**Suggested Reading:**


Course Code | Course Title | Core / Elective
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PE503EE | FACTS Devices (Professional Elective – I) | Core

### Prerequisite

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### Course Objectives

- To understand the concepts and Importance of different loads characteristics, Design of Sub-Transmission Lines, Sub-Stations and Feeders.
- To make the students understand about importance of Power Quality and Applications of capacitors in distribution systems.

### Course Outcomes

At the end of the course the student will be able to:

- Apply impedance, phase angle and voltage control for real and reactive power flow in ac transmission systems
- Analyze and select a suitable FACTS controller for a given power flow condition

### UNIT-I

**Flexible AC Transmission Systems (FACTS):** FACTS concepts and general system conditions: Power flow in AC systems, Relative importance of controllable parameters, Basic types of FACTS controllers, shunt and series controllers, Current source and Voltage source converters

### UNIT-II

**Static Shunt Compensators:** Objectives of shunt compensation, Methods of controllable VAR generation, Static Var Compensator, its characteristics, TCR, TSC, FC-TCR configurations, STATCOM, basic operating principle, control approaches and characteristics.

### UNIT-III

**Static Series Compensators:** Objectives of series compensator, variable impedance type of series compensators, TCSC, TSSC-operating principles and control schemes, SSSC, Power Angle characteristics, Control range and VAR rating, Capability to provide reactive power compensation, external control.

### UNIT-IV

**Combined Compensators:** Introduction to Unified Power Flow Controller, Basic operating principles, Conventional control capabilities, Independent control of real and reactive power
UNIT-V

Application of FACTS : Improvement of system stability limit-enhancement of system damping-Enhancement of transient stability-Prevention of voltage instability

Suggested Reading
1. Understanding FACTS – Concepts and Technology of Flexible AC Transmission Systems by Narain G.Honorani, Laszlo Gyugi
Course Code | Course Title | Core/Elective
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PC551EE | ELECTRICAL MACHINES LAB-I | Core

Prerequisite | L | T | D | P | CIE | SEE | Credits
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Course Objectives:
- To learn operation and performance characteristics of d.c machines by conducting various experiments and tests practically.
- To understand the operation and performance characteristics of transformers by conducting various experiments and tests.

Course Outcomes:

On successful completion of this course student will be able to

- Estimate the efficiency and voltage regulation of D.C. generator and transformers under various loading conditions.
- Acquire the knowledge of efficiency and speed regulation D.C. Motors under various loading conditions.

LIST OF EXPERIMENTS

1. Magnetization characteristics of a separately excited D.C. generator.
2. Determination of the load characteristics of shunt and compound generators.
3. Determination of the performance and mechanical characteristics of series, shunt and compound motors (Any one).
5. Speed control of D.C. Shunt motor using shunt field control and armature control methods.
7. Open circuit and short circuit and load test on a single phase transformer.
8. Sumpner's test on two identical transformers.
10. Three phase to two phase transformation and open delta connection.
11. Hopkinson's test.

Note: Atleast ten experiments should be conducted in the Semester.

Suggested Reading:
# Power Electronics Lab
(Common to EEE and EIE)

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## Course Objectives:
- To be able to understand various power switching devices, trigger circuits, characteristics and applications by conducting the experiments.
- To learn and understand the rectifiers, choppers and inverters principle operation, characteristics and applications.

## Course Outcomes:
On successful completion of this course student will be able to
- Able to understand speed control of motors by using controlled rectifier
- Able to understand the applications of cycloconverters
- Able to simulate different power electronic devices using softwares.

## List of Experiments:
2. Design and fabrication of trigger circuits for single phase half-controlled and fully controlled bridge rectifiers.
3. Study of SCR chopper.
4. Design and fabrication of trigger circuit for MOSFET chopper.
5. Study of forced commutation techniques of SCRs.
6. Speed control of separately excited DC motor by controlled rectifier.
7. Study of single phase half and fully controlled rectifier.
8. Study of single phase and three phase AC voltage controller.
10. Study of single phase cyclo converter.
11. IGBT based PWM inverters.
12. Simulation of single phase half and fully controlled rectifier.
13. Simulation of single phase and three phase AC voltage controller.
14. Simulation of single phase inverter & three phase inverter.

**Note:** At least ten experiments should be conducted in the Semester.

**Suggested Reading:**
Faculty of Engineering, O.U
With effect from Academic Year 2018 - 2019

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**Course Objectives:**

- To train the students for acquiring practical knowledge for measuring resistance, inductance and capacitance using various bridges.
- To train the student for the usage of A.C. and D.C. potentiometers.
- To make the student understand the operation of CRO and its usefulness in finding the amplitude, phase and frequency of waveforms.

**Course Outcomes:**

On successful completion of this course student will be able to

- Measure the inductance, capacitance and resistance using various bridges.
- Measure resistance and calibrate ammeter, voltmeters and wattmeters using A.C. and D.C. potentiometers.
- Have hands on experience on the operation of CRO

---

**List of Experiments:**

**PART – A: CIRCUITS**

1. Verification of KCL & KVL using Mesh and nodal analysis
2. Verification of (a) Thevenins Theorem (b) Norton Theorem (c) Super Position Theorem (d) Max power transfer theorem
3. Frequency and time response of 2nd order RLC circuits
4. Open circuit, short and ABCD parameters of two port parameters
5. Simulation of 2nd order RLC using Pspice

**PART – B: MEASUREMENTS**

6. Measurement of low resistance by Kelvin’s double bridge
7. Measurement of active, reactive power measurements using two wattmeter method
8. Calibration of Single phase energy meter by Phantom loading and measurement of power direct loading
9. Measurement of power by 3-voltmeter and 3-Ammeter methods
10. Measurement of a) Inductance by Maxwell’s and Andersons bridge b) Measurement of capacitance by DeSauty’s bridge

**Note:** Atleast ten experiments should be conducted in the Semester.
Suggested Reading:

## SCHEME OF INSTRUCTION & EXAMINATION

**B.E. VI – Semester**  
**(ELECTRICAL AND ELECTRONICS ENGINEERING)**

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Course Code</th>
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<td><strong>Scheme of Instruction</strong></td>
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<tr>
<td>1.</td>
<td>PC601EE</td>
<td>Electrical Machines-III</td>
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<td>Microprocessors and Microcontrollers</td>
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<td>Switchgear and Protection</td>
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<td>Professional Elective-II</td>
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<td>6.</td>
<td>OE-I</td>
<td>Open Elective-I</td>
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### Practical / Laboratory Courses

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<tr>
<td>7.</td>
<td>PC651EE</td>
<td>Electrical Machines Lab-II</td>
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<td>8.</td>
<td>PC652EE</td>
<td>Digital Signal Processing Lab</td>
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<td>9.</td>
<td>PC653EE</td>
<td>Control Systems Lab</td>
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<tr>
<td>10.</td>
<td>MC</td>
<td>Mandatory Course</td>
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<tr>
<td>11.</td>
<td>SI</td>
<td>Summer Internship*</td>
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### Professional Elective-II

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<tr>
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<tr>
<td>PE601EE</td>
<td>AI Techniques</td>
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<td>PE602EE</td>
<td>Electric Distribution System</td>
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<td>PE603EE</td>
<td>Digital Control Systems</td>
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### Open Elective-1

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<tr>
<td>OE601CE</td>
<td>Disaster Management</td>
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<td>OE602CE</td>
<td>Geospatial Techniques</td>
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<td>OE601CS</td>
<td>Operating Systems</td>
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<td>OE602CS</td>
<td>OOPS using JAVA</td>
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<td>OE601EC</td>
<td>Embedded Systems</td>
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<tr>
<td>OE602EC</td>
<td>Digital System Design Using Verilog HDL</td>
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<tr>
<td>OE601EE</td>
<td>Reliability Engineering**</td>
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<tr>
<td>OE602EE</td>
<td>Basics of Power Electronics**</td>
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<td>OE601ME</td>
<td>Industrial Robotics</td>
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<td>Material Handling</td>
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<td>OE601LA</td>
<td>Intellectual Property Rights</td>
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### Mandatory course

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<tr>
<td>MC951SP</td>
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<tr>
<td>MC951SP</td>
<td>National Service Scheme</td>
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<tr>
<td>MC951SP</td>
<td>Sports</td>
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</table>
* The students have to undergo a Summer Internship of 6 weeks duration after VI semester and credits will be awarded in VII semester after evaluation.

**Indicates that subject not offered to the students of Electrical and Electronics Engineering Department.

BS: Basic Sciences   ES: Engineering Sciences   MC: Mandatory Course
PC: Professional Course   HS: Humanities and Sciences
L: Lectures   T: Tutorials   Pr : Practicals   Drg: Drawing
CIE: Continuous Internal Evaluation   SEE: Semester End Examination (Univ. Exam)

Note: 1) Each contact hour is a Clock Hour
2) The practical class can be of two and half hour (clock hours) duration as per the requirement of a particular laboratory.
## Course Code | Course Title | Core / Elective
---|---|---
PC601EE | ELECTRICAL MACHINES-III | Core

<table>
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<tr>
<th>Prerequisite</th>
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## Course Objectives
- To be able to understand in detail about synchronous machines. Construction, principle, performance characteristics and testing.
- To understand the construction, principle and performance characteristics of special machines.

## Course Outcomes
At the end of the course students will be able to
- Acquire the knowledge of types, Constructional Details, characteristics and applications of synchronous generator, synchronous motor, PMSM and brushless DC motors.
- Explain different methods used to evaluate voltage regulation of synchronous generator.
- Analyze the behavior of an alternator under transient disturbances

### UNIT - I
Synchronous machines: Types and Constructional Details - Types of Winding, Winding factors - E.M.F. equation - Fractional pitch and fractional slot windings - Suppression of harmonics and tooth ripple - Armature reaction and reactance - Synchronous impedance.

### UNIT - II

### UNIT-III

UNIT- IV

Permanent Magnet Synchronous Motor: Construction, principle operation of PMSM and their operating characteristics

UNIT-V
Switched Reluctance Motor: Constructional features, Principle of operation, Torque production, Torque - angle characteristics, various operating modes of SRM, applications.

Suggested Reading:
<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Core / Elective</th>
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</thead>
<tbody>
<tr>
<td>PC602EE</td>
<td>Microprocessor and Microcontroller (Common to EEE and EIE)</td>
<td>Core</td>
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</table>

**Course Objectives**

- To be able to understand in detail about 8086 microprocessor architecture, programming and interfacing.
- To be able to understand about 8051 microcontroller architecture, and programming.

**Course Outcomes**

At the end of the course students will be able to

- Acquire the knowledge of Architecture of 8086, writing assembly language programming for different applications.
- Explain types of microcontrollers and their applications.

**UNIT- I**

*Microprocessor*: Architecture of 8086 - Segmented memory, Addressing modes, Instruction set, Minimum and maximum mode operations.

**UNIT-II**

*Introduction to Programming*: Assembly language programming,Assembler directives, Simple programs using assembler, Strings, Procedures, Macros timing.

**UNIT-III**

*Interfacing to Microprocessor*: Memory and I/O interfacing, A/D and D/A interfacing, 8255(PPI), Programmable Internal Timer (8253), Keyboard and display interlace, Interrupts of 8086.

**UNIT- IV**


**UNIT-V**
**Introduction to Programming** : Basic Assembly Language Programming, instruction cycle, Addressing modes, 8051 instruction set, Classification of instructions. Simple programs.

**Suggested Reading** :

Course Code | Course Title | Core / Elective
--- | --- | ---
PC603EE | SWITCHGEAR AND PROTECTION | Core

<table>
<thead>
<tr>
<th>Prerequisite</th>
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**Course Objectives**
- To be able to understand the need of protection in power system and protection with conventional and static relays.
- To understand the protection of transformers, generators and need of circuit breakers.

**Course Outcomes**
At the end of the course students will be able to
- Acquire the knowledge of construction, working principles of different electromagnetic and static relays used to protect generators, transformers, transmission lines and distribution feeders.
- Analyze the Characteristics of over current, over voltage, distance and differential relays and also their applications in power system networks.
- Explain the working principle. Construction, rating and applications of different types of circuit breakers used in power system networks.
- Understand the construction details, advantages, disadvantages of Gas Insulation substations.

**UNIT- I**

*Introduction to Protective Relays*: Need for protection - primary protection - backup protection
Zones of protection - Definitions of relay pick up and reset values - Classification of relays - Operating principles and construction of Electromagnetic and Induction type relays. Over current relay - Over voltage - Directional relay - Universal relay torque equation. Over current protection for radial feeder and ring mains - Protection of parallel lines - Relay settings for over current relays Earth fault and phase fault protection.

**UNIT - II**

*Static phase and Amplitude comparators*: Characteristics of dual input comparators. Static Relays -Instantaneous over current relay - Definite time over current relay - Inverse time over current relay - Directional over current relay (Block diagram approach only)
Distance protection - Characteristics of 2- input distance relays on the RX diagram - Input characteristics for various types of distance relays - 3-step distance relays, Microprocessor based over current relay (block diagram).

UNIT- III

UNIT- IV

UNIT- V
Gas Insulated Substations & Over Voltage Protection: Constructional details (components), Merits and Demerits of Gas Insulated Substations over conventional Air insulated Substations. Protection of transmission lines against direct lightning strokes – ground wires - Protection angle Protection zone - Tower footing resistance and its effects - Equipment protection assuming rod gaps, arcing horns - Different types of lightning arrester - their construction Surge absorbers - Peterson coil - Insulation coordination.

Suggested Reading:
Course Code | Course Title | Core / Elective
--- | --- | ---
PC604EE | RENEWABLE ENERGY TECHNOLOGIES | Core

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Course Objectives
- To understand the concepts and Importance of renewable energy sources such as solar, wind, biomass, tidal power.
- To make the students understand the advantages and disadvantages of different renewable energy sources.

Course Outcomes
At the end of the course students will be able to
- Explain the advantages, disadvantages and applications of different conventional and non conventional sources.
- Acquire the knowledge of various components, principle of operation and present scenario of different conventional and non conventional sources.

UNIT-I

UNIT-II

UNIT-III
Wind energy- Principles of wind energy conversion systems - Nature of wind - Power in the Wind-Basic components of WECS -Classification of WECS -Site selection
considerations -Advantages and disadvantages of WECS -Wind energy collectors -Wind electric generating and control systems - Applications of Wind energy -Environmental aspects.

UNIT-IV

UNIT-V
Energy from Biomass - Biomass conversion technologies / processes - Photosynthesis - Photosynthetic efficiency - Biogas generation - Selection of site for Biogas plant - Classification of Biogas plants - Details of commonly used Biogas plants in India - Advantages and disadvantages of Biogas generation -Thermal gasification of biomass - Biomass gasifiers.

Suggested Reading:
Course Code | Course Title | Core / Elective
--- | --- | ---
PE601EE | **AI TECHNIQUES**  
(Professional Elective-II) | Core

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<thead>
<tr>
<th>Prerequisite</th>
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**Course Objectives**
- To be able to understand basics of ANN & Fuzzy based systems.
- To make the students to understand the ANN based systems for function approximation used in load forecasting.

**Course Outcomes**
At the end of the course students will be able to
- Understand how the soft computing techniques can be used for solving the problems of Electrical Engineering.
- Design of ANN based systems for function approximation used in load forecasting.
- Design of Fuzzy based systems for load frequency control in power systems.
- Solve problem of Optimization in power systems.

**UNIT-I:**
**Introduction:** Introduction: definition of AI -difference between soft computing techniques and hard computing systems, expert systems brief history of ANN, Fuzzy and GA

**UNIT-II:**

**UNIT-III:**
**Fuzzy Logic:** Introduction –Fuzzy versus crisp, Fuzzy sets-Membership function –Basic Fuzzy set operations, Properties of Fuzzy sets –Fuzzy cartesian Product, Operations on
Fuzzy relations – Fuzzy logic – Fuzzy Quantifiers, Fuzzy Inference - Fuzzy Rule based system, Defuzzification methods.

UNIT-IV:
**Genetic Algorithms:** Introduction- Encoding – Fitness Function - Reproduction operators, Genetic Modeling – Genetic operators - Cross over - Single site cross over, Two point cross over – Multi point cross over – Uniform cross over, Matrix cross over - Cross over Rate - Inversion & Deletion, Mutation operator – Mutation – Mutation Rate - Bit-wise operators, Generational cycle - convergence of Genetic Algorithm.

UNIT-V:
**Applications of ANN:** Fuzzy logic and GA in power systems operation and control for solving problems of load forecasting, voltage control, voltage stability, security assessment, feeder load balancing, AGC, Economic load dispatch, Unit commitment. Condition monitoring.

**Reference Books:**
1. Neural Networks, Fuzzy logic and Genetic algorithms By S. Rajasekaran, G. A. Vijayalakshmi Pai PHI publication,
2. Optimization for Engineering Design by Kalyanmoy Deb PHI publication
3. Multi-objective Optimization using Evolutionary Algorithms By Kalyanmoy Deb Willey Publication
4. Artificial intelligence techniques in power systems by KEVIN WARWICK, ARTHUR EKWUE RAJ AGRAWAL
Course Code: PE602EE
Course Title: PROGRAMMABLE LOGIC CONTROLLER (Professional Elective-II)
Core / Elective: Core

Prerequisite: NIL
Contact Hours per Week: L 3, T 0, D 0, P 0
CIE 30, SEE 70
Credits: 3

Course Objectives
- To be able to understand basics of Programmable logic controllers, basic programming of PLC.
- To make the students to understand the Functions and applications of PLC

Course Outcomes
At the end of the course students will be able to
- Develop PLC programs for industrial applications.
- Acquire the knowledge of PLC counter functions and PLC Arithmetic functions and data handling functions.

UNIT-I
**PLC Basics:** Definition and History of PLC - PLC advantages and disadvantages - Over all PLC Systems - CPUs and Programmer Monitors - PLC input and output models - Printing PLC Information- Programming Procedures - Programming Equipment - Programming Formats- Proper Construction of PLC Diagrams - Devices to which PLC input and output modules are connected - Input on/off switching devices - Input analog devices - Output analog on/off devices and output analog devices.

UNIT-II
**Basic PLC Programming:** Programming on/off inputs to produce on/off outputs - PLC input instructions - Outputs - Operational procedures - Contact and coil input/output programming examples - Relation of digital gate logic contact / coil logic - PLC programming and conversion examples - Creating ladder diagrams from process control descriptions - Sequence listings - Large process ladder diagram constructions.
UNIT-III

Basic PLC Functions: General Characteristics of Registers - Module addressing - Holding registers - Input registers - output registers - PLC timer functions - examples of timer functions. Industrial applications - PLC counter functions.

UNIT-IV

Intermediate Functions: PLC Arithmetic functions - PLC additions and subtractions - The PLC repetitive clock - PLC Multiplications, Division and Square Root - PLC trigonometric and log functions - Other PLC arithmetic functions - PLC number comparison functions. PLC basic comparison functions and applications - Numbering systems and number conversion functions - PLC conversion between decimal and BCD-Hexadecimals numbering systems.

UNIT-V

Data Handling Functions: The PLC skip and master control relay functions - Jump functions - Jump with non return - Jump with return. PLC data move Systems - The PLC functions and applications. PLC functions working with bits - PLC digital bit functions and applications - PLC sequence functions - PLC matrix functions.

Suggested Reading:
Course Objectives
- This course gives fundamentals digital control systems, z-transforms, state space representation of the control systems, concepts of controllability and observability, estimation of stability in different domains, design of discrete time control systems, compensators, state feedback controllers, state observers through various transformations.

Course Outcomes
The students will be able to:
- Develop PLC programs for industrial applications.
- Acquire the knowledge of PLC counter functions and PLC Arithmetic functions and data handling functions.

UNIT-I
**Introduction:** Introduction, Examples of Data control systems — Digital to Analog conversion and Analog to Digital conversion, sample and hold operations. **Z TRANSFORMS:** Introduction, Linear difference equations, pulse response, Z transforms, Theorems of Z — Transforms, the inverse Z — transforms, Modified Z-Transforms. Z-Transform method for solving difference equations; Pulse transforms function) block diagram analysis of sampled — data systems, mapping between s-plane and z-plane.

UNIT-II
**State Space Analysis:** State Space Representation of discrete time systems, Pulse Transfer Function Matrix solving discrete time state space equations, State transition matrix and its Properties, Methods for Computation of State Transition Matrix, Discretization of continuous time state — space equations. Concepts of Controllability and Observability, Tests for controllability and Observability. Duality between Controllability and Observability, Controllability and Observability conditions for Pulse Transfer Function.

UNIT-III
UNIT-IV

UNIT-V
State Feedback Controllers & Observers: Design of state feedback controller through pole placement — Necessary and sufficient conditions, Ackerman’s formula. State Observers — Full order and Reduced order observers.

Text Book

Reference Books
Course Code | Course Title | Core / Elective
--- | --- | ---
OE601BE | MICROELECTRO-MECHANICAL SYSTEMS (Open Elective-I) | Core

<table>
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Course Objectives
- To provide knowledge of semiconductors and solid mechanics to fabricate MEMS devices.
- To introduce various sensors and actuators
- To introduce different materials used for MEMS
- To educate on the applications of MEMS to various disciplines

Course Outcomes
The students will be able to:
- Ability to design the micro devices, micro systems using the MEMS fabrication process.
- Ability to understand the operation of micro devices, micro systems and their applications.

UNIT-I

UNIT-II

UNIT-III
UNIT IV

UNIT-V
Polymer and Optical MEMS: Polymers in MEMS – Polimide - SU-8 - Liquid Crystal Polymer (LCP) – PDMS – PMMA – Parylene – Fluorocarbon - Application to Acceleration, Pressure, Flow and Tactile sensors- Optical MEMS – Lenses and Mirrors – Actuators for Active Optical MEMS.

TEXT BOOKS:
Mohamed Gad-el-Hak, editor, *The MEMS Handbook*, CRC press Baco Ra
### Course Code: OE601CE
#### Course Title: Disaster Management (Open Elective-I)
#### Core / Elective: Core

<table>
<thead>
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### Course Objectives
- To provide students an exposure to disasters, their significance and types.
- To ensure that students begin to understand the relationship between vulnerability, disasters, disaster prevention and risk reduction.
- To gain a preliminary understanding of approaches of Disaster Risk Reduction (DRR).
- To enhance awareness of institutional processes in the country and to develop rudimentary ability to respond to their surroundings with potential disaster response in areas where they live, with due sensitivity.

### Course Outcomes
The students will be able to:
- Understand the impact on Natural and manmade disasters.
- Able to classify disasters and destructions due to cyclones.
- Able to understand disaster management applied in India.

### UNIT-I

**Introduction to Disasters:** Concepts and definitions of Disaster, Hazard, Vulnerability, Resilience, Risks.

**Natural and Manmade disasters,** impact of drought, review of past disasters and drought in India, its classification and characteristics. Classification of drought, causes, Impacts (including social, economic, political, environmental, health, psychosocial, etc.).

### UNIT-II

**Disaster:** Classifications, Causes, Impacts including social, economic, political, environmental, health, psychosocial etc.

**Differential Impacts** - in terms of caste, class, gender, age, location, disability. Global trends in disasters, urban disasters, pandemics, complex emergencies, climate change.

**Cyclones and Floods:** Tropical cyclones & Local storms, Destruction by tropical cyclones and local storms, Cumulative atmospheric hazards/ disasters, Cold waves, Heat waves, Causes of floods, Rood hazards in India.
UNIT-III

*Approaches to Disaster Risk Reduction:* Disaster cycle - its analysis, Phases, Culture of safety, prevention, mitigation and preparedness community based DRR, Structural-nonstructural sources, roles and responsibilities of community, Panchayati Raj Institutions/Urban Local Bodies (PRis/ULBs), states, Centre, and other stake-holders.

UNIT-IV

*Inter-relationship between Disasters and Development:* Factors affecting Vulnerabilities, differential impacts, impact of development projects such as dams, embankments, changes in Land-use etc. Climate Change Adaptation, Relevance of indigenous knowledge, appropriate technology and local resources.

UNIT-V

*Disaster Risk Management in India:* Hazard and Vulnerability profile of India Components of Disaster Relief: Water, Food, Sanitation, Shelter, Health, Waste Management Institutional arrangements (Mitigation, Response and Preparedness, OM Act and Policy, other related policies, plans, programmes and legislation)

*Field Work and Case Studies:* The field work is meant for students to understand vulnerabilities and to work on reducing disaster risks and to build a culture of safety. Projects must be conceived creatively based on the geographic location and hazard profile of the region where the college is located.

*Suggested Reading:*

OE602CE | GEOSPATIAL TECHNIQUES (Open Elective-I) | Core
---|---|---
Prerequisite | Contact Hours per Week | CIE | SEE | Credits
NIL | 3 | 0 | 0 | 0 | 30 | 70 | 3

**Course Objectives**
- Description about various spatial and non-spatial data types, and data base management techniques
- Development of the concepts and professional skills in utility of geospatial techniques
- Enhancement of knowledge of geospatial techniques to field problems

**Course Outcomes**
The students will be able to:
- The students will be able to understand and apply GIS tools
- Will be able to analyse and process data to apply to the GIS tools.
- Will be able assimilate knowledge on field problems using remote sensing

**UNIT-I**

*Introduction*: Basic concepts, socioeconomic challenges, fundamentals of geographical information systems (GIS), history of geographical information system, components of geographical information systems.

*Projections and Coordinate Systems*: Map definitions, representations of point, line, polygon, common coordinate system, geographic coordinate system, map projections, transformations, map analysis.

**UNIT-II**

*Data Acquisition and Data Management*: data types, spatial, non spatial (attribute) data, data structure and database management, data format, vector and raster data representation, object structural model filters and files data in computer, key board entry, manual digitizing, scanner, aerial photographic data, remotely sensed data, digital data, cartographic database, digital elevation data, data compression, data storage and maintenance, data quality and standards, precision, accuracy, error and data uncertainty.

*Data Processing*: Geometric errors and corrections, types of systematic and non systematic errors, radiometric errors and corrections, internal and external errors.

**UNIT-III**

*Data Modeling*: Spatial data analysis, data retrieval query, simple analysis, recode overlay, vector data model, raster data model, digital elevation model, cost and path analysis, knowledge based system.
**GIS Analysis and Functions:** Organizing data for analysis, analysis function, maintenance and analysis of spatial data, buffer analysis, overlay analysis, transformations, conflations, edge matching and editing, maintenance and analysis of spatial and non-spatial data.

UNIT-IV

**Applications of GIS:** Environmental and natural resource management, soil and water resources, agriculture, land use planning, geology and municipal applications, urban planning and project management, GIS for decision making under uncertainty, software scenario functions, standard GIS packages, introduction to Global Positioning Systems (GPS) and its applications.

UNIT-V

**Introduction to Remote Sensing:** General background of remote sensing technology, objectives and limitations of remote sensing, electro-magnetic radiation, characteristics, interaction with earth surface and atmosphere, remote sensing platforms and sensors, satellite characteristics, digital image processing, IRS series and high resolution satellites, software scenario functions, remote sensing applications to watershed modeling, environmental modeling, urban planning and management.

**Suggested Reading:**


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<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Core / Elective</th>
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<tbody>
<tr>
<td>OE601CS/ OE 664CS</td>
<td>OPERATING SYSTEMS (Open Elective-1)</td>
<td>Core</td>
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</table>
Course Objectives
- To understand CPU, Memory, File and Device management
- To learn about concurrency control, protection and security
- To gain knowledge of Linux and Windows NT internals

Course Outcomes
The students will be able to:
- Student will be able to
- Explain the components and functions of operating systems.
- Analyze various Scheduling algorithms.
- Apply the principles of concurrency
- Compare and contrast various memory management schemes
- Perform administrative tasks on Linux Windows Systems

UNIT-I

UNIT-II

UNIT-III

UNIT-IV
*Device Management*: Disk scheduling methods, Disk management, Device drivers and interfaces, CPU- Device interactions, I/O optimization.

UNIT-V
Suggested Reading:
<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Core / Elective</th>
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<tbody>
<tr>
<td>OE602CS/ OE665CS</td>
<td>OPPS USING JAVA (Open Elective-I)</td>
<td>Core</td>
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**Course Objectives**
- To introduce fundamental object oriented concepts of Java programming Language
- such as classes, inheritance packages and interfaces.
- To introduce concepts of exception handling and multi threading.
- To use various classes and interfaces in java collection framework and utility classes.
- To understand the concepts of GUI programming using AWT controls.
- To introduce Java I/O streams and serialization

**Course Outcomes**
The students will be able to:
- Able to develop java applications using OO concepts and packages.
- Able to write multi threaded programs with synchronization
- Able to implement real world applications using java collection frame work and I/O classes
- Able to write Event driven GUI programs using AWT/Swing

UNIT – I
**Object Oriented System Development**: understanding object oriented development, understanding object oriented concepts, benefits of object oriented development.

**Java Programming Fundamentals**: Introduction, overview of Java, data types, variables and arrays, operators, control statements

UNIT – II
**Java Programming OO concepts**: classes, methods, inheritance, packages and interfaces. Exceptional Handling, Multithreaded Programming

UNIT – III
I/O Basics, Reading Console Input and Output, Reading and Writing Files, Print Writer Class, String Handling Exploring Java Lang, Collections Overview, Collection Interfaces, Collection Classes, Iterators, Random Access Interface, Maps, Comparators, Arrays, Legacy Classes and Interfaces, String Tokenizer
UNIT – IV


AWT Controls: Control Fundamentals, Labels, Using Buttons, Applying Check Boxes, Checkbox Group, Choice Controls, Using Lists, Managing Scroll Bars, Using Text Field, Using Text Area, Understanding Layout Managers, Menu bars and Menus, Dialog Boxes, File Dialog, Handling events by Extending AWT Components, Exploring the controls, Menus and Layout Managers.

UNIT – V

Java I/O Classes and Interfaces, Files, Stream and Byte Classes, Character Streams, Serialization.

Suggested Readings:
James M Slack, Programming and Problem Solving with JAVA, Thomson learning, 2002
Course Code | Course Title | Core / Elective
--- | --- | ---
OE601EC | EMBEDDED SYSTEMS (Open Elective-I) | Core

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**Course Objectives**
- To understand the fundamentals of embedded systems
- To study the block diagram and advanced hardware fundamentals
- To study the software architecture of embedded systems
- To learn the tool chain of embedded systems
- To understand the tools and debugging process of embedded systems.

**Course Outcomes**
The students will be able to:
- Able to acquire an overview of what an embedded system implies
- Able to understand the architecture of a microprocessor and microcontroller to enable to design embedded applications using them.
- Able to apply theoretical learning to practical real time problems for automation.
- Able to understand how to build and debug an embedded system application.
- Able to analyze and design real world applications and interface peripheral devices to the microprocessor.

**UNIT – I**
**Fundamentals of embedded systems:** Definition of Embedded system, Examples of Embedded Systems, Typical Hardware, Terminology, Gates, A few other basic considerations, Timing Diagrams, Memory

**UNIT – II**
**Advanced hardware fundamentals:** Microprocessors, Buses, Direct Memory Access, Interrupts, Other Common Parts, Built-Ins on the Microprocessor, Conventions used in Schematics, Microprocessor Architecture, Interrupts Basics, Shared Data Problem, Interrupt Latency.

**UNIT – III**

UNIT – IV

UNIT – V
Debugging techniques: Testing on your host machine, Instruction Set Simulators, The assert Macro, Using Laboratory Tools

Suggested Readings:
Course Code | Course Title | Core / Elective
--- | --- | ---
OE602EC | DIGITAL SYSTEM DESIGN USING VERILOG HDL (Open Elective-I) | Core

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**Course Objectives**
- To familiarize with various modeling styles: structural, dataflow and behavioral of Verilog HDL.
- To develop combinational and sequential circuits using various modeling styles of Verilog HDL.
- To design and develop Verilog HDL models of data path and control units of Central Processing Unit (CPU).
- To learn Synthesis and FPGA design flow.
- To design and develop real time applications: Booth’s multiplier, Divider, hardwired control for basic CPU and FIR filter.

**Course Outcomes**
The students will be able to:
- Able to implement and distinguish different Verilog HDL modeling styles
- Able to construct and analyze Verilog HDL models of combinational and sequential circuits
- Able to design and develop Verilog HDL modeling and test bench for digital systems for the given specifications
- Able to outline FPGA design flow and timing analysis

UNIT-I
**Structural Modeling**: Overview of Digital Design with Verilog HDL, Basic concepts, modules and ports, gate-level modeling, hazards and design examples

UNIT-II
**Dataflow and Switch Level Modeling**: dataflow modeling, operands and operators. Switch Level Modeling: CMOS switches and bidirectional switches and design examples

Unit-III

UNIT-IV
Synthesis and Verification: Tasks and Functions: Differences between Tasks and Functions. Verilog HDL synthesis, Application Specific IC (ASIC) and Field Programmable Gate Array (FPGA) design flow. Verification: Timing analysis and Test bench design. Design examples.

UNIT-V
Real Time Implementations: Fixed-Point Arithmetic modules: Addition, Multiplication, Division, Arithmetic and Logic Unit (ALU), Timer, Universal Asynchronous Receiver and Transmitter (UART), DSP modules: FIR and IIR filters, CPU design: Data path and control units.

Suggested Readings:
Course Code | Course Title | Core / Elective
--- | --- | ---
OE601EE | RELIABILITY ENGINEERING (Open Elective-I) | Core

Prerequisite | Contact Hours per Week | CIE | SEE | Credits
--- | --- | --- | --- | ---
NIL | L T D P | 30 | 70 | 3

Course Objectives
- To understand the concepts of different types of probability distributions. Importance of reliability evaluation of networks.
- To make the students understand about Reliability, availability model of Power Systems and markov modeling of Power Plants. with identical and nonidentical units

Course Outcomes
The students will be able to:
- Understand the meaning of discrete and continuous random variables and their significance, causes of failures of a system.
- Acquire the knowledge of different distribution functions and their applications.
- Able to develop reliability block diagrams and evaluation of reliability of different systems.

UNIT- I

UNIT - II

UNIT- III

UNIT- IV
Availability, MTTR and MTBF, Markov models and State transition matrices. Reliability models for single component. two components, Load sharing and standby systems. Reliability and availability models of two unit parallel system with repair and standby systems with repair.

UNIT-V

Suggested Reading:
OE601ME | INDUSTRIAL ROBOTICS (Open Elective-I) | Core
--- | --- | ---
Prerequisite | Contact Hours per Week | CIE | SEE | Credits
--- | --- | --- | --- | ---
NIL | L 3  | T 0  | D 0  | P 0  | 30  | 70  | 3

**Course Objectives**
- To familiarize the student with the anatomy of robot and their applications
- To provide knowledge about various kinds of end effectors usage
- To equip the students with information about various sensors used in industrial robots
- To make the student understand the importance of spatial transformation of robots using forward and inverse kinematics
- To specify and provide the knowledge of techniques involved in robot vision in industry
- To equip students with latest robot languages implemented in industrial manipulators.

**Course Outcomes**
The students will be able to:
- Able to demonstrate knowledge of the relationship between mechanical structures of industrial robots and their operational workspace characteristics and Have an understanding of the functionality and limitations of robot actuators and sensors
- Able to demonstrate an ability to apply spatial transformation to obtain forward/Inverse kinematics equation of robot manipulators using analytical/numerical/simulation tools
- Able to apply knowledge and choose the best & economically suitable sensors/end effectors required for specific applications
- Able to understand the importance of robot vision and apply the learnt techniques to get the required information from input images
- Able to design and develop a industrial robot for a given purpose economically
- Appreciate the current state and potential for robotics in new application areas.

**UNIT-I**
*Introduction to Robotics:* Basic structure of Robots. Degree of freedom of Robots. Work envelope. Classification of Robots based on Drive Technology, Work-Envelope and
motion control methods. Application of Robots in Industry, Repeatability, Precision and Accuracy as applied to Robots, Specifications of robots used for various applications. End effectors – Grippers: Mechanical grippers, pneumatic and hydraulic grippers, magnetic grippers, vacuum grippers, RCC grippers – Two fingered and three fingered grippers – Internal grippers and external grippers – Selection and design considerations.

UNIT-II
Requirements of a sensor, principles and applications of the following types of sensors – Position of sensors (Piezo electric sensor, LVDT, Resolvers, Optical encoders, Pneumatic position sensors) – Range sensors (Triangulation principle, Structured, Lighting approach, Time of flight range finders, Laser range meters) – Proximity sensors (Inductive, Hall effect, Capacitive, Ultrasonic and Optical proximity sensors) – Touch sensors (Binary sensors, Analog sensors) – Wrist Sensors – Compliance Sensors – Slip Sensors.

UNIT-III
Kinematic Analysis of robots: Rotation matrix. Homogeneous transformation matrix, Denavit & Hartenberg representation, Euler and RPY angles representation. Representation of absolute position and orientation in terms of joint parameters, Direct Kinematics of manipulators, Inverse kinematics of Robot arm for position and orientation. Redundancy in Robots. Static force analysis

UNIT-IV

UNIT-V

Suggested Reading:
5. 5 Saha & Subir kumar saha, "robotics", TMH, India.
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<td>OE602ME</td>
<td>MATERIAL HANDLING (open Elective-I) (Open Elective-I)</td>
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**Course Objectives**
- To know about the working principle of various material handling equipments
- To understand the Material handling relates to the loading, unloading and movement of all types of materials
- To understand the estimation of storage space and maintenance of material handling equipments

**Course Outcomes**
The students will be able to:
- Able to understand various conveying systems that available in industry
- Able to understand various bulk solids handling systems and their design features
- Able to understand and various modern material handling systems and their integration.
- Able to calculate number of MH systems required, storage space, cost and maintenance.

**UNIT-I**
*Mechanical Handling Systems:* Belt Conveyors and Desing, Bucket Elevators, Package conveyors, Chain and Flight Conveyors, Screw Conveyors, Vibratory Conveyors, Cranes and Hoists.

**UNIT-II**

**UNIT-III**
UNIT-IV

**Modern Material Handling Systems:** Constructional features of (i) AGV (ii) Automated storage and retrieval systems. Sensors used in AGVs and ASRS. Bar code systems and RFID systems: Fundamentals and their integration with computer-based information systems.

UNIT-V

**Total MH Throughput:** Calculation for no. of MH systems; storage space estimation based on no of aisles. Maintenance of MH equipment, spare parts management, cost of materials handling, cost per unit load computations.

**Suggested Reading:**
Course Code | Course Title | Core / Elective
--- | --- | ---
OE601LA | INTELLECTUAL PROPERTY RIGHTS (open Elective-I) | Core

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**Course Objectives**
- To create awareness on Engineering Ethics providing basic knowledge about ethics, moral issues & moral dilemmas and professional ideals.
- To understanding, define and differentiate different types of intellectual properties (IPs) and their roles in contributing to organizational competitiveness.
- To expose to the Legal management of IP and understanding of real life practice of Intellectual Property Management.

**Course Outcomes**
The students will be able to:
- Identify different types of Intellectual Properties (IPs), the right of ownership, scope of protection as well as the ways to create and to extract value from IP.
- Recognize the crucial role of IP in organizations of different industrial sectors for the purposes of product and technology development.
- Identify activities and constitute IP infringements and the remedies available to the IP owner and describe the precautionous steps to be taken to prevent infringement of proprietary rights and duties in products and technology development.

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**Unit-I**


**Unit-II**

*Introduction to the leading International instruments concerning Intellectual Property Rights*
Unit-III
Select aspects of the Law of Copyright in India — The Copy Right Act, 1957 -
Historical evolution — Meaning of copyright — Copyright in literary, dramatic and
musical works, computer programmes and cinematograph films — Neighbouring rights
— Rights of performers and broadcasters, etc. — Ownership and Assignment of
copyright — Author's special rights — Notion of infringement — Criteria of
infringement — Infringement of copyright in films, literary and dramatic works —
Authorities under the Act — Remedies for infringement of copyright.

Unit-IV
Intellectual Property in Trademarks and the rationale of their protection - The Trade
Marks Act, 1999 — Definition of Trademarks — Distinction between Trademark and
Property Mark - Registration — Passing off —Infringement of Trademark — Criteria of
Infringement — Remedies. The Designs Act, 2000 — Definition and characteristics of
Design — Law in India — Protection and rights of design holders — Copyright in design
— Registration — Remedies for infringement.

Unit-V
Patents — Concept of Patent — Historical overview of the Patents Law in India —
Patentable Inventions — Kinds of Patents — Procedure for obtaining patent — The
Patents Act, 1970 — Rights and obligations of a patentee — Term of patent protection —
Use and exercise of rights
— Exclusive Marketing Rights — Right to Secrecy — The notion of ‘abuse‘ of patent
rights — Infringement of patent rights and remedies available.

Suggested Readings:
2. Roy Chowdhary, S.K. & Other: Law of Trademark, Copyrights, Patents and Designs,
OE602LBE

ENGINEERING APPLICATIONS IN MEDICINE
(open Elective-I)

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**Course Objectives**

- To provide a basic knowledge of human physiology to engineering graduate students.
- Understand the applications of various branches of engineering in Medicine.

**Course Outcomes**

The students will be able to:

- Able to learn the concepts of Brain-computer interface and apply them in real time applications.
- Able to learn the physiological concepts and apply innovative engineering principles.

UNIT-I


UNIT-II

**Solid mechanics**-Analysis of muscle force and joint reaction force for the limb joints.
Fluid mechanics-Factors governing and opposing blood flow, Wind-Kessel model, Application of Hagen-Poiseuille flow to blood flow.

UNIT-III

**Brain-Computer Interface**: Brain signals for BCIs, Generic setup for a BCI, Feature extraction and Feature translation involved in BCIs.
Typical applications-Word forming, Device control.

UNIT-IV

**Bioelectricity**: Excitable cells, Resting potential, Action potential, Accommodation, Strength- Duration Curve, Propagation of impulses in myelinated and unmyelinated nerves.
Medical Instrumentation system- Functions, Characteristics, Design Challenges. Signal Processing-QRS detection.

UNIT-V
Materials and Tissue Replacements-Types of Biomaterials- Metals, Polymers, Ceramics and Composites and their applications in Soft and Hard tissue replacements.

**Suggested Readings:**
Course Code | Course Title | Core/Elective
--- | --- | ---
PC651EE | ELECTRICAL MACHINES LAB-II | Core

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**Course Objectives:**
- To learn operation and performance characteristics of induction machines by conducting various experiments and tests practically.
- To understand the operation and performance characteristics of synchronous machines by conducting various experiments and tests.

**Course Outcomes:**
On successful completion of this course student will be able to
- Able to understand Performance characteristics of single phase induction motor
- Able to understand the importance of Voltage regulation of an alternator
- Able to explain different methods used to measure the voltage regulation of an alternator

**LIST OF EXPERIMENTS:**
1. No-load test, blocked rotor test and load test on 3-phase induction motor.
2. Speed control of 3-phase induction motor by (a) Cascade connection (b) Rotor resistance control (C) Pole changing (d) Slip power recovery scheme.
4. Voltage regulation of an alternator by (a) Synchronous impedance method (b) Ampere - turn method (c) Z.P.F. method.
5. Regulation of alternator by slip test.
7. Power angle characteristics of a synchronous machine.
10. Speed control of BLOC motor.
11. Load characteristics of induction generator.
12. Speed control of SRM motor.

**Note:** Atleast ten experiments should be conducted in the Semester.

**Suggested Reading :**
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<tr>
<td>PC652EE</td>
<td>DIGITAL SIGNAL PROCESSING LAB (Common to EEE and EIE)</td>
<td>Core</td>
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**Course Objectives:**
- To prepare the students
- To develop MATLAB code to generate different discrete signals and perform basic operations.
- To develop MATLAB code to convert continuous to discrete by DFT and FFT computations. to obtain Convolution of sequences and sampling theorem.
- To develop MATLAB code to design FIR and IIR filters.
- To use DSP kit and CCS, write code to obtain convolution of sequences, design of FIR and IIR filters, compute DFT and FFT algorithms, Impulse response and generate basic waves

**Course Outcomes:**
On successful completion of this course student will be able to

- Compute and write MATLAB code to generate basic waves and perform basic operations on them.
- Compute and write MATLAB code to apply sampling theorem, to obtain convolution and compute DFT and FFT.
- Compute and write MATLAB code to design FIR and IIR filters.
- Compute and write MATLAB code to obtain convolution of sequences, Design of FIR and IIR filters, compute DFT and FFT algorithms, Impulse response and generate basic waves using DSP kit

**List of Experiments**
1. Generation of different discrete signal sequences and Waveforms.
2. Basic Operations On Discrete Time Signals
3. DFT Computation and FFT Algorithms.
4. Verification of Convolution Theorem.
5. Verification of sampling theorem.
8. To perform linear and circular convolution for the given sequences.
9. Design and implementation of FIR and IIR filter.
11. Generation of basic waves.
12. Impulse response.

Note: Atleast ten experiments should be conducted in the Semester
Course Objectives:
- To prepare the students
  - To develop transfer function of various control system plants practically by conducting the experiments.
  - To understand the various controllers, basic features of PLC
  - Programming and control system concepts using MATLAB.

Course Outcomes:
On successful completion of this course student will be able to
- Able to understand Performance of P, PI and PID Controllers
- Able to develop PLC programs for certain applications
- Acquire the knowledge of Data acquisition system and Industrial process control

LIST OF EXPERIMENTS
2. Characteristics of synchros.
3. Frequency response of second ordersystem.
4. Operating characteristics of Stepper motor.
5. Step response of second order system.
7. A.C. Position control system.
9. Design of lag and lead compensation.
10. ON - OFF temperature control systems.
11. Simulation of control system concepts using MATLAB.
12. PLC (Programmable Logic Controller) applications. (a) Bottle filling (b) Speed control of Stepper motor (c) Liquid level control.
13. Data acquisition system and applications.

Note: Atleast ten experiments should be conducted in the Semester.

Suggested Reading:
Course Code | Course Title | Core/Elective
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PW661EE | SUMMER INTERNSHIP | Core

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Course Objectives:
- To prepare the students
  - To give an experience to the students in solving real life practical problems with all its constraints.
  - To give an opportunity to integrate different aspects of learning with reference to real life problems.
  - To enhance the confidence of the students while communicating with industry engineers and give an opportunity for useful interaction with them and familiarize with work culture and ethics of the industry

Course Outcomes:
On successful completion of this course student will be able to
- Able to design/develop a small and simple product in hardware or software.
- Able to complete the task or realize a prespecified target, with limited scope, rather than taking up a complex task and leave it.
- Able to learn to find alternate viable solutions for a given problem and evaluate these alternatives with reference to prespecified criteria.
- Able to implement the selected solution and document the same.

Summer Internship is introduced as part of the curricula for encouraging students to work on problems of interest to industries. A batch of two or three students will be attached to a person from an Electronics Industry / R & D Organization / National Laboratory for a period of 8 weeks. This will be during the summer vacation following the completion of the VI semester course. One faculty member will act as an internal guide for each batch to monitor the progress and interacts with the Industry guide.

After the completion of the project, students will submit a brief technical report on the project executed and present the work through a seminar talk to be organized by the department. Award of sessionals are to be based on the performance of the student at the work place to be judged by industry guide and internal guide (25 Marks) followed by presentation before the committee constituted by the department (25 Marks). One faculty member will co-ordinate the overall activity of Summer Internship.

*Students have to undergo summer internship of 6 Weeks duration at the end of semester VI and credits will be awarded after evaluation in VII semester.*