# SCHEME & SYLLABUS OF UNDERGRADUATE DEGREE COURSE

## Electrical Engineering

## V Semester

**Effective for the students admitted in year 2021-22 and onwards.**

# Teaching and Examination Scheme 3rd Year – V Semester

| S. No. | Category | Code | Course Title | Contact hrs./week L | T | P | Marks Exam Hrs. | IA | ETE | Total | Cr |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **THEORY** | | | | | | | | | | | |
| 1 | DC | 5EE4-01 | Control System Engineering | 3 | 0 | 0 | 3 | 30 | 70 | 100 | 3 |
| 2 | DC | 5EE4-02 | Power System-I | 3 | 0 | 0 | 3 | 30 | 70 | 100 | 3 |
| 3 | DC | 5EE4-03 | Computer Architecture and Microprocessors | 3 | 0 | 0 | 3 | 30 | 70 | 100 | 3 |
| 4 | DC | 5EE4-04 | High Voltage Engineering | 3 | 0 | 0 | 3 | 30 | 70 | 100 | 3 |
| 5 | DE-1 | 5EE5-11 | Digital Electronics | 2 | 0 | 0 | 2 | 30 | 70 | 100 | 2 |
| | | 5EE5-12 | Optimisation Techniques | | | | | | | | |
| | | 5EE5-13 | Introduction to VLSI | | | | | | | | |
| 6 | DE-2 | 5EE5-14 | Engineering Materials | 2 | 0 | 0 | 2 | 30 | 70 | 100 | 2 |
| | | 5EE5-15 | Fundamentals of Communication Systems | | | | | | | | |
| | | 5EE5-16 | Energy Conversion and Auditing | | | | | | | | |
| | | | **Sub Total** | **16** | **0** | **0** | **-** | **180** | **420** | **600** | **16** |
| **PRACTICAL & SESSIONAL** | | | | | | | | | | | |
| 7 | DC | 5EE4-20 | Control System Engineering Lab | 0 | 0 | 3 | | 60 | 40 | 100 | 1.5 |
| 8 | DC | 5EE4-21 | MATLAB Programming Lab | 0 | 0 | 3 | | 60 | 40 | 100 | 1.5 |
| 9 | DC | 5EE4-22 | Microprocessors Lab | 0 | 0 | 3 | | 60 | 40 | 100 | 1.5 |
| 10 | DC | 5EE4-23 | High Voltage Engineering Lab | 0 | 0 | 3 | | 60 | 40 | 100 | 1.5 |
| 11 | UI | 5EE7-30 | Industrial Training (45 days) | 0 | 0 | 6 | | 60 | 40 | 100 | 3 |
| 12 | UGE | 5EE8-00 | *Co-Curricular Activities* | 0 | 0 | 2 | | 60 | 40 | 100 | 1 |
| | | | **Sub- Total** | **0** | **0** | **20** | | **360** | **240** | **600** | **10** |
| | | | **TOTAL OF V SEMESTER** | **16** | **0** | **20** | | **540** | **660** | **1200** | **26** |

# B.Tech. (Electrical Engineering)
## III Year V Semester

| 5EE4-01: Control System Engineering | |
|---|---|
| **Credit:3** | **Max Marks:100(IA: 30,ETE: 70)** |
| **3L+0T+ 0P** | **EndTermExams:3hrs.** |

**Course Outcomes:**

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

**CO-1:** Understand the concept of control systems and their types. Representation of control systems by block diagram and signal flow graph.

**CO-2:** Learn the importance of control systemsandtheir transient analysis along with their design specifications. Also able to apply Laplace Transform for evaluation of time response.

**CO-3:**Know the concept of stability and its determination through Routh-Hurwitz stability criteria and Root Locus.

**CO-4:**Find the frequency response of a system through Polar plot, Nyquist plot and Bode plots.

| S.No. | Contents | Hours |
|---|---|---|
| 1. | **Introduction:** Objective, scope and outcome of the course. | **1** |
| 2. | **Introduction of Control Systems**: Concept of open loop and closed loop control systems, Examples and applications of open loop and closed loop systems, Elements of control systems, Differential equations representation of Electro-Mechanical systems, Transfer function calculation by block diagram reduction techniques and signal flow method. | **9** |
| 3. | **Laplace Transform and Transient Analysis of Control System:** Laplace Transformation, inverse Laplace transformation, Application of initial and final value theorem, Time response of first and second-order systems with impulse, step, ramp and parabolic inputs, Design specifications for second-order systems, Order, type and characteristics equation of control systems. | **9** |
| 4. | **Error Analysis and Stability of Control System:** Steady state errors and error constants, Transient and steady state analysis of control systems, concept of stability and necessary conditions, Routh-Hurwitz stability criteria and limitations. Stability analysis through Root Locus Technique. | **8** |
| 5. | **Control System Components and Controllers:** AC servomotor, synchronous and stepper motor. Application of Proportional, Integral and Derivative Controllers, Lead, Lag and Lead-Lag compensators. | **7** |
| 6. | **Frequency Response Analysis:** Correlation between time and frequency responses, Polar plot, Nyquist plot and Nyquist stability criterion. Bode plots, Gain Margin and Phase Margin. | **7** |
| | **Total** | **41** |

**Suggested Books:**

1. I. J. Nagrath and M. Gopal: Control Systems Engineering, New AgePublication.
2. K. Ogata: Modern Control Engineering, Prentice Hall of India.
3. Benjamin C. Kuo, Automatic Control Systems, Wiley India.
4. A.K. Jairath, Problems and Solutions of Control Systems, CBS Publishers.

III Year V Semester

| 5EE4-02: Power System-I | |
|---|---|
| **Credit:3** | **Max Marks:100(IA: 30,ETE: 70)** |
| **3L+0T+ 0P** | **EndTermExams:3 hrs.** |

**Course Outcomes:**

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

**CO-1:** Understand the basics of supply systems, requirement of conductor material and effect of voltage on size of conductor.

**CO-2:** Calculate the sag and tension of overhead transmission lines and also know about the effect of wind and ice loading, conductor vibrations and vibration dampers.

**CO-3:** Evaluate the electrical parameters like resistance, inductance and capacitance of overhead lines and also know about the Skin, Proximity effectsand Corona effect.

**CO-4:** Know about the various types of insulators and underground cables.

| S. No. | Contents | Hours |
|---|---|---|
| 1. | **Introduction:** Objective, scope and outcome of the course. | **1** |
| 2. | **Supply and Distribution Systems:** Basic network topology of power system. Transmission and distribution voltage, effect of system voltage on size of conductor and losses. Comparison of supply systems. Transmission and Distribution Systems: Line diagrams, transmission and distribution voltage levels, Kelvin's law for conductor size. | **7** |
| 3. | **Mechanical Parameters of Overhead Lines:** Conductor material and types of conductor. Conductor arrangements and spacing. Calculation of sag and tension, supports at different levels, effect of wind and ice loading, stringing chart and sag template. Conductor vibrations and vibration dampers. | **8** |
| 4. | **Electrical Parameters of Overhead Lines:** Resistance, inductance and capacitance of overhead lines, effect line transposition. Geometric mean radius and distance. Inductance and capacitance of line with symmetrical and unsymmetrical spacing, Inductance and capacitance of double circuit lines. Skin and Proximity effects. Equivalent circuits and performance of short and medium transmission lines. | **9** |
| 5. | **Transmission Line Parameters:** Equivalent circuit of transmission lines, Ferranti effect. Interference with communication circuits. Corona: Electric stress between parallel conductors. Disruptive critical voltage and visual critical voltage, Factors affecting corona. Corona power loss. Effects of corona. | **8** |
| 6. | **Insulators and Underground Cables:** Insulators: Pin, shackle, suspension, post and strain insulator. Insulator string, string efficiency, grading and methods of improving string efficiency.<br>Types of underground cable, Materials for conductor, insulator, sheathing and armouring. Insulator resistance and capacitance calculation. Electrostatic stresses and reduction of maximum stresses. Causes of breakdown. Thermal rating of cable. Introduction to oil filled and gas filled cables. | **8** |
| | **Total** | **41** |

**Suggested Books:**

1. C. L. Wadhwa, Electrical Power Systems, New Age Publications.
2. Nagrath, Kothari, Modern Power System Analysis, McGraw Hill Education.
3. Ashfaq Hussain, Electrical Power System, CBS Publisher.
4. Soni, Gupta and Bhatnagar: A Course in Electrical Power, Dhanpat Rai.
5. B. R. Gupta: Power System Analysis & Design, S. Chand Publishers.
6. A. S. Pabla: Electric Power Distribution, McGraw Hill Education.

## III Year V Semester

| 5EE4-03: Computer Architecture and Microprocessors | |
|---|---|
| **Credit:3** | **Max Marks:100(IA: 30,ETE: 70)** |
| **3L+0T+ 0P** | **EndTermExams:3 hrs.** |

**Course Outcomes:**

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

**CO-1:** To understand the architecture and working of the microprocessor.

**CO-2:** To write the assembly language programming,

**CO-3:** To understand the overview of computer organization.

**CO-4:** To understand the principle of CPU system.

**CO-5:** To understand the principle of memory system

**CO-6:** To explain the principle of data flow.

| S. No. | Contents | Hours |
|---|---|---|
| 1. | **Introduction:** Objective, scope and outcome of the course. | 1 |
| 2. | Fundamental of Microprocessor: Introduction to Microprocessors, Microprocessor systems with bus organization, Microprocessor architecture and operation, 8085 Microprocessor and its operation, 8085 instruction cycle, machine cycle, T states, Addressing modes in 8085, Introduction to 8086. | 10 |
| 3. | Introduction to Assembly Language Programming: Assembly Language Programming Basics, Classification of Instructions and Addressing Mode, 8085 Instruction Sets, Assembling, Executing and Debugging the Programs, Developing Counters and Time Delay Routines, Interfacing Concepts | 9 |
| 4. | Basic Computer Architecture:<br>**Introduction:** History of Computer architecture, Overview of computer organization, Memory Hierarchy and cache, Organization of hard disk.<br><br>**Instruction Codes:** Stored Program Organization-Indirect Address, Computer Registers, Common bus system, Instruction set, Timing and Control-Instruction Cycle. | 4 |
| 5. | Micro-programmed Control: Basic Computer Design of Accumulator: Control of Ac Register, ALU Organization; Control Memory-Address Sequencing; Conditional Branching, Mapping of Instruction-Subroutines; Micro Program: Symbolic Micro Program, Binary Micro Program;<br><br>Design of Control Unit: Basic Requirement of Control Unit, Structure of Control Unit, Micro Program Sequencer. | 8 |

| | | |
|---|---|---|
| 6. | Central Processing Unit:<br>**General Register Organization:** Control Word, Stack Organization and Instruction; Formats-Addressing Models.<br><br>**Data Transfer and Manipulation:** Data Transfer Instruction, Data Manipulation Instructions, Arithmetic Instructions, Logical and Bit Manipulation Instruction, Shift Instructions. | **8** |
| | **Total** | **40** |

**Suggested Books:**

1. Ramesh S. Gaonkar: Microprocessor Architecture, Programming, and Applications with 8085, prentice Hall
2. Morris Mano: Computer system Architecture, Third Edition, prentice Hall
3. Malvino: Digital Computer system Electronics (An introduction to Microcomputers)
4. Douglas V. Hall: Microprocessor and Interfacing programming and Hardware, McGraw Hill.
5. Computer Organization and Architecture, William Stallings, 9th Edition, Pearson.

III Year V Semester

| 5EE4-04: High Voltage Engineering | |
|---|---|
| **Credit:3** | **Max Marks:100(IA: 30,ETE: 70)** |
| **3L+0T+ 0P** | **EndTermExams:3 hrs.** |

**Course Outcomes:**

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

**CO-1:** understand the process of generation of high voltage DC and AC.

**CO-2:** know about the Over voltages and Travelling Waves and their causes and effects.

**CO-3:**Learn about the breakdown in gases, liquids and solids and insulation tests.

**CO-4:** Analyze the protection scheme of the high voltage equipments like surge absorber, rod-gap, arcing horn and lighting arresters.

| S. No. | Contents | Hours |
|---|---|---|
| 1. | **Introduction:** Objective, scope and outcome of the course. | **1** |
| 2. | **High Voltage DC and AC Generation:** Generation of high voltage DC, basic voltage multiplier circuit, High voltage AC generation through Cascaded Transformers.<br>**Impulse Voltage generation:** Impulse voltage, basic impulse circuit, Mark's multistage impulse generator, Construction and operation of Sphere-gap. | **8** |
| 3. | **Over voltages and Travelling Waves:** Causes of over-voltages, introduction to lightning phenomena, over-voltages due to lighting. Travelling waves on transmission lines-open end line, short circuited line, line terminated through a resistance, line connected to a cable, reflection and refraction at a T-junction and line terminated through a capacitance. Attenuation of traveling waves. | **8** |
| 4. | **Breakdown in Gases, Liquids and Solids:** Introduction to mechanism of breakdown in gases, Townsend's breakdown mechanism. Breakdown in electromagnetic gases, Application of gases in power system.<br>Introduction to mechanism of breakdown in liquids, suspended solid particle mechanism and cavity breakdown. Application of oil in power apparatus.<br>Introduction to mechanism of breakdown in solids, electromechanical breakdown, treeing and tracking breakdown and thermal breakdown. | **8** |
| 5. | **Insulation Tests:** Measurement of resistively, dielectric constant and loss factor. High Voltage Schering Bridge- measurement of capacitance and dielectric loss.<br>Introduction to partial discharge, partial discharge equivalent circuit. Basic wide-band and narrow band PD detection circuits. | **8** |
| 6. | **Over Voltage Protection:** Basic construction and operation of ground wires protection angle and protective zone, ground rods, counterpoise, surge absorber, rod-gap and arcing horn, lighting arresters - expulsion type, non -linear gap type andmetal oxide gapless type. Introduction of Insulation Coordination. | **8** |
| | **Total** | **41** |

**Suggested Books:**

1. Naidu: High Voltage Engineering, MGH.
2. C. L.Wadhwa: High Voltage Engineering, Wiley Eastern Ltd.
3. Ravindra Arora, Bharat Singh Rajpurohit: Fundamentals of High Voltage Engineering,Wiley.
4. Subir Ray: An Introduction to High Voltage Engineering, Prentice Hall of India.

## III Year V Semester

| 5EE5-11: Digital Electronics | |
|---|---|
| Credit:2 | Max Marks:100(IA: 30,ETE: 70) |
| 2L+0T+ 0P | EndTermExams:2 hrs. |

**Course Outcomes:**

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

**CO-1:** Understand the basics of number systems and logic gates.

**CO-2:** Explain finite state model and minimization techniques

**CO-3:** Know structure and design of combinational and sequential logic circuits.

**CO-4:** Understand the concept different logic families.

| S. No. | Contents | Hours |
|---|---|---|
| 1. | **Introduction:** Objective, Scope and Outcome of the course | 1 |
| 2. | **Number System, Codes and Logic Gates:** Arithmetic of Nonconventional Number System, Weighted Codes, Binary codes, Code Conversion, Error Correction/Detection Codes, BCD codes, Fixed point & floating point Number System. Basic, Exclusive and Universal Gates, Hazardous in the circuits. | 8 |
| 3. | **Logic Simplification and Minimization Techniques:** Review of Boolean Algebra and De Morgan’s Theorem, SOP & POS forms, Canonical forms, Karnaugh maps up to 6 variables, Tabulation Method. | 7 |
| 4. | **Combinational Logic Circuits Design:** Half and Full Adders, Subtractors, Serial and Parallel Adders, BCD Adder, Magnitude Comparators, Multiplexers, Encoder, Decoder, Driver & Multiplexed Display, Logic Implementation using combination blocks. | 8 |
| 5. | **Sequential Logic Circuits Design:** Building blocks like S-R, JK and Master-Slave JK FF, Edge triggered FF, Ripple and Synchronous counters, Shift registers, Finite state machines, Design of Synchronous FSM, Algorithmic State Machines charts. Designing synchronous circuits like Pulse train generator, Pseudo Random Binary Sequence generator, Clock generation | 8 |
| 6. | **Logic Families and PLD Concept:** TTL NAND gate, Specifications, Noise margin, Propagation delay, fan-in, fan-out, Tristate TTL, ECL, CMOS families and their interfacing. Basics of HDL (VHDL/Verilog) , Syntax and Semantics of HDL. Concept of Programmable logic devices like FPGA. Logic implementation using programmable devices. | 8 |
| | **Total** | **40** |

**Suggested Books:**

1. M. Morris Mano: Digital Design, Third Edition, Prentice Hall
2. R. P. Jain: Modern Digital Electronics, Third Edition, TMH
3. Taub and Schilling: Digital Integrated Electronics, McGRAW HILL
4. Sandige: Digital concept Using standard ICs
5. R. J. Tocci: Digital Systems: Principles and Applications, Fourth Edition, Prentice Hall

**III Year V Semester**

| 5EE5-12:Optimization Techniques | |
|---|---|
| **Credit:2** | **Max Marks:100(IA: 30,ETE: 70)** |
| **2L+0T+ 0P** | **EndTermExams:2 hrs.** |

Course Outcomes:

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

**CO-1:** To study the concept of optimization techniques and their classification.

**CO-2:** To study the Linear programming concepts and able for problem solving using various LP methods.

**CO-3:** To study and understand Queuing models and distributions.

**CO-4:** Define and explain the different statistical distributions like Binomial, Poisson, Normal, Uniform, and Exponential distributions and compute the method of least squares, correlation and regression.

**CO-5:** To study and understand the Unconstrained Optimization methods.

**CO-6:** To study and understand the Constrained Optimization methods.

| S. No. | Contents | Hours |
|---|---|---|
| 1. | **Introduction:** Objective, scope and outcome of the course. | **1** |
| 2. | **INTRODUCTION:** Introduction to Optimization: Engineering application of Optimization – Statement of an Optimization problem – Optimal Problem formulation – Classification of Optimization problem. | **7** |
| 3. | **LINEAR PROGRAMMING:** Examples of linear programming problems – formulation simplex methods variable with upper bounds – principle- duality - dual simplex method - sensitivity analysis – revised simplex procedure – solution of the transportation problem – assignment – network minimization – shortest route problem – maximal two problem – L.P. representation of networks. | **10** |
| 4. | **QUEUING THEORY:** Queuing Models, classification of queuing models, probability distribution in queuing systems, poison and exponential distributions -Queues with combined arrivals and departures-random and series queues. | **6** |
| 5. | **UNCONSTRAINED OPTIMIZATION:** Maximization and minimization of convex functions. Necessary and sufficient conditions for local minima – speed and order of convergence – unibariate search – steepest and desent methods-metcher reeves method -conjugate gradient method. | **9** |
| 6. | **CONSTRAINED OPTIMIZATION:** Necessary and sufficient condition – equality constraints, inequality constraints -kuhu – tucker conditions – gradient projection method – penalty function methods – cutting plane methods of sibel directions. | **8** |
| | **Total** | **41** |

**Suggested Books:**

1. Rao S.S, “Optimization – Theory and applications”, Wiley Easter Ltd., 1979
2. Hadley G. “Nonlinear and – dynamic programming” Addison Wesley Publishing Co. 1964.
3. Cordan C.C. Beveridge and Robert S. Schedther, “Optimization, Theory and Practice” McGraw Hill Co.1970.
4.HarndyA.Tahh. “Operations Research, An Introduction”, Macmillan Publishers Co.NewYork, 1982.
5. Beightferand S., “Foundations of Optimization Pill”, New Delhi, 1979.

**III Year V Semester**

| 5EE5-13: Introduction to VLSI | |
|---|---|
| **Credit:2** | **Max Marks:100 (IA: 30,ETE: 70)** |
| **2L+0T+ 0P** | **EndTermExams:2 hrs.** |

**Course Outcomes:**

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

**CO-1:** To study the MOS transistors and understand MOS fabrication techniques.
**CO-2:** To study the NMOS and CMOS Inverter design concepts.
**CO-3:** To understand various CMOS logic circuits and their working.
**CO-4:** To design simple CMOS logic circuits.
**CO-5:** To study VHDL and coding for sequential circuits.

| S. No. | Contents | Hours |
|---|---|---|
| 1. | **Introduction:** Objective, scope and outcome of the course. | **01** |
| 2. | **Introduction to MOS Technology:** Basic MOS transistors, Enhancement Mode transistor action, Depletion Mode transistor action, NMOS and CMOS fabrication. | **08** |
| 3. | **Basic Electrical Properties of MOS Circuits:** IDS versus VDS relationship, Aspects of threshold voltage, Transistor Trans conductance. The NMOS inverter, Pull up to Pull-down ratio for a NMOS Inverter and CMOS Inverter (Bn/Bp), MOS transistor circuit Model, Noise Margin. | **08** |
| 4. | **CMOS Logic Circuits:** The inverter, Combinational Logic, NAND Gate NOR gate, Compound Gates, 2input CMOS Multiplexer, Memory latches and registers Transmission Gate, Gate delays, CMOS-Gate Transistor sizing, Power dissipation | **08** |
| 5. | **Basic Physical Design of Simple Gates and Layout Issues:** Layout issues for inverter, Layout for NAND and NOR Gates, Complex Logic gates Layout, Layout optimization for performance. | **08** |
| 6. | **Introduction to VHDL:** Verilog and other design tools. VHDL Code for simple Logic gates, flip-flops, shift-registers, Counters, Multiplexers, adders and subtractors. | **07** |
| | **Total** | **40** |

**Suggested Books:**

1. S M Sze: VLSI Technology (TMH)
2. SM KANG:CMOS Digital Integrated Circuits, TMH
3. Stephen A Compbell: The Science & Engineering of Microelectronic Fabrication, Oxford.
4. James D Plummer, Micheal Deal & Petter B Griffin: Silicon VLSI Tech. Fundamental, Practice & Modeling, Prentice Hall. .

**III Year V Semester**

| 5EE5-14: Engineering Materials | |
|---|---|
| **Credit:2** | **Max Marks:100(IA: 30,ETE: 70)** |
| **2L+0T+ 0P** | **EndTermExams:2 hrs.** |

**Course Outcomes:**

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

**CO-1:** Know about the basic concepts of the materials and their bonds.

**CO-2:** Understand the various properties of the conducting materials, free electron theory of metals,electrical and thermal conductivity of metals

**CO-3:** Apply the knowledge of semiconductor materials and relevant concepts.

**CO-4:** Define and explain the different magnetics materials and their applications. Also able to explain the superconductivity and zero resistance.

**CO-5:** Explain the dielectric properties of insulators, piezoelectricity, frequency dependence of electronic and ionic polarizability and dielectric losses.

| S. No. | Contents | Hours |
|---|---|---|
| 1. | **Introduction:** Objective, scope and outcome of the course. | **1** |
| 2. | **Concepts of Materials Science:** Ionic, covalent, metallic and molecular bindings-Bond angle, bondlength and bond energy, Bonding and types of solids, Crystalline state and their defects, Classical theory of electrical and thermal conduction in solids, temperature dependence of resistivity. | **8** |
| 3. | **Conducting Materials**: Conductivity of metals, Free electron theory of metals Ohm's law and relaxation time of electrons, collision time and meanfree path, electron scattering and resistivity of metals. Electricaland thermal conductivity of metals. | **8** |
| 4. | **Semiconductor Materials:**Classification of semiconductors, semiconductor conductivity, temperature dependence, Carrier density and energy gap, Trends in semiconductor materials used in electrical equipment. | **7** |
| 5. | **Magnetic Properties of materials and Superconductivity:** Magnetization of matter, Magnetic Material Classification, Magnetic properties – Dia-magnetism Para-magnetism, Ferro-magnetism,Ferri-magnetismand Antiferro-magnetism, Curie-Weiss Law, Soft and Hard Magnetic Materials,Superconductivity and its origin, Zero resistance and Meissner Effect. | **9** |
| 6. | **Dielectric Properties of Insulators:** Dielectric Properties in Static and Alternating fields, Dielectric constant of mono-atomic gases, poly-atomic molecules and solids, Internal field in solids and liquids, Properties of Ferro-Electric materials, Polarization, Piezoelectricity, Frequency dependence of Electronic and Ionic Polarizability, Complex dielectric constant of non-dipolar solids, dielectric losses. | **8** |
| | **Total** | **41** |

**Suggested Books:**

1. Introduction to Materials Science and Engineering, William J Callister, John Wiley & Sons, Inc.
2. W. D. Callister, "Materials Science and Engineering: An Introduction", John Wiley & Sons.
3. V. Raghavan, “Materials Science and Engineering: A First Course", Prentice Hall

III Year V Semester

| 5EE5-15: Fundamentals of Communication Systems | |
|---|---|
| Credit:2 | Max Marks:100(IA: 30,ETE: 70) |
| 2L+0T+ 0P | EndTermExams:2 hrs. |

**Course Outcomes:**

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

**CO-1:** Analyze the power and transmission bandwidth of Amplitude and Frequency Modulated signals.

**CO-2:** Familiarize the process of reproduction of base band signal.

**CO-3:** Analyze various pulse analog and pulse digital Modulation Techniques.

**CO-4:** Understand the transmission of binary data in communication systems.

| S. No. | Contents | Hours |
|---|---|---|
| 1. | **Introduction:** Objective, scope and outcome of the course. | 1 |
| 2. | **Amplitude Modulation:** Introduction to Modulation, Need for Modulation, Ordinary Amplitude Modulation – Modulation index, Side bands, AM Power, Double Side Band Suppressed Carrier Modulation, Single Side Band Modulation, Vestigial Side Band Modulation, AM demodulation, Applications of AM. | 10 |
| 3. | **Angle Modulation:** Angle Modulation fundamentals, Frequency Modulation – Modulation index and sidebands, Narrowband FM, Wideband FM, Principles of Phase Modulation, Frequency Modulation verses Amplitude Modulation, FM demodulation, Frequency Division Multiplexing, Applications of FM. | 9 |
| 4. | **Signal Sampling and Analog Pulse Communication:** Ideal Sampling, Pulse Amplitude Modulation, Pulse Width Modulation, Pulse Position Modulation.<br>**Digital Communication Techniques:** Quantization, Digital Transmission of Data, Parallel and Serial Transmission, Data Conversion, Time Division Multiplexing, Pulse Code Modulation, Delta Modulation. | 10 |
| 5. | **Transmission of Binary Data in Communication Systems:** Digital Codes, Principles of Digital Transmission, Transmission Efficiency, Modem Concepts and Methods – FSK, BPSK, Error Detection and Correction. | 10 |
| | **Total** | **40** |

**Suggested Books:**

1. George Kennedy, Bernard Davis, S. R. M Prasanna, Kennedy's Electronic Communication System, McGraw Hill , 6th Edition 2017

2. S Haykins, Communications Systems, Wiley , 4th Edition 2006

3. Wayne Tomasi, Electronic Communication Systems, 5th Edition, Pearson Education.

4. B.P.Lathi, "Modern Digital and Analog Communication Systems", 4th Edition, Oxford University Press, 2011.

5. D.Roody, J.Coolen, Electronic Communications, 4th edition, PHI, 2006.

6. B.Sklar, "Digital Communications Fundamentals and Applications", 2nd Edition Pearson Education, 2007.

7. H P Hsu, Schaum Outline Series - "Analog and Digital Communications" TMH, 2006

## III Year V Semester

| 5EE5-16: Energy Conversion and Auditing | |
|---|---|
| **Credit:2** | **Max Marks:100(IA: 30,ETE: 70)** |
| **2L+0T+ 0P** | **EndTermExams:2 hrs.** |

**Course Outcomes:**

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

**CO-1:** Explain thebasic principles of energy conversion, Energy in magnetic systems, energy and co-energy and single excited systems.

**CO-2:** Know about the energy conversion systems like solar to thermal, solar to electrical, wind to electrical energy and OTEC and bio-mass.

**CO-3:** Define **energy management, e**nergy audit and its need, types of energy audit and energy audit instruments.

**CO-4:** Implement the energy efficient devices,automatic power factor controllers, maximum demand controllers, energy efficient motors and soft starters with energy saver.

| S. No. | Contents | Hours |
|---|---|---|
| 1. | **Introduction:** Objective, scopeandoutcomeofthecourse. | **1** |
| 2. | **Principals of Energy Conversion:** Introduction, Flow of energy in electromechanical devices, Energy in magnetic systems, energy and co-energy, single excited systems: determination of force, mechanical energy, torque equations. | **8** |
| 3. | **Conversion of Renewable Energy**: Introduction to world energy scenario, renewable energy resources, Solar energy: solar to thermal energy, solar to electrical energy, solar photovoltaic system, Wind energy: basic principles of wind energy conversion, basic components of wind energy conversion system, Introduction to Ocean Thermal Energy Conversion (OTEC), Bio Mass energy conversion. | **8** |
| 4. | **Energy Management and Audit:** Energy audit and its need, types of energy audit. Energy management, understanding energy costs, optimizing the input energy requirements, energy audit instruments. Material and Energy balance: Facility as an energy system, methods for preparing process flow, material and energy balance diagrams. | **7** |
| 5. | **Energy Efficiency in Electrical Systems:** Electricity billing, electrical load management and maximum demand control, power factor improvement and its benefits, selection and location of capacitors, performance assessment of PF capacitors, distribution and transformer losses. Electric motors: Types, losses in induction motors, motor efficiency, factors affecting motor performance. | **9** |
| 6. | **Energy Efficient Technologies in Electrical Systems:** Automatic power factor controllers, Maximum demand controllers, energy efficient motors, soft starters with energy saver, variable speed drives, energy efficient transformers, electronic ballast, occupancy sensors, energy efficient lighting controls, energy saving potential of each technology. | **8** |
| | **Total** | **41** |

**Suggested Books:**

1. G.D.Rai, Non-Conventional Energy Sources, Khanna Publishers.
2. P.C. Sen, Principles of Electric Machines and Power Electronics, Wiley India Pvt. Ltd.
3. Mehmet Kanoğlu, Yunus A. Çengel, "Energy Efficiency and Management for Engineers",McGraw-Hill Education.

**III Year V Semester**

| 5EE4-20: Control System Engineering Lab | |
|---|---|
| **Credit:1.5** | **Max Marks:100(IA:60,ETE: 40)** |
| **0L+0T+3P** | **EndTermExams:3 hrs.** |

**Course Outcomes:**

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

**CO-1:** Obtain the step, ramp and impulse responses of first and second order control systems.
**CO-2:** Design the lag, lead and lag-lead controllers.
**CO-3:**Draw the frequency responses plot of a given control system.
**CO-4:**Analysis the stability of a system using Bode plot, Nyquist plot and Root-loci.
**CO-5:** Design P, PI and PID controllers.

| S. No. | List of Experiments | Hours |
|---|---|---|
| 1. | Introduction to MATLAB computing control software and its control tools. | 3 |
| 2. | To design a first order R-C circuit and observe its step, ramp and impulse response. | 3 |
| 3. | Plot step, ramp and impulse response of a given second order control system. Take different values of damping ratio $\delta$ and natural frequency of oscillations $\omega_n$. | 3 |
| 4. | Plot and examine the frequency response of following compensating networks and find out corner frequencies.<br>(a) Lag Network<br>(b) Lead Network and<br>(c) Lag-lead Network | 3 |
| 5. | Draw the bode plot for a second order transfer function and observe the Gain cross—over frequency, Phase cross-over frequency, Gain Margin and Phase-Margin. | 3 |
| 6. | Check for the stability of a given closed loop system using Nyquist plot. | 3 |
| 7. | Examine the stability of a given transfer function of a control system using the root-loci. | 3 |
| 8. | Design P, PI and PID controllers for the given specifications and calculate $K_p$, $K_i$and $K_d$ for them. | 3 |
| 9. | Draw and study the characteristics of AC servomotor. | 3 |
| | **Total** | **27** |

## III Year V Semester

| 5EE4-21: MATLAB Programming Lab | |
|---|---|
| Credit:1.5 | Max Marks:100(IA:60,ETE: 40) |
| 0L+0T+3P | EndTermExams:3 hrs. |

**Course Outcomes:**

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

**CO-1:** Write scripts and function in MATLB to perform mathematical operations on matrixes, arrays and constants.

**CO-2:** Draw the responses of any kind of system using plot features of MATLAB.

**CO-3:** Demonstrate the loop, if-else, control flow, break-point operations.

**CO-4:**Simulate a model in Simulink to get the desired response.

| S. No. | List of Experiments | Hours |
|---|---|---|
| 1. | Introduction to MATLAB, its various tools and files. | 3 |
| 2. | Create matrices, vectors, array,multi-dimensional matricesand their operations through script file in MATLAB (one example of each). | 3 |
| 3. | Scripts and functions; Global Variables; Open, saving and loading data; Debugging of scripts. | 3 |
| 4. | Create script files demonstrating plot and sub-plot of simple graphs and their editing through figure editor tools. Perform label, title, legend, axis, zoom-in, zoom-out etc. operations. | 3 |
| 5. | Demonstrate Loops, Advanced data objects, Break-point and Structures by writing script files.(Through tutorial sheets) | 3 |
| 6. | Demonstrate If-else, Branches and Control flow through writing example script files.(Through tutorial sheets) | 3 |
| 7. | Applications: linear algebra, curve fitting, interpolation, Numerical integration, Ordinary differential equation. (Cover through tutorial sheets) | 3 |
| 8. | Simulink: Basics of Simulink, Problems based on Simulink. Draw and simulate a Simulink model of a transfer function and get its step and ramp responses. | 3 |
| 9. | Implement a PID controller and perform its tuning through PID controller tuning toolbox. | 3 |
| | **Total** | **27** |

III Year V Semester

| 5EE4-22: Microprocessors Lab | |
|---|---|
| Credit:1.5 | Max Marks:100(IA:60,ETE: 40) |
| 0L+0T+3P | EndTermExams: 3 hrs. |

**Course Outcomes:** Upon successful completion of the course, students will be able to
**CO-1:** Write assembly language programs for 8085 microprocessor
**CO-2:** Understand the interfacing of peripherals with 8085 microprocessors
**CO-3:** Learn programming concepts of 8051 microcontroller
**CO-4:** Implement 8051 interfacing with peripherals
**CO-5:** Application of microprocessor, working on mini projects.

| S. No. | List of Experiments | Hours |
|---|---|---|
| 1 | Study the hardware, functions, memory structure, Instruction set and operation of 8085 microprocessor kit. | 3 |
| 2 | Write an assembly language program to Add/Subtract two 8-bit/16-bit number. | 1.5 |
| 3 | To perform multiplication and division of two 8 bit numbers using 8085. | 1.5 |
| 4 | Write an assembly language program to Data transfer/Exchange from one memory block to another in forward and reverse order. | 3 |
| 5 | To write a program to arrange an array of data in ascending and descending order. | 1.5 |
| 6 | To find the largest and smallest number in an array of data using 8085 instruction set. | 1.5 |
| 7 | Write a program using 8085 Microprocessor for addition and subtraction of two BCD numbers. | 3 |
| 8 | Write a program using 8085 Microprocessor to generate square and triangular wave. | 3 |
| 9 | Write an assembly language program for displaying the decimal numbers in 7 Segment display using Microcontroller | 3 |
| 10 | Write an assembly language program for interfacing stepper motor with 8051. | 3 |
| 11 | Write an assembly language program to interface relay with 8051 | 3 |
| | **Total** | **27** |

III Year V Semester

| 5EE4-23: High Voltage Engineering Lab | |
|---|---|
| Credit:1.5 | Max Marks:100(IA:60,ETE: 40) |
| 0L+0T+3P | EndTermExams:3 hrs. |

**Course Outcomes:**

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

**CO-1:** Know about the transformer oil properties, its filtration, treatment and test of dielectric strength.

**CO-2:** Understand the applications of the various types of insulating materials.

**CO-3:** Perform the high voltage test of line insulator, cable, bushing, power capacitor,and power transformer.

**CO-4:**Know the operation of circuit breakers and Buchholz relay for the protection of transformer.

| S. No. | List of Experiments | Hours |
|---|---|---|
| 1. | Study desirable properties of transformer oil. Also study about itsfiltration and treatment. | 3 |
| 2. | Perform a test to determine dielectric strength of transformer oil. | 3 |
| 3. | Determine capacitance and dielectric loss of an insulating material using Schering bridge. | 3 |
| 4. | Study different types of insulating materials and their applications. | 3 |
| 5. | Measurement of insulation resistance of cables. | 3 |
| 6. | Perform flashover testson wet and dry insulator. | 3 |
| 7. | Study and perform direct testing and indirect testing of circuit breakers. | 3 |
| 8. | Study high voltage testing of electrical equipment: line insulator, cable, bushing, power capacitor, and power transformer. | 3 |
| 9. | Study the Buchholz relay and also explain its operation. | 3 |
| | **Total** | **27** |

# SCHEME & SYLLABUS OF UNDERGRADUATE DEGREE COURSE

## Electrical Engineering

## VI Semester

**Effective for the students admitted in year 2021-22 and onwards.**

L: Lecture, T: Tutorial, P: Practical, IA: Internal Assessment, ETE: End Term Exam, Cr: Credits

| | | | | | |
|---|---|---|---|---|---|
| DC: | Departmental Core | DE: | Departmental Elective | UC: | University Core |
| UI: | University Independent Elective | UGE: | University General Elective | | |

## Teaching and Examination Scheme

## 3rd Year – VI Semester

| THEORY | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| S. No. | Category | Code | Course Title | Contact hrs./week | | | Marks | | | | Cr |
| | | | | L | T | P | Exam Hrs. | IA | ETE | Total | |
| 1 | DC | 6EE4-01 | Power Electronics | 3 | 0 | 0 | 3 | 30 | 70 | 100 | 3 |
| 2 | DC | 6EE4-02 | Modern Control Systems | 3 | 0 | 0 | 3 | 30 | 70 | 100 | 3 |
| 3 | DC | 6EE4-03 | Power System-II | 3 | 0 | 0 | 3 | 30 | 70 | 100 | 3 |
| 4 | DC | 6EE4-04 | Switchgear and Protection of Power System | 3 | 0 | 0 | 3 | 30 | 70 | 100 | 3 |
| 5 | DC | 6EE4-05 | Signals and Systems | 3 | 0 | 0 | 3 | 30 | 70 | 100 | 3 |
| 6 | DE-3 | 6EE5-11 | Electromagnetic Field Theory | 2 | 0 | 0 | 2 | 30 | 70 | 100 | 2 |
| | | 6EE5-12 | Neural Network and Fuzzy Logic Control | | | | | | | | |
| | | 6EE5-13 | Digital Control System | | | | | | | | |
| **Sub Total** | | | | **17** | **0** | **0** | | **180** | **420** | **600** | **17** |
| | | | | | | | | | | | |
| **PRACTICAL & SESSIONAL** | | | | | | | | | | | |
| 7 | DC | 6EE4-20 | Power Electronics Lab | 0 | 0 | 3 | | 60 | 40 | 100 | 1.5 |
| 8 | DC | 6EE4-21 | Power System Lab | 0 | 0 | 3 | | 60 | 40 | 100 | 1.5 |
| 9 | UI | 6EE7-50 | Mini project | 0 | 0 | 4 | | 60 | 40 | 100 | 2 |
| 10 | UGE | 6EE8-00 | *Co-Curricular Activities* | 0 | 0 | 4 | | 60 | 40 | 100 | 2 |
| **Sub- Total** | | | | **0** | **0** | **14** | | **240** | **160** | **400** | **7** |
| **TOTAL OF VI SEMESTER** | | | | **17** | **0** | **14** | | **420** | **580** | **1000** | **24** |

**L**: Lecture, **T**: Tutorial, **P**: Practical, **C**r: Credits

**ETE**: End Term Exam, **IA**: Internal Assessment

# Syllabus
## B. Tech. (Electrical Engineering)
### III Year VI Semester

| 6EE4-01: Power Electronics | |
|---|---|
| **Credit: 3** | **Max Marks: 100 (IA: 30, ETE: 70)** |
| **3L+0T+ 0P** | **End Term Exams: 3hrs.** |

**Course Outcomes:**
Upon successful completion of the course, the students will be able to:

**CO-1:** Understand the operation, characteristics and applications of Power Diode, Power Transistor, Power MOSFET, IGBT, TRIAC, DIAC and MCT.

**CO-2:** Know the characteristics, specification, ratings, interconnections, protection and turning-on/off methods of SCR.

**CO-3:** Analyze the single-phase and three-phase converters with different loads.

**CO-4:** Evaluate the performance of choppers with their operating principal and control strategies.

**CO-5:** Analyze the operation of inverter and harmonic elimination techniques in PWM Inverters.

| S.No. | Contents | Hours |
|---|---|---|
| 1. | **Introduction:** Objective, scope and outcome of the course. | **1** |
| 2. | **Power Semiconductor Devices:** Construction, operation, characteristics and applications of Power Diode, Power Transistor, Power MOSFET, IGBT, MCT, TRIAC and DIAC, pulse transformer, optical isolators. | **3** |
| 3. | **Thyristor:** Construction, characteristics, specification and ratings of SCR, methods of turn on, Protection of SCR against over voltage, over current, dv/dt, di/dt, Gate protection. | **3** |
| 4. | **Single-Phase & Three-Phase rectifiers**: Single-phase half and full-wave converters with RL and RLE load, Conduction angle, Extinction angle, Single-phase semi converters, Three phase half-wave converters. Three phase full converters with RL and RLE load. Three-phase semi converters with RL and RLE load Effect of load and source impedance on the performance of converters. | **8** |
| 5. | **DC-DC Converters (Choppers):** Introduction, Classification, Principle and Operation, Control strategies, Chopper configurations, Thyristor chopper commutation circuits, Switched Mode Power Supply, Buck, Boost and Buck-Boost converters, Cuk converter. | **8** |
| 6. | **DC-AC Converters (Inverters):** Introduction, Classification, Single phase half and full bridge VSI, Three phase VSI: 120 and 180 degree conduction mode. Performance Parameters of Inverter, Voltage control of single phase and three phase Inverter. | **8** |
| 7. | **PWM Inverters:** Principle of PWM control, PWM techniques classifications, Unipolar and Bipolar PWM, Sinusoidal PWM, Hysteresis band current control PWM, Comparison of PWM techniques, Voltage and frequency control of single phase and three-phase inverters, Harmonic Cancellation techniques. | **9** |
| | **Total** | **40** |

**Suggested Books:**

1. P. S. Bimbhra: Power Electronics, Khanna Publishers.
2. M. D. Singh and K. B. Khanchandani: Power Electronics,McGraw Hill Education.
3. M. H. Rashid: Power Electronics, Circuits Devices and Applications, Pearson.
4. Ned Mohan: Power Electronics, John Wiley.

**III Year VI Semester**

| 6EE4-02: Modern Control Systems | |
|---|---|
| **Credit: 3** | **Max Marks: 100 (IA: 30, ETE: 70)** |
| **3L+0T+ 0P** | **End Term Exams: 3hrs.** |

**Course Outcomes:**

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

**CO-1:** Define the state, state space, state vector and find the state model equations of electrical and mechanical systems.

**CO-2:** Represent a system by Physical form, Phase variables form, Canonical form & companion form and inter-convert them.

**CO-3:** Solve the state equations using state transition matrix. Also evaluate the controllability and observability of the given system.

**CO-4:** Know about the digital control systems, stability analysis in state space through Jury stability criterion and Routh-Hurwitz criterion.

| S. No. | Contents | Hours |
|---|---|---|
| 1. | **Introduction:** Objective, scope and outcome of the course. | **1** |
| 2. | **State Space Approach of Control System:** Modern versus conventional control theory, Concept of state, State variable, State vector, State space, State space equations, Writing state space equations of mechanical and electrical systems, Analogous systems. | **7** |
| 3. | **State Space Representation:** Physical form, Phase variables form, Canonical form and companion form of system representation. Block diagram representation of state model, Signal flow graph representation, State space representation using canonical variables. Diagonal matrix. Jordan canonical form, Derivation of transfer functions from state-model. | **6** |
| 4. | **Solution of State Equations:** Eigen values and Eigen vectors, Matrix, Exponential, State transition matrix, Properties of state transition matrix, Computation of State transition matrix, Concepts of controllability and observability, Pole placement by state feedback. | **9** |
| 5. | **Digital Control Systems:** Introduction, sampled data control systems, signal reconstruction, difference equations, Z-transform, Z-transfer Function, Block diagram analysis of sampled data systems, z and s domain relationship. | **6** |
| 6. | **Stability Analysis in State Space:** Modeling of sample-hold circuit, steady state accuracy, stability in z-plane and Jury stability criterion, bilinear transformation, Routh-Hurwitz criterion on s-planes, Digital PID controllers. | **6** |
| 7. | **Introduction to advanced control techniques: -** Introduction to Robust Control, adaptive control and sliding mode control. Determination of describing function of nonlinearities for relay, dead zone and saturation. | **6** |
| | **Total** | **41** |

**Suggested Books:**

1. I. J. Nagrath and M. Gopal: Control Systems Engineering, 3rd Ed, New AgePublication.
2. B. C. Kuo: Digital Control System, Oxford.
3. M. Gopal: Digital Control and State Variable Methods, MGH.
4. D. Roy, Choudhary: Modern Control Engineering, Prentice Hall of India.
5. Richard C. Dorf, Robert H. Bishop: Modern Control Systems, Prentice-Hall.

## III Year VI Semester

| 6EE4-03: Power System-II | |
|---|---|
| **Credit: 3** | **Max Marks: 100 (IA: 30, ETE: 70)** |
| **3L+0T+ 0P** | **End Term Exams: 3hrs.** |

**Course Outcomes:**

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

**CO-1:** Create the admittance and impendence model which are further used in the power system analysis.

**CO-2:** Solve a power flow problem using Gauss-Seidel, Newton-Raphosn, Decoupled and fast decoupled methods.

**CO-3:** Analyze the symmetrical and unsymmetrical faults.

**CO-4:** Understand the concept of frequency and voltage control using active and reactive power control respectively and automatic generation control.

| S. No. | Contents | Hours |
|---|---|---|
| 1. | **Introduction:** Objective, scope and outcome of the course. | **1** |
| 2. | **Admittance and Impendence Model:** Percent and per unit quantities. Single line diagram for a balanced 3-phase system, Branch and node admittances, Equivalent admittance network and calculation of Y bus, Modification of an existing Y bus, Bus admittance and impedance matrices. Thevenin's theorem and Z bus. Direct determination of Z bus. Modification of an existing bus. | **8** |
| 3. | **Load Flow Analysis:** Load flow problem, development of load flow equations, Classification of buses, Gauss-Seidel, Newton-Raphosn, Decoupled and fast decoupled methods for load flow analysis. Comparison of load flow methods. | **9** |
| 4. | **Fault Analysis:** Fortescue theorem, symmetrical component transformation. Sequence Impedances of transmission lines, Synchronous Machine and Transformers, zero sequence network of transformers and transmission lines. Construction of sequence networks of power system, Analysis of single line to ground faults using symmetrical components, connection of sequence networks under the fault condition, Analysis of line-to-line and double line to ground faults using symmetrical components. | **8** |
| 5. | **Power System Analysis:** Swing Equations of a synchronous machine connected to an infinite bus, Power angle curve, Phenomena of loss of synchronism in a single-machine infinite bus (SMIB) system, Analysis using numerical integration of swing equations using Forward Euler and Runge-Kutta method, Equal Area Criterion. Impact of stability constraints on Power System Operation. | **7** |
| 6. | **Control of Frequency and Voltage:** Turbines and Speed-Governors, Frequency dependence of loads, Droop Control and Power Sharing. Automatic Generation Control. Generation and absorption of reactive power by various components of a Power System. Excitation System Control in synchronous generators, Automatic Voltage Regulators. | **8** |
| | **Total** | **41** |

**Suggested Books:**

1. C. L. Wadhwa: Electrical Power Systems, New age international Ltd. Third Edition.
2. D. P. Kothari & I. J. Nagrath: Modern Power System Analysis, MGH.
3. P. Kundur: Power System Stability and Control, MGH.
4. W. D. Stevenson: Element of Power System Analysis, MGH.
5. O. I. Elgerd: Electric Energy System Theory, MGH. 1983

## III Year VI Semester

| 6EE4-04: Switchgear and Protection of Power System | |
|---|---|
| **Credit: 3** | **Max Marks: 100 (IA: 30, ETE: 70)** |
| **3L+0T+ 0P** | **End Term Exams: 3hrs.** |

**Course Outcomes:**

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

**CO-1:** Understand the preliminaries about protective relays used in power systems.

**CO-2:** Know about the power line carrier system, directional comparison and phase comparison carrier protection of transmission lines.

**CO-3:** Learn about the protection of generator transformer unit. Also study the effect of magnetizing inrush currents and methods to minimize the effects.

**CO-4:** Analyze the protection provided by different types of circuit breakers. Also learn about the digital protection used in power systems.

| S. No. | Contents | Hours |
|---|---|---|
| 1. | **Introduction:** Objective, scope and outcome of the course. | **1** |
| 2. | **Protective relays:** Functional characteristics of relays, Primary and backup protection, Classification of relays, Operation and characteristics of over current relays, Directional over current relays, Differential relays, Percentage differential relays and Distance relays, Connection of distance relays for line and earth fault protection. | **9** |
| 3. | **Protection of Transmission Line:** Over current protection of radial feeder, parallel feeder and ring mains using time and current grading, Distance protection, Effect of arcing and power swings on the performance different distance relays, Carrier Current Protection of Transmission Lines: Basic apparatus used for power line carrier system, Principle operation of directional comparison and phase comparison carrier protection. | **8** |
| 4. | **Protection of Synchronous Generators and Transformers:** Faults in stator winding of alternators, Single and multiple ground faults on the rotor protection against excitation failure and prime-mover failure, Negative sequence protection, Differential protection of generator transformer unit, Differential protection of 3-phase transformers, Effect of magnetizing inrush currents and methods for minimizing the effects. | **9** |
| 5. | **Circuit Breakers:** Classification of switchgears, Arc quenching in circuit breakers, Arc interruption theories– recovery rate theory and energy balance theory. Oil circuit breakers-bulk oil and minimum oil circuit breakers, Air circuit breakers, Construction and operation of Air blast, SF6 and Vacuum circuit breakers. Selection of circuit breakers. | **8** |
| 6. | **Digital Protection:** Introduction to digital protection, Brief description of block diagram of digital relay, Introduction to digital over-current, transformer differential and transmission line distance protection. | **6** |
| | **Total** | **41** |

**Suggested Books:**

1. B. Ravindranath and M. Chander: Power system Protection and Switchgear, Wiley.
2. B. Ram and D. N. Vishwakarma: Power System Protection and Switchgear, McGraw Hill Education.
3. S. S. Rao: Switchgear and Protection, Khanna Publishers.
4. Bhuvanesh A. Oza and Nair: Power System Protection and Switchgear, McGraw Hill Education.

**III Year VI Semester**

| 6EE4-05: Signals and Systems | |
|---|---|
| **Credit: 3** | **Max Marks: 100 (IA: 30, ETE: 70)** |
| **3L+0T+ 0P** | **End Term Exams: 3 hrs.** |

**Course Outcomes:**

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

**CO-1:** Develop input output relationship for linear shift invariant system.

**CO-2:** Understand the convolution operator for continuous and discrete time system.

**CO-3:** Understand and resolve the signals in frequency domain using Fourier series and Fourier transforms.

**CO-4:** Understand the Relation between continuous and discrete time systems.

| S. No. | Contents | Hours |
|---|---|---|
| 1. | **Introduction:** Objective, scope and outcome of the course. | **1** |
| 2. | **Introduction to Signals and Systems:** Signals and systems as seen in everyday life, and in various branches of engineering and science. Signal properties: periodicity, absolute integrability, determinism and stochastic character. Some special signals of importance: the unit step, the unit impulse, the sinusoid, the complex exponential, some special time-limited signals; continuous and discrete time signals, continuous and discrete amplitude signals. System properties: linearity: additivity and homogeneity, shift-invariance, causality, stability, realizability. | **7** |
| 3. | **Behavior of continuous and discrete-time LTI systems**: Impulse response and step response, convolution, input-output behavior with aperiodic convergent inputs, cascade interconnections. Characterization of causality and stability of LTI systems. System representation through differential equations and difference equations. State-space Representation of systems. State-Space Analysis, Multi-input, multi-output representation. State Transition Matrix and its Role. Periodic inputs to an LTI system, the notion of a frequency response and its relation to the impulse response. | **8** |
| 4. | **Fourier, Laplace:** Fourier series representation of periodic signals, Waveform Symmetries, Calculation of Fourier Coefficients. Fourier Transform, convolution/multiplication and their effect in the frequency domain, magnitude and phase response, Fourier domain duality. The Discrete Time Fourier Transform (DTFT) and the Discrete Fourier Transform (DFT). Parseval's Theorem. Review of the Laplace Transform for continuous time signals and systems, system functions, poles and zeros of system functions and signals, Laplace domain analysis, solution to differential equations and system behavior. | **9** |
| 5. | **Z- Transforms**: The z-Transform for discrete time signals and systems, system functions, poles and zeros of systems and sequences, z-domain analysis. | **7** |

| | | |
|---|---|---|
| 6. | **Sampling and Reconstruction**: The Sampling Theorem and its implications. Spectra of sampled signals. Reconstruction: ideal interpolator, zero-order hold, first-order hold. Aliasing and its effects. Relation between continuous and discrete time systems. | **8** |
| | **Total** | **40** |

**Suggested Books:**

1. Lathi, Principles Of Linear Systems and Signals, Oxford
2. Willsky, Nawab, Signals And Systems, PHI
3. M J Roberts, Signals And Systems, Mc-Graw Hill

**III Year VI Semester**

| 6EE5-11: Electromagnetic Field Theory | |
|---|---|
| **Credit: 2** | **Max Marks: 100 (IA: 30, ETE: 70)** |
| **2L+0T+ 0P** | **End Term Exams: 2 hrs.** |

**Course Outcomes:**

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

**CO-1:** Understand the different forms of vector relations and gradients used in field theory.

**CO-2:** Learn about the electric filed intensity, Gauss law and Electrostatic Energy.

**CO-3:** Learn about the magnetic field intensity, flux density, polarization and magnetization. Also learn about their boundary conditions.

**CO-4:** Know the displacement current and equation of continuity, pointing vector and power considerations.

| S. No. | Contents | Hours |
|---|---|---|
| 1. | **Introduction:** Objective, scope and outcome of the course. | **1** |
| 2. | **Vector Relation and Gradient:** Vector relation in Rectangular, cylindrical, spherical and general curvilinear coordinate system. Concept and physical interpretation of gradient, Divergence and curl, Green's Stoke's and Helmholz theorems. | **6** |
| 3. | **Electrostatics:** Electric field due to various charge configurations, Electric field vectors: Electric field intensity, flux density and polarization, Electric potential and displacement vector, Gauss's law, Poisson's and Laplace's equation and their solution, Uniqueness theorem, Continuity equation, Electrostatic energy, Field determination by method of images, Boundary conditions. | **6** |
| 4. | **Magnetostatics:** Magnetic field vector: Magnetic field intensity, flux density and magnetization, Biot-Savart's law, Ampere's law, Magnetic vector potential, Energy stored in magnetic field, Interaction of moving charge and current with magnetic field, Boundary conditions, Analogy between electric and magnetic fields. | **8** |
| 5. | **Time Varying Fields:** Faraday's law, Displacement current and equation of continuity, Maxwell's equations, Uniform plane wave in free space, Dielectrics and conductors, Skin effect, Reflection of a plane wave at normal incidence, Standing wave ratio, Pointing vector and power considerations. | **8** |
| | **Total** | **29** |

**Suggested Books:**

1. G. S. N. Raju: Electromagnetic Field Theory and Transmission Lines, Pearson.
2. V.V. Sarwate: Electromagnetic Field and Waves, Willey Eastern Ltd.
3. Hayt: Engineering Electromagnetics, McGraw-Hill Education.
4. Matthew N. O. Sadiku: Principles of Electromagnetics, Oxford.

**III Year VI Semester**

| **6EE5-12: Neural Network and Fuzzy Logic Control** | |
|---|---|
| **Credit: 2** | **Max Marks: 100 (IA: 30, ETE: 70)** |
| **2L+0T+ 0P** | **End Term Exams: 2 hrs.** |

**Course Outcomes:**
Upon successful completion of the course, the students will be able to:
**CO-1:** Learn concepts, architecture and working of artificial neural networks.
**CO-2:** Understand supervised and unsupervised learning algorithms.
**CO-3:** Understand Fuzzy set theory and operations, Fuzzy Relations and inference system.
**CO-4:** Design Fuzzy logic controller for industrial applications.

| S. No. | Contents | Hours |
|---|---|---|
| 1. | **Introduction:** Objective, Scope and Outcome of the course. | 1 |
| 2. | **Introduction to Artificial Neural Networks:** Artificial neural network and their biological motivation, Terminology, Introduction to ANN Architecture, Models of neuron, Topology, Characteristics of artificial neural networks, Types of activation functions. | 6 |
| 3. | **Learning Methods:** Error correction learning, Hebbian learning, Perceptron, XOR Problem, Perceptron learning rule, Convergence theorem, Adeline. | 5 |
| 4. | **Supervised and Unsupervised Learning:** Multilayer Perceptron, Back propagation learning algorithm, Momentum factor, Radial basis function network. | 5 |
| 5. | **Fundamentals of Fuzzy Logic:** Introduction to classical sets - Properties, operations and relations; Fuzzy sets, Uncertainty, Operations, properties, cardinalities, membership functions. Fuzzy relations**:** Fuzzy Cartesian product, Composition-Max min and Max-product composition, Tolerance and Equivalence relations. | 7 |
| 6. | **Fuzzy Inference Systems and Control:** Fuzzification, Membership value assignment, Defuzzification to crisp sets, Defuzzification methods, Natural language, Linguistic hedges, and Fuzzy rule base system, Graphical techniques of inference, Basic architecture of Fuzzy logic controller, Fuzzy Engineering process control. | 7 |
| | **Total** | **31** |

**Suggested Books:**

1. Timothy J. Ross, Fuzzy Logic with Engineering Applications, John Wiley and sons, 2010.
2. Neural Networks, Fuzzy logic, Genetic algorithms: synthesis and applications by Rajasekharan and Rai – PHI Publication.
3. Introduction to Neural Networks using MATLAB 6.0 - S.N. Sivanandam, S. Sumathi, S.N. Deepa, TMH, 2006
4. S. Haykin, "Neural Networks, A Comprehensive Foundation", Pearson, 2008.

**III Year VI Semester**

| 6EE5-13: Digital Control System | |
|---|---|
| **Credit: 2** | **Max Marks: 100 (IA: 30, ETE: 70)** |
| **2L+0T+ 0P** | **End Term Exams: 2 hrs.** |

**Course Outcomes:**

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

**CO-1:** Describe the various control blocks and components of digital control systems for modeling.

**CO-2:** Analyze sampled data systems in z-domain.

**CO-3:** Design a digital controller/ compensator in frequency domain.

**CO-4:** Apply state variable concepts to design controller for linear discrete time system.

| S. No. | Contents | Hours |
|---|---|---|
| 1. | **Introduction:** Objective, scope and outcome of the course. | **1** |
| 2. | **Discrete Representation of Continuous Systems:** Basics of Digital Control Systems. Discrete representation of continuous systems. Sample and hold circuit. Mathematical Modeling of sample and hold circuit. Effects of Sampling and Quantization. Choice of sampling frequency. ZOH equivalent. | **5** |
| 3. | **Discrete System and it's stability analysis:** Z-Transform and Inverse Z Transform for analyzing discrete time systems. Pulse Transfer function. Pulse transfer function of closed loop systems. Mapping from s-plane to z plane. Solution of Discrete time systems. Time response of discrete time system. Stability analysis by Jury test. Stability analysis using bilinear transformation. | **5** |
| 4. | **State Space Approach for discrete time systems:** State space models of discrete systems, State space analysis. Lyapunov Stability. Controllability, reach-ability, Reconstructibility and observability analysis. Effect of pole zero cancellation on the controllability & observability. | **6** |
| 5. | **Design of Digital Control System:** Design of Discrete PID Controller, Design of discrete state feedback controller. Design of set point tracker. Design of Discrete Observer for LTI System. Design of Discrete compensator. Design of discrete output feedback control. | **7** |
| 6. | **Deadbeat response design:** Design of digital control systems with deadbeat response, Practical issues with deadbeat response design, Sampled data control systems with deadbeat response. | **6** |
| | **Total** | **30** |

**Suggested Books:**

1. M. Gopal ,Digital Control and State Variable Methods, MacGraw Hill education
2. B.C. Kuo, Digital Control system, Oxford University Press.

### III Year VI Semester

| 6EE4-20: Power Electronics Lab | |
|---|---|
| **Credit: 1.5** | **Max Marks: 100 (IA:60, ETE: 40)** |
| **0L+0T+3P** | **End Term Exams: 3 hrs.** |

**Course Outcomes:**

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

**CO-1:** To plot and study characteristics of devices SCR, MOSFET, IGBT and their switching behaviour.

**CO-2:** To convert fixed dc to variable dc using dc-dc converter circuits.

**CO-3:** Study operation of semi controlled and full controlled operation of 1-phase & 3-phase rectifier.

**CO-4:** Study operation three -phase bridge inverter and obtain harmonic profile.

| S. No. | List of Experiments | Hours |
|---|---|---|
| 1. | Determine V-I characteristics of SCR and measure forward breakdown voltage, latching and holding currents. | 3 |
| 2. | Find output and transfer characteristics of MOSFET and IGBT. | 3 |
| 3. | Study the Buck, Boost, Buck-Boost converter circuit and obtain output waveforms. | 3 |
| 4. | Study the natural, forced, auxiliary and resonant commutation circuits. | |
| 5. | Study and obtain waveforms of single-phase half wave controlled rectifier with and without filters. | 3 |
| 6. | Study and obtain waveforms of single-phase full controlled bridge converter with R and RL loads. | 3 |
| 7. | Study and obtain waveforms of Three-phase full controlled bridge converter with R and RL loads. | 3 |
| 8. | Study the operation of single-phase bridge inverter with sinusoidal pulse width modulation method. | 3 |
| 9. | Study and perform an experiment on the operation of single-phase bridge inverter with sinusoidal pulse width modulation method. | 3 |
| 10. | Control the speed of a DC motor using single-phase half -controlled rectifier. Plot armature voltage versus speed characteristics. | 3 |
| | **Total** | **30** |

**III Year VI Semester**

| 6EE4-21: Power System Lab | |
|---|---|
| **Credit: 1.5** | **Max Marks: 100 (IA:60, ETE: 40)** |
| **0L+0T+3P** | **End Term Exams: 3 hrs.** |

**Course Outcomes:**

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

**CO-1:** Create the MATLAB Simulink model of Swing Equation, synchronous and induction machine.

**CO-2:** Draw the responses of the synchronous machine with the PSS and excitation system.

**CO-3:** Demonstrate the Single Machine Infinite Bus (SMIB) system by writing a script in MATLAB.

**CO-4:** Simulate models of wind power system and solar PV system.

| S. No. | List of Experiments | Hours |
|---|---|---|
| 1. | Simulate Swing Equation in MATLAB Simulink and get its responses under different disturbance conditions. | 3 |
| 2. | Model and simulate the Synchronous Machine and draw its outputs. | 3 |
| 3. | Model and simulate the Induction Doubly fed induction generator (DFIG) and obtain its outputs. | 3 |
| 4. | Modeling and simulation of Synchronous Machine with PSS. | 3 |
| 5. | Modeling and simulation of Synchronous Machine with excitation system. | 3 |
| 6. | Write a script in MATLAB to simulate the Single Machine Infinite Bus (SMIB) system. | 3 |
| 7. | Write a script in MATLAB to simulate the wind power generation system. | 3 |
| 8. | Model and simulate the solar PV system. Verify the responses by writing a script in MATLAB. | 3 |
| 9. | Study the operation of micro-controller based over current relay in DMT type and IDMT type. | 3 |
| 10. | Study the micro-controller based under voltage relay and Over Voltage Relay. | 3 |
| | **Total** | **30** |