

**SCHEME OF TEACHING**  
**VII SEMESTER**

Sl. No.	Course Code	Course Name	Category	Credits				Contact Hours
				L	T	P	Total	
1.	EE71	Switchgear and Protection	PCC	4	0	0	4	4
2.	EE72	High Voltage Engineering	PCC	3	1	0	4	5
3.	EE73	Entrepreneurship & Management	HSS	3	0	0	3	3
4.	EEExxx	Department Elective – 4	Elective	3	0	0	3	3
5.	EEExxx	Department Elective – 5	Elective	3	0	0	3	3
6.	EEL76	Power Systems Lab.	Lab	0	0	1	1	2
7.	EEL77	Protection & High Voltage Lab.	Lab	0	0	1	1	2
8.	EESE01	Seminar	Seminar	0	0	1	1	
<b>Total</b>				<b>16</b>	<b>1</b>	<b>3</b>	<b>20</b>	<b>22</b>

Elective Code	Elective Title	Elective Code	Elective Title
EEE741	Electric Drives	EEE751	Digital Image Processing
EEE742	Low Power Integrated Circuits	EEE752	Generation, Economics & Reliability Aspects of Power Systems
EEE743	Artificial Neural Network	EEE753	Electromagnetic Compatibility

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3.	EE73	Entrepreneurship & Management	HSS	3	0	0	3	3
4.	EEExxx	Department Elective – 4	Elective	3	0	0	3	3
5.	EEExxx	Department Elective – 5	Elective	3	0	0	3	3
6.	EEL76	Power Systems Lab.	Lab	0	0	1	1	2
7.	EEL77	Protection & High Voltage Lab.	Lab	0	0	1	1	2
8.	EESE01	Seminar	Seminar	0	0	1	1	
<b>Total</b>				<b>16</b>	<b>1</b>	<b>3</b>	<b>20</b>	<b>22</b>

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**SCHEME OF TEACHING**  
**VIII SEMESTER**

Sl. No.	Course Code	Course Name	Category	Credits				Contact Hours
				L	T	P	Total	
1.	EEIN2	Internship / NPTEL courses	Internship	3	0	0	3	3
2.	EEP3	Project Work	Project	0	0	14	14	-
<b>Total</b>				<b>4</b>	<b>0</b>	<b>14</b>	<b>17</b>	<b>3</b>

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## VII SEMESTER

### SWITCHGEAR AND PROTECTION

**Subject Code: EE71**

**Credit: 4: 0: 0**

**Prerequisites: Nil**

**Contact Hours: 56**

**Course Coordinator/s: Sri. Ramakrishna Murthy**

#### Course Content

##### Unit I

**Switches and Fuses:** Isolating switch, Fuse law, cut-off characteristics and time current characteristics, Fuse material, HRC fuse, Liquid fuse, Application of fuse, Selection of fuses.

**Principles of Circuit Breakers:** Principles of AC circuit breaking, Principles of DC circuit breaking, Arc initiation, maintenance and interruption, Arc interruption theories - Slepian's theory and energy balance theory, Re-striking voltage, Recovery voltage, Rate of rise of re-striking voltage, Current chopping.

##### Unit II

**Circuit Breakers:** Classification of circuit breakers (CB), Air blast circuit breakers, Air break CB, Oil circuit breakers - single break, double break, minimum oil, SF<sub>6</sub> breaker - properties of SF<sub>6</sub> gas puffer and non-puffer type of SF<sub>6</sub> breakers, Vacuum CB, Operating mechanism of CB, Rating of CB.

**Philosophy of protective relaying system:** Need for protective system, Types and effects of faults, Zones of Protection, Primary and Back up Protection, Essential qualities of protective relaying, Classification of protective relays, Classification of protective schemes, CT & PT for Protection.

##### Unit III

**Relays:** Principle of relay operation, Static relays (block diagrams) – overcurrent, directional, distance relays, Advantages and limitations of static relays, Comparators - duality between amplitude and phase comparators, Rectifier bridge and phase splitting type amplitude comparators, coincidence type phase comparator.

**Relay characteristics:** Non-directional and Directional overcurrent relays, IDMT and directional characteristics. Differential relay – Types of differential relay, Distance Protection - impedance relay, reactance, Mho relay.

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**Subject Code: EE71**

**Credit: 4: 0: 0**

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**Contact Hours: 56**

**Course Coordinator/s: Sri. Ramakrishna Murthy**

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## Unit IV

**Protection Schemes:** Generator protection scheme - stator & rotor protection. Transformer protection - external and internal faults protection, Buchholz Relay, Bus-zone protection - differential current protection, frame leakage protection of busbar, ring main protection, Motor protection - ground fault and phase fault protection, Pilot relaying schemes - circulating current scheme, balanced voltage scheme, Carrier aided distance protection.

## Unit V

**Numerical Protection:** Numerical over current and distance protection (generalized interface).

**Wide area measurement application:** Introduction, PMU, WAMS architecture, Adaptive relaying - transformer protection, transmission line protection, reclosing, WAMS based protection concepts - supervision of backup zones, intelligent load shedding, load shedding and restoration.

### Text Books

1. Badriram and ViswaKharma, '*Power System Protection and Switchgear*', 2<sup>nd</sup> edition, TMH, 2011.
2. Sunil S. Rao, '*Switchgear and Protection*', 10<sup>th</sup> edition, Khanna Publishers, 1992.
3. James S. Thorp; Arun G. Phadke, '*Computer Relaying for Power Systems*', John Wiley & Sons, 2<sup>nd</sup> edition, 2009.

### Reference Books

1. Soni, Gupta and Bhatnagar, '*A Course in Electrical Power*', 4<sup>th</sup> edition, Dhanapat Rai Publications, 2010.
2. Y.G. Painthankar and S R Bhide, '*Fundamentals of Power system Protection*', PHI, 2007.

### Course Outcomes (COs):

A student completing this course should be able to:

1. Select a fuse and/or a circuit breaker for a given application. (PO-1) (PSO-1)
2. Distinguish between various types of circuit breakers. (PO-1) (PSO-1)
3. Compare the characteristic of different relays and identify a suitable relay for different zones of protection. (PO-1, 6) (PSO-1)
4. To identify different faults in generator, power transformers, transmission lines, busbars and motors and their protection. (PO-1, 6) (PSO-1)
5. To apply the basic concept of numerical relay and WAMS for protection. (PO-1) (PSO-1)

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# HIGH VOLTAGE ENGINEERING

**Subject Code: EE72**

**Credit: 3: 1: 0**

**Prerequisites: Nil**

**Contact Hours: 70**

**Course Coordinator/s: Dr. Chandrashekhar Badachi/Dr. Pradipkumar Dixit**

## Course Content

### Unit I

#### **Conduction and breakdown in Gases:**

Gases as insulating media, Ionization Processes, ionization by collision, Photo-ionization, secondary ionization processes, Electron emission due to positive ion impact, electron emission due to photons, electron emission due to metastable and neutral atoms. Townsend's current growth equation, current growth in the presence of secondary processes. Townsend's criterion for breakdown. Breakdown in electronegative gases, electron attachment process. Time lags for breakdown. Streamer theory of breakdown in Gases, Paschen's law, breakdown in non-uniform fields and corona discharges.

### Unit II

#### **Conduction and breakdown in liquid dielectrics:**

Liquid as insulation, conduction and breakdown in commercial liquids, suspended particle theory, Bubble theory, stressed oil volume theory.

#### **Breakdown in Solid dielectrics:**

Introduction, Intrinsic breakdown, Electromechanical breakdown, Thermal breakdown, breakdown due to treeing and tracking, breakdown due to internal discharges.

#### **Generation of HVDC Voltages:**

Half and full wave rectifier circuits, voltage doubler circuit, Cockcroft-Walton voltage multiplier circuit, expression for ripple and voltage drop, Electrostatic generators, Van-de-Graaff generator.

### Unit III

#### **Generation of HVAC voltages:**

Cascade transformers, Resonant transformers, Generation of high frequency AC high voltages.

#### **Generation of Impulse Voltages:**

Standard impulse wave shapes, single stage impulse generator circuits and their analysis, Marx circuit, components of a multistage impulse generator. Generation of switching surges.

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**Credit: 3: 1: 0**

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**Contact Hours: 70**

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### **Generation of Impulse currents:**

Definition of impulse current waveforms, circuit for producing impulse current waves, generation of high impulse currents, generation of rectangular current pulses, Trigatron gap.

## **Unit IV**

### **Measurement of High Voltages:**

High ohmic series resistance with microammeter, Generating voltmeters, Electrostatic voltmeter, Chubb-Fortescue method, Sphere gaps, Potential dividers for impulse voltage measurements, Resistance potential divider for very low impulse voltages and fast rising pulses, Resistance and Capacitance potential dividers with oscilloscope (impedance matching).

## **Unit V**

### **Non-destructive Testing of Electrical Apparatus:**

Measurement of Dielectric constant and loss factor: Low frequency measurement method-More's bridge, power frequency measurement methods – high voltage Schering bridge, Schering bridge arrangement for grounded capacitors

Partial discharge measurements: Introduction, terminology used, Straight discharge detection method, balanced detection method

### **High Voltage Testing of Electrical Apparatus:**

Testing of Insulators, Bushings and Transformers

### **Text Book**

1. M. S. Naidu and V. Kamaraju, '*High Voltage Engineering*', 3ed, Tata McGraw Hill Publishing Company Limited, New Delhi, 2005.

### **Reference Books**

1. E. Kuffel, W. S. Zaengl and J. Kuffel, '*High Voltage Engineering – Fundamentals*', Second edition 2000, published by Butterworth-Heinemann.
2. C. L. Wadhwa, '*High Voltage Engineering*', New Age International (P) Limited, Publishers, 2003.
3. R. S. Jha, '*High Voltage Engineering*', Dhanpat Rai & Sons, New Delhi, 1984.

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### **Course Outcomes (COs):**

At the end of the course, the student is able to:

1. Classify the insulation and analyze the Electrical breakdown phenomena in any insulating medium. (PO-1) (PSO 1)
2. Identify the methods for generating High AC & DC Voltages. (PO-1) (PSO 1)
3. Justify the need and design of circuits for generation of impulse voltages and currents. (PO-1,3) (PSO 1)
4. Recognize the different techniques for measurement of High Voltages (PO-1) (PSO 1)
5. Identify different types of high voltage testing. (PO-1) (PSO 1)

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5. Identify different types of high voltage testing. (PO-1) (PSO 1)

## Entrepreneurship & Management

**Subject Code: EE73**

**Credit: 3: 0: 0**

**Prerequisites: Nil**

**Contact Hours: 42**

**Course Coordinator/s: Smt. Mamatha G M**

### Course Content

#### Unit I

**Introduction:** Meaning, nature & characteristics of managements Scope & functional areas of management, Management as a science, art of profession, management & administration, Role of management, levels of management.

**Planning:** Nature & Importance of planning process, Types of planning & decisions, Importance of planning, Steps in planning, Hierarchy of plans, Case Studies

#### Unit II

**Organizing & Staffing:** Nature & purpose of organization, Types of organization, Departments & committees. Centralization & decentralization of authority & responsibility, Nature & importance of staffing, Process of selection & recruitment.

**Directing & Controlling:** Meaning & nature of directing, Leadership styles, Motivation theories, Coordination, Meaning & importance, Steps involved in control essentials of sound control system, Methods of establishing control, Case Studies

#### Unit III

**Introduction to Economics:** Managerial Economics, Nature & Scope, Role of Managerial Economics in decision making, Objectives of Business firma, Alternative Objectives of the firm, Demand Analysis, Law of demand, Exceptions to Law of demand, Market Structures, Perfect competitions, Monopolic Competitions, Oligopoly competitions.

**Entrepreneur:** Meaning of Entrepreneur, Evolution of the Concept, Functions of an Entrepreneur, Types of Entrepreneur, Intrapreneur – an emerging Class. Concept of

**Entrepreneurship:** Evolution of Entrepreneurship, development of Entrepreneurship steps in entrepreneurial process, Role of entrepreneurs in Economic Development: Entrepreneurship in India; Entrepreneurship – is Barriers.

#### Unit IV

**Small scale industry:** Definition; Characteristics; Need and rationale: Objectives: Scope; role of SSI in Economic Development. Advantages of SSI. Steps to start in SSI – Government policy towards SSI; Different Policies of S.S.I.; Government Support

## Entrepreneurship & Management

**Subject Code: EE73**

**Credit: 3: 0: 0**

**Prerequisites: Nil**

**Contact Hours: 42**

**Course Coordinator/s: Smt. Mamatha G M**

### Course Content

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**Introduction:** Meaning, nature & characteristics of managements Scope & functional areas of management, Management as a science, art of profession, management & administration, Role of management, levels of management.

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for S.S.I. during 5 year plans. Impact of Liberalization, Privatisation, Globalization on S.S.I., Effect of WTO/GATT Supporting Agencies of Government for S.S.I., Meaning; Nature of Support; Objectives; Functions; Types of Help, Brief concepts about SEZ & SME.

### **Unit V**

**Preparation of Project:** Meaning of Project; Project Identification; Project Selection; Project Report; Need and Significance of Report; Contents; formulation; Guidelines by Planning Commission for Project report; Network Analysis; Errors of Project Report; Project Appraisal.

**Identification of Business Opportunities:** Market Feasibility Study; Technical Feasibility Study; Financial Feasibility Study: Payback period, IRR, Pre-Feasibility Report, Feasibility Report, Detailed Project Report (D.P.R), Social Feasibility Study

#### **Text Books:**

1. P.C.Tripathi, P.N.Reddy, "*Principles of Management*", Tata McGraw Hill 4Th Edition.
2. Vasant Desai, "*Dynamics of Entrepreneurial Development & Management*", Himalaya publishing House .2007 Edition.
3. Jhingam Stephan, "*Managerial Economics*", Vrinda Publication 1998 Edition.

#### **Reference Books:**

1. Dr. NVR Naidu and T.KrishnaRao, "*Management and Entrepreneurship*"- I K International Publishing House Pvt. Ltd., New Delhi, 2008.
2. Poornima M Charantimath, "*Entrepreneurship Development – Small Business Enterprises*", Pearson Education, 2006.

#### **Course Outcomes (COs):**

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

1. Explicate Management and know its different perspectives. (PO – 11) (PSO-3)
2. Interpret the various functions of Management. (PO – 8,9) (PSO-3)
3. Know the importance of Managerial Economics in today's business market. (PO – 8,10) (PSO-2)
4. Cognize the Entrepreneurship and steps involved in the process and the government policies towards SSI. (PO – 7,9) (PSO-3)
5. Identify the project / business opportunities and its demand. (PO –7,10,11) (PSO-4)

## POWER SYSTEMS LAB

**Subject Code: EEL76**

**Credit: 0: 0: 1**

**Prerequisites: Nil**

**Contact Hours: 28**

**Course Coordinator/s: Dr. Sridhar. S**

### LIST OF EXPERIMENTS

1. Determination of ABCD Parameters, Regulation and transmission efficiency of transmission line.
2. Determination of power angle characteristics for salient and non-salient pole synchronous machines.
3. Fault analysis of an isolated 3- $\Phi$  synchronous machine.
4. Y-bus formation for a given power systems (without mutual coupling)
5. Formation of Z-Bus (without mutual coupling) using building algorithm.
6. Optimal generator scheduling for thermal power plant
7. Load flow analysis using Gauss Seidal Method/ Newton–Raphson method.
8. To plot Swing curve, find the system stability and Critical clearing time for a single machine connected to infinite bus.
9. Voltage control by load compensation.
10. Fault Analysis in power system.

*Note: The above experiments can be done using any standard simulation software package.*

### Course Outcomes (COs):

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

1. Determine the power angle characteristics of synchronous machines. Solve the swing equation and determine the transient stability. (PO-1,5) (PSO-1,2)
2. Determine the transmission line performance. (PO-1,5) (PSO-1,2)
3. Obtain economic load dispatch of a thermal power plant. (PO-1,5) (PSO-1,2)
4. Conduct a study on power system faults. (PO-1,5) (PSO-1,2)
5. Analyze the Power flow of a given system. (PO-1,5) (PSO-1,2)

## **PROTECTION & HIGH VOLTAGE LAB**

**Subject Code: EEL77**

**Credit: 0: 0: 1**

**Prerequisites: Nil**

**Contact Hours: 28**

**Course Coordinator/s: Sri. Ramakrishna Murthy**

### **LIST OF EXPERIMENTS**

1. Over current relay: IDMT non-directional characteristics
2. IDMT characteristics of over voltage or under voltage relay (solid state or electromechanical type)
3. Current-time characteristics of fuse
4. Operating characteristics of microprocessor based (numeric) over-current relay
5. Operating characteristics of microprocessor based (numeric) over/under voltage relay.
6. Motor protection scheme fault studies
7. Field mapping using electrolytic tank for any one-model cable / capacitor / transmission line/sphere gap models.
8. Flashover characteristics of sphere gaps under AC and DC corrected to STP
9. Determine the breakdown strength of transformer oil
10. Flashover characteristics of non-uniform field gaps under HVAC
11. Measurement of HVAC using sphere gaps
12. Determine the breakdown voltage of solid insulations

### **Course Outcomes (COs):**

A student completing this course should be able to:

1. Demonstrate the characteristics of fuse. (PO-1,4,9) (PSO-1)
2. Demonstrate the characteristics of voltage and current relays (PO-1,4,9) (PSO-1)
3. Realize the field distribution of a coaxial cable / parallel plate capacitor. (PO-1,4,9) (PSO-1)
4. Determine the breakdown voltage of air in uniform and non-uniform fields. (PO-1,4,9) (PSO-1)
5. Determine the breakdown voltage/strength of solid and liquid insulations. (PO-1,4,9) (PSO-1)

## PROJECT WORK

**Subject Code: EEP3**

**Credit: 0: 0:14**

**Prerequisites: Nil**

**Contact Hours: 78**

**Course Coordinator/s: Dr. S. Dawnee**

### Course Content

Students will analyze, design and implement ideas pertaining to different aspects of electrical and electronics engineering. They will work in a group of 3/4 to solve a problem of current concern requiring an engineering solution. They are required to follow a systematic approach towards developing the solution by considering technical and non-technical factors. The working model of the solution along with the design documentation will be considered for final evaluation. Emphasis will also be on the skills to communicate effectively and present ideas clearly and coherently in both the written and oral forms.

### Course Outcomes (COs):

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

1. Define the problem to be solved in a clear and unambiguous terms. (POs – 1, 2, 3, 4, PSO – 1)
2. Identify and establish the need to solve the problem by gathering relevant literature. (POs – 1, 2, 3, 4, PSO – 1)
3. Describe the proposed design method in terms of technical block diagram or flowchart. (POs – 2, 3, 10, PSOs – 2, 3).
4. Implement and demonstrate the proposed design method using software/hardware tools. (POs – 2, 3, 4, 5, PSOs – 2, 3).
5. Document and present the solution to the peer group. (POs – 9, 10, PSOs – 2, 3)

# ELECTRIC DRIVES

**Subject Code: EEE741**

**Credit: 3: 0: 0**

**Prerequisites: Nil**

**Contact Hours: 42**

**Course Coordinator/s: Dr. Kodeeswara Kumaran G/ Dr. Rakesh Kumar**

## Course content

### Unit I

#### Introduction to Electrical drives

Introduction, advantages of electrical drives, parts of electrical drives, choice of electrical drives, status of dc and ac drives, dynamics of electrical drives, fundamental torque equation, components of load torque, nature and classification of load torques, speed-torque conventions and multi-quadrant operation, equivalent values of drive parameters.

### Unit II

#### DC Drives

**Basic Concepts:** Speed torque characteristics, starting, braking and speed control techniques of shunt/separately excited dc motor (theory only).

**Rectifier controlled dc drives:** Types of rectifiers- review, fully controlled rectifier fed dc drives, half controlled rectifier fed dc drives, multi-quadrant operation of rectifier controlled dc drives.

**Chopper controlled dc drives:** Types of choppers – review, chopper controlled dc drives – motoring and braking operation, multi-quadrant operation of chopper controlled dc drives.

### Unit - III

#### AC Drives

**Basic Concepts:** Speed-Torque characteristics of induction motors. Concept of induction motor starting. Types of starter - star delta, auto transformer, reactor, part winding, rotor resistance. Concept of induction motor braking. Methods of braking - regenerative, plugging, dynamic braking (theory only)

**Speed control techniques:** Rotor resistance control, Stator voltage control, stator frequency control, V/f control.

### Unit IV

#### Special Machine Drives

**Synchronous motors:** Construction, operation from fixed frequency supply –

starting, pulling in, braking. Synchronous motor variable speed drives. Self-controlled synchronous motor drive employing load commutated thyristor inverter.

**DC brushless motors:** Construction, speed-torque characteristics, brushless dc motor controllers – rotor position measurement, commutation logic, speed controller.

### Unit V

**Stepper Motor Drives:** Principle of operation of stepper motor, single stack variable reluctance motors, speed torque characteristics, control of stepper motors, unipolar and bipolar drive circuits

#### Text Book

1. G.K Dubey, *Fundamentals of Electrical Drives*, Narosa publishing house Chennai, 2 Edition, 5<sup>th</sup> reprint.
2. Mohamed A. El-Sharkawi, *Fundamentals of Electric Drives*, Thomson Learning, 2002

#### Reference Books

1. Dave Polka, *Motors and Drives: A Practical Technology Guide*, The Instrumentation, Systems and Automation Society, 200.
2. N.K De and P.K. Sen, *Electrical Drives*, PHI, 2007.
3. M.H.Rashid, '*Power Electronics: Circuits, Devices and Applications*', Pearson Education, 3<sup>rd</sup> Edition.

#### Course Outcomes (COs):

The course will enable the student to:

1. Describe the structure of a drive system and analyze the mutliquadrant operation of a drive system. (PO-1,2) (PSO-1)
2. Elucidate the operating principles of dc drives and solve problems related to it. (PO-1,2) (PSO-1)
3. elucidate the operating principles of ac drives and solve problems related to it. (PO-1,2) (PSO-1)
4. explain the functions of drive components and operating principles of special machine drives (including BLDC motor drive, synchronous motor drive and stepper motor drive). (PO-1) (PSO-1)
5. suggest required drive components and determine the design parameters for a given drive system specification. (PO-3) (PSO-1)

# LOW POWER INTEGRATED CIRCUITS

**Subject code: EEE742**

**Credits: 3:0:0**

**Prerequisites: Nil**

**Contact Hours: 42**

**Course Coordinator: Sri. Victor George**

## Course content

### UNIT 1

Introduction to low power design techniques, overview of CMOS technology, Statistical Dispersion of Transistor Electrical Parameters, Physical and Electrical Gate Oxide Thickness, Innovative Transistor Architectures, concept of the different leakage components of MOS transistors — gate tunnelling, subthreshold conduction, GIDL, junction leakage, and punch through leakage, basic concepts of circuit level leakage current in basic CMOS gates.

### UNIT 2

Basic concepts and physical phenomena in the nanoscale MOSFET, Passive Photonic Devices for Signal Routing- waveguides, resonators, photonic crystals, Link Performance (Comparison of Optical and Electrical Systems), Low power arithmetic operators, carry look ahead adder, modified booth multiplier, floating-point arithmetic, content addressable memory, phase locked loops, Low-Power and Standard Cell Libraries, gated clocks, Latch-Based Designs, Cell Drives, basics of low-power very fast dynamic logic circuits.

### UNIT 3

Circuits Techniques for Dynamic Power Reduction, Dynamic Power Consumption Component, Power Reduction Approaches, Circuit Parallelization, Memory Parallelization, Parallelized Shift Register, voltage scaling-based circuit techniques, Multiple Voltages Techniques, Low Voltage Swing, Circuit Technology-Independent Power Reduction, Precomputation, Retiming, Circuit Technology-Dependent Power Reduction, Path Balancing, Technology Decomposition.

### UNIT 4

Low-Power and Low-Voltage Communication for SoCs, Basics of Wires, Power Consumption Related to Interconnect, Strategies for Power Savings in Interconnect, efficient on chip power management using fully integrated DC-DC converters, inductive and capacitive converter, Concept of single inductor dual output (SIDO) and single inductor multiple output (SIMO) DC-DC converters.

## UNIT 5

Circuit techniques for improving the power density of switched capacitor converters, capacitor charge sharing loss and concept of soft charging, EMC applications, digital circuit power distribution, digital circuit radiation, conducted emissions, RF and transient immunity, Electrostatic discharge.

### Text Books:

1. Christian Piguet, '*Low power CMOS circuits- technology, logic design and CAD tools*', Taylor and Francis, 2006.
2. Mona M Hella, Patrick Mercier, '*Power management Integrated circuits*', CRC Press, 2016.
3. Henry W Ott, '*Electromagnetic compatibility engineering*', Wiley, revised edition, 2009.

### Course Outcomes (COs):

At the end of the course the students will be able to

1. Understand the causes of leakage currents at device and circuit levels
2. Understand the various low power techniques used for data transfer, arithmetic operations and logic circuitries in an IC
3. Identify various circuits techniques for dynamic power reduction
4. Understand the topologies and techniques used in DC/DC converters for efficient on chip power management
5. Identify the electromagnetic compatibility issues related to digital circuits



# ARTIFICIAL NEURAL NETWORK

**Subject Code: EEE743**

**Credit: 2: 1: 0**

**Prerequisites: Nil**

**Contact Hours: 56**

**Course Coordinator/s: Smt. Kusumika Krori Dutta**

## Course content

### Unit I

#### **Introduction:**

Fundamental concepts and Models of Artificial Neural systems, Biological Neural Networks, Typical Architectures, Setting the Weights, Common Activation Functions, Mc-Culloch –Pitts model- AND gate, OR gate, AND-NOT gate, XOR gate.

### Unit II

#### **Fundamental Models of Artificial Neural Networks:**

Simple neural nets for Pattern Classification, Hebb net, examples, Single Layer Perceptron Classifiers, Single Layer Feedback Networks, examples, Perceptron learning.

### Unit III

#### **Associative memory networks:**

Pattern associations, applications, Training algorithm, Hebb rule & Delta rule, Classification of associative memory, Hetero associative neural net architecture, Examples with missing and mistake data, Auto associative net architecture, Examples with missing and mistake data, Storage capacity.

### Unit IV

#### **Feed Back Networks:**

Recurrent linear auto associate, Examples, Discrete Hopfield net, Examples with missing and mistake data, Bidirectional associative net, architecture, Examples with missing and mistake data, Hamming distance, Fixed weight competitive nets, Architecture, applications.

#### **Feed forward Network:**

Architecture, applications, examples of back propagation neural network (BPN), and Radial Basis Function Network (RBFN)

### Unit V

#### **Special Networks:**

Introduction to Boltzmann machines, Boltzmann machine with learning.

### **Self-organizing Feature Map:**

Kohonen Self-organizing Feature Map, Learning Vector Quantization, Max net, Mexican Hat, Hamming Net

### **References:**

1. LaureneFausett, '*Fundamentals of Neural Networks: Architecture, Algorithms and Applications*', Person Education, 2004.
2. Simon Hayking, '*Neural Networks: A Comprehensive Foundation*', 2<sup>nd</sup> Ed., PHI.
3. S.N Sivanandam, S Sumathi, S.N Deepa '*Introduction to Neural Net using Matlab 6.0*', TMH, 2008

### **Course Outcomes (COs):**

The course enables the students to:

1. Describe the relation between real brains and simple artificial neural network models. (PO-1) (PSO-1)
2. Design basic model of logic gates and circuits using Perceptron, Hebbian algorithm and McCulloch -Pitt's models and verify the same using MATLAB. (PO-1,3) (PSO-1,2)
3. Identify the main implementation issues for common neural network systems (PO-1) (PSO-1)
4. Apply the models of ANN in different areas like optimization of efficiency (PO-1) (PSO-1)
5. Apply ANN models to data compression, pattern identification, etc. (PO-1) (PSO-1)

# DIGITAL IMAGE PROCESSING

**Subject Code: EEE751**

**Credit: 2:0:1**

**Prerequisites: Nil**

**Contact Hours: 56**

**Course Coordinator/s: Smt. Kusumika Krori Dutta**

## Course content

### Unit I

#### **Digital Image Fundamentals:**

What is Image Processing? Fundamental steps in Digital Image Processing, Components of an Image Processing System, Elements of Visual Perception, Image Sensing and Acquisition, Image Sampling and Quantization, Some Basic relationships between Pixels.

### Unit II

#### **Image Enhancement in Spatial Domain:**

Image Enhancement in Spatial Domain, some basic Gray level transformations, Histogram processing, Enhancement using arithmetic/logic operations.

### Unit III

#### **Spatial Domain Filtering:**

Basics of Spatial filtering, smoothing spatial filters, Sharpening spatial filters.

#### **Frequency domain Filtering:**

Image Enhancement in frequency domain, smoothing frequency domain filters, Sharpening frequency domain filters. Constrained least squares filtering, Geometric mean filter.

### Unit IV

#### **Image Segmentation:**

Detection of discontinuities, edge linking and boundary detection, Thresholding region based segmentation. Segmentation using morphological watersheds, Some basic morphological algorithms.

### Unit V

#### **Image Transforms:**

Two-dimensional orthogonal & unitary transforms, properties of unitary transforms, two dimensional discrete Fourier transform, Discrete cosine transform, Sine transform, Hadamard transform, Haar transform, KL transform.

**Lab Experiments:**

1. Basic concepts of Images: Read and display, information about the image.
2. Image display: Basics, bit planes, quantization and dithering.
3. Point processing: Arithmetic operation, image negative.
4. Filtering, create filters, high and low pass filters.
5. Image geometry: Scaling smaller, rotation.
6. The Fourier transform: two dimensional DFT.
7. Image segmentation: thresholding, edge detection.
8. Canny edge detection, second derivatives.

**Text Book:**

1. Rafael C. Gonzalez and Richard E. Woods," Digital Image Processing", Pearson Education, I Ed, 2001, ISBN-13:9780131687288

**Reference Book:**

1. Anil K. Jain, "*Fundamentals of Digital Image Processing*", Pearson Education, PHI, 2001, ISBN-13:9780133361650

**Course outcomes (COs):**

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

1. Describe the processes of Image acquisition and Image Processing. (PO-1) (PSO-2)
2. Extract the information from the image through spatial domain enhancement methods. (PO-1, 2) (PSO-2)
3. Enhance the image quality through different filtering and restoration techniques. (PO-2 ,5) (PSO-2)
4. Extract the information from the image through segmentation methods. (PO-2,5) (PSO-2)
5. Apply and analyse different types of Image transforms on conversion of spatial domain to frequency domain and vice versa. (PO-2) (PSO-2)

# GENERATION, ECONOMICS & RELIABILITY ASPECTS OF POWER SYSTEMS

**Subject Code: EEE752**

**Credit: 3: 0: 0**

**Prerequisites: Nil**

**Contact Hours: 42**

**Course Coordinator/s: Sri. Vinayaka Rao V**

## Course content

### Unit I

**Generating station: Steam station:** Advantages, disadvantages, block diagram, choice of site, efficiency, equipment.

**Hydroelectric station:** Advantages, disadvantages, block diagram, choice of site, equipment.

**Diesel station:** Advantages, disadvantages, block diagram.

**Nuclear station:** Advantages, disadvantages, block diagram, selection of site.

### Unit II

**Economic aspects:** Important terms and factors, load curves, types of loads, Numerical. Points in selection of units, advantages of interconnected systems, Numerical.

**Economics of power generation:** cost of electrical energy, expressions for the cost of electrical energy, methods of determining depreciation, Numerical.

**Tariff:** Desirable characteristics of Tariff, types of tariff, Numerical

### Unit III

**Reliability aspects:** Basic power system reliability aspects: probabilistic evaluation of power systems, adequacy and security, need for power system reliability evaluation, functional zones, hierarchical levels, reliability cost/reliability worth, reliability data, reliability test systems.

**Generation system adequacy evaluation:** Analysis of IEEE reliability test systems, LOLE analysis of the base case, effect of rounding, derated states, load forecast uncertainty, scheduled maintenance, peak load etc. Numerical.

### Unit IV

**Montecarlo simulation:** modelling, convergence & computing time, advantages and disadvantages.

**Composite System adequacy evaluation:** Factors in contingency enumeration approach, appropriate network solution technique, appropriate load curtailment

philosophies, effect of load curtailment passes, appropriate contingency levels, station originated outages. Comparison between ENEL & U of S approach. Numerical.

### Unit V

**Distribution System adequacy evaluation:** Definition of basic distribution indices, Numerical

**Assessment of reliability worth:** Interruption costs for commercial, industrial, residential customers.

**Smart Grid:** Introduction, Functional units of smart grid

Reliability in Smart Grid: Preliminaries on reliability Quantification, System adequacy Quantification, Congestion Prevention: An Economic Dispatch Algorithm.

#### Text books:

1. V K Mehta, '*Principles of power systems*', S Chand Publishers, 2005
2. Roy Billington & Alan, '*Reliability Assessment of large power systems*', Kluwer Academic Press 1989.
3. James Momoh, '*SMART GRID Fundamentals of Design and Analysis*', IEEE-press, Wiley Publishers, 2012.
4. K G Boroojeni 'Smart Grids: Security and Privacy Issues' Springer Publication, 2017

#### Reference books:

1. G R Nagapal, '*Power plant engineering*', 14<sup>th</sup> edition, Khanna Publishers, 2000.
2. Arora and Doomkundwar, '*A course in power plant engineering*', Dhanpat Rai publishers, 2001.
3. B R Gupta, '*Generation of Electrical Energy*', Eurasia Publishing House, 3<sup>rd</sup> Edition.
4. Dr. S Uppal, '*Electrical power*', Khanna Publishers, 6<sup>th</sup> Edition.
5. Soni Gupta & Bhatnagar, '*A course in electrical power*', Dhanpat Rai & Sons, 2<sup>nd</sup> Edition.
6. R K Rajput, '*Utilization of Electrical Power*', Laxmi publications, First Edition, 2006.
7. Moslehi "*Smart Grid – A Reliability Perspective*", IEEE-PES Conference on Innovative Smart Grid Technologies, 2010

### **Course Outcomes (COs):**

At the end of the course, the student is able to:

1. Describe and compare different types of power generation. (PO-1,10) (PSO-1,3)
2. Apply the concepts of economic aspects of power generation to determine the cost of electrical energy, depreciation and tariffs. (PO-1,2) (PSO-1)
3. Apply the reliability concepts to different hierarchy levels of power systems (PO-1,2) (PSO-1)
4. Evaluate the adequacy of HL-I, HL-II and HL-III by determining their reliability indices (PO-1,2) (PSO-1)
5. Discuss and explain the reliability worth in terms of interruption cost for different types of customers and smart grid. (PO-1,2) (PSO-1)

# ELECTROMAGNETIC COMPATIBILITY

**Subject Code: EEE753**

**Credit: 3: 0: 0**

**Prerequisites: Nil**

**Contact Hours: 42**

**Course Coordinator/s: Smt. Mamatha G M/ Dr. Pradipkumar Dixit**

## Course content

### Unit I

**Electrostatic field, their control & Estimation:** Electric field intensity, Electric strength, classification of electric fields, Degree of uniformity of electric fields, control of electric field intensity, estimation of electric field intensity, Basic Equation for potential and field intensity in electrostatic fields, Analysis of electrostatic fields in homogeneous single dielectric medium.

**Sources:** EMC regulation, typical noise path and use of network theory, Method of noise coupling, miscellaneous noise sources and methods of eliminating interference.

### Unit II

**Cabling:** Capacitive coupling, effect of shield on magnetic coupling, mutual inductance effect, agnatic field between shield & inner conductor, shielding to prevent magnetic radiation, shielding a receptor against magnetic fields, Shield transfer impedance, Coaxial cable vs shielded twisted pair cables.

**Digital circuit radiation:** Differential radiation, Common mode radiation, controlling techniques for Differential & common mode radiation, EMC testing procedures.

### Unit III

**Shielding:** Near & Far fields, Characteristics & Wave impedance shielding effectiveness, Absorption loss, Reflection loss, composite absorption & reflection loss, Shielding with magnetic materials, effects of apertures, conductive windows, coatings, cavity resonance.

**Intrinsic noise sources:** Thermal noise, contact noise, shot noise & popcorn noise, Measuring random noise, Noise factor, Measurement of noise factor. Digital circuit Noise & layout, Power Distribution noise.

### Unit IV

**Electrostatic Discharge:** Static generation, human body mode, Static discharge and ESD protection in equipment design, Software & ESD protection, ESD vs EMC.

**Contact Protection:** Glow discharge, Arc Discharge, Loads with high inrush currents, contact protection fundamentals Contact protection networks for inductive loads and resistive loads.



## Unit V

**Balancing & filters:** Balancing, Power supply decoupling, Decoupling filters, High frequency decoupling, System bandwidth, Modulation and coding.

**Grounding:** safety grounds, Signal grounds, Single point ground systems, multipoint ground systems, Functional ground layout, Hardware grounds, ground loops, Grounding of cable shields, Guard shields, Guard meters.

**EMC applications:** RF& Transient Immunity, PCB layout & stack up

### Text books:

1. Henry W. Ott., “*Electromagnetic Compatibility Engineering*”, Revised Edition, John Wiley 2009.
2. Ravindra Arora, “*High Voltage insulation engineering*”, New age International Publication 1995.

### Reference books:

1. Henry ott., “*Noise reduction techniques in electronic systems*”, 2nd Edition, John Wiley 1988.

### Course Outcomes (COs):

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

1. Interpret on Estimation and Control of Electric Field Intensity. (PO 1, 2, 8, 10) (PSO 1, 2, 3)
2. Analyze the factors affecting EMC. (PO 1, 5, 6, 7, 10) (PSO 1, 2, 3)
3. Design a Cabling and Filtering network for various circuits to mitigate EMC issues. (PO 1, 2, 3, 4, 5, 8, 10) (PSO 1, 2, 3)
4. Recognize Shielding and methods of Grounding for different EMC applications. (PO 1, 2, 3, 4, 5, 8, 10) (PSO 1, 2, 3)
5. Justify the need of protection of equipments against ESD. (PO 1, 5, 6, 7, 10) (PSO 1, 2, 3)