Teaching Scheme and Syllabus

For

Bachelor of Technology

In Electrical Engineering

Honors in Electrical Engineering

Department of Electrical Engineering

Sardar Vallabhbhai National Institute of Technology

Honors in Electrical Engineering

Sr. No.	Subject Code	Subject Name	Scheme (Th-Tu-P)	Credits	Specific Note [If Any]
B. Tech./M.Sc., 4th Semester (Second Year) (Any one from following subjects)					
1	EE291	Modeling of electrical Machines	3-1-0	4	
2	EE292	Computer Methods for Power Systems	3-1-0	4	
3	EE293	Industrial Automation and Control	3-1-0	4	
B. Tech./M.Sc., 5th Semester (Third Year) (Any one from following subjects)					
4	EE391	Power Electronic Systems and Electrical Drives	3-1-0	4	
5	EE392	Restructuring and Deregulation of Power Systems	3-1-0	4	
6	EE393	Discrete-time Control Systems	3-1-0	4	
B. Tech (Electrical Engineering) , 6th Semester (Third Year) (Any one from following subjects)					
7	EE394	Flexible AC Transmission Controllers	3-1-0	4	
8	EE395	Optimal Control	3-1-0	4	
B. Tech (Electrical Engineering) , 7th Semester (Forth Year) (Any one from sr. no. 9 to 11 subject)					
9	EE491	Advanced Power Electronics	3-1-0	4	
10	EE492	Power System Transients	3-1-0	4	
11	EE493	Advanced Industrial Instrumentation	3-1-0	4	
12	EE4XX	Mini Project	0-0-4	2	

B. Tech. II year, Semester IV
MODELING OF ELECTRICAL MACHINES
(For B. Tech. in Electrical Engineering with honors)

L	T	P	Credit
3	1	0	04

EE291 **Scheme**

1. Course Outcomes (COs):

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

CO1	explain the basic principle of electrical machines based on principle of electromagnetic energy conversion
CO2	develop the mathematical model of DC machine
CO3	explain various reference frame theories for modeling electric machines
CO4	deduce the mathematical model of induction, synchronous and permanent magnet synchronous machines based on reference frame theory
CO5	analyze the performance of electric machines based on the derived mathematical machines
CO6	simulate various electric machines based on mathematical models

2. Syllabus

- **BASIC PRINCIPLE OF ELECTRIC MACHINE** **(05 Hours)**
  Review of Magnetic circuit and electromagnetics (Faraday's law, Ampere's law, Bio Savart's law, Kirchhoff law and Maxwell's equation (integral form and point form)), Principle of transformer action, Principle of Electromagnetic Energy Conversion, Elementary electric machine
- **DC MACHINE MODELLING** **(06 Hours)**
  Modeling of D.C. Machine (Separately Excited, shunt and series type), Linearization of machine equations, State-Space Modeling of the machine.
- **INDUCTION MACHINE MODELING** **(12 Hours)**
  Distributed Winding in AC Machinery, winding function, air gap mmf, rotating mmf, Flux linkage and Inductance, Stator and rotor voltage equation and torque equation in stator reference frame, Reference frame theory: Space phasor description, Derivation of induction motor modelling in rotor flux and stator flux reference frame, Derivation of steady state model.
- **PERMANENT MAGNET MACHINE MODELING** **(11 Hours)**
  Voltage and torque equation of surface mount permanent magnet machine in stator reference frame, Voltage and torque equation of surface mount permanent magnet machine in rotor reference frame, Derivation of steady state model.
- **SYNCHRONOUS MACHINE MODELING** **(11 Hours)**
  Voltage and torque equation of salient pole synchronous machine including damper winding in stator reference frame, Voltage and torque equation of salient pole synchronous machine including damper winding in rotor reference frame.

Total Hours: 45

3. Books Recommended:

1. P. C. Krause, Oreg Wasynczuk, Scott D. Sudhoff, "Analysis of Electric Machinery and drive systems", Wiley Interscience, 2nd Edition, 2010.
2. P. S. Bimbhra, "Generalized theory of Electrical M/C", Khanna Publication, 2000.
3. S. K. Sen, "Electrical Machinery", Khanna Pub., Delhi, 2012.
4. Mrittunjay Bhattacharya, "Electrical Machines: Modelling and Analysis", PHI, 2016.
5. R. Ramanujam, "Modelling and Analysis of Electrical Machines", Wiley, 2019.

B. Tech. II year, Semester IV
COMPUTER METHODS IN POWER SYSTEM
(For B. Tech. in Electrical Engineering with honors)

L	T	P	Credit
3	1	0	04

EE292 **Scheme**

1. Course Outcomes (COs):

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

CO1	illustrate various methods of solving linear system
CO2	apply various methods of solving non- linear system to power system problems.
CO3	apply various methods of solving sparse matrices to power system problems.
CO4	use various methods of numerical integration to solve differential equation pertaining to power system.
CO5	use modal analysis for small signal stability study of power systems.
CO6	Estimate states of the system using optimization techniques

2. Syllabus

- **SOLUTION OF LINEAR SYSTEMS** **(07 Hours)**
  Gaussian elimination, LU factorization with partial and complete pivoting, condition numbers and error propagation, relaxation methods, conjugate gradient methods.

- **SOLUTION OF NONLINEAR SYSTEMS** **(07 Hours)**
  Method to solve nonlinear system: Newton's method, Broyden's method, Finite difference method, Power system applications: Power flow, regulating transformers, Decoupled power flow, Fast Decoupled power flow, PV curves and continuation power flow, Three phase power flow.

- **SPARSE MATRIX SOLUTION TECHNIQUES** **(07 Hours)**
  Storage methods, sparse matrix representation, Ordering schemes: Scheme O, Scheme I, Scheme II, Other scheme, Power system applications.

- **NUMERICAL INTEGRATION** **(07 Hours)**
  explicit methods, implicit methods, One step methods, Multistep methods, fixed step methods, variable step methods, Stability and accuracy-analysis of numerical methods, stiff systems, step size selection, differential algebraic systems, Power system application: Transient stability analysis.

- **EIGENVALUE PROBLEMS** **(08 Hours)**
  Eigen value computations methods: QR algorithm, Power method, Arnoldi methods, Prony method. Power system applications: Modal analysis, participation factors, SSR analysis.
- **OPTIMIZATION** **(09 Hours)**
  Least squares optimization, Weighted Least square optimization, Steepest Descent algorithm, Newton's method. Power system applications: Optimal power flow, Linear and Nonlinear least square state estimation.

Total Hours: 45

3. Books Recommended:

1. Mariesa Crow, Computational Methods for Electric Power Systems, 2nd edition, Electric power engineering series, CRC Press, 2009.
2. S. A. Soman, S. A. Khaparde, and Shubha Pandit, Computational Methods for Large Sparse Power System Analysis, Kluwer Academic Publishers, 2012.
3. Stagg and El-Abiad, Computer Methods in Power System Analysis, McGraw Hill Series, International student Edition, 1968.
4. Reijer Idema and Domenico J. P. Lahaye, Computational Methods in Power System Analysis, Volume 1, Atlantis Press, Atlantis Studies in Scientific Computing in Electromagnetics. 2014.
5. J. Arrillaga and C. P. Arnold, Computer Analysis of Power Systems, John Wiley & Sons Ltd, 1990

B.Tech. II year, Semester IV

EE293 Industrial Automation and Control

(For B. Tech. in Electrical Engineering with Honors)

L	T	P	Credit
3	1	0	04

---

1. Course Outcomes (Cos):

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

CO1	Classify various types of Automation
CO2	Explain working of various sensors and actuators of Industrial automation
CO3	Discuss various control system configurations
CO4	Develop ladder logic program using PLC
CO5	Discuss DCS, SCADA and case study of Industrial automation

2. Syllabus:

- **INTRODUCTION TO INDUSTRIAL AUTOMATION AND CONTROL (04 Hours)**
  Need of Industrial Automation and Control, Advantages and disadvantages of automation, application, classify various types of Automation.

- **SENSORS AND ACTUATORS (08 Hours)**
  Discrete and Analog sensors, potential free and transistor based output, sensor selection criterions for industrial automation. Electromagnetic Actuator, Relay and Contactors, pneumatic actuators, Hydraulic actuators.
- **CONTROL SYSTEM CONFIGURATIONS (05 Hours)**
  On/Off control, Open loop control, Feedback control, Control with PWM, Various controller for Industrial automation application.

- **PROGRAMMABLE LOGIC CONTROLLER (PLC) (08 Hours)**
  Introduction, architecture of PLC, Types of PLC, Scan time, scan cycle, I/0 connections and protections, communications of PLC with PC, input and output modules connections with sensors and actuators.

- **PROGRAMMING PLC (12 Hours)**
  Software Environment and Programming of PLCs, Ladder logic diagrams, development of ladder logic using Bit logic, timer and Counter Instructions. Compare and Mathematical instructions. Handling of Analog Inputs with PLC.
- **DCS and SCADA (04 Hours)**
  Introduction, need, features of DCS and SCADA.

- **CASE STUDY (04 Hours)**
  Development of ladder logic for conveyor belt system.

(45 Hours)

3 Books Recommended:

1. John Webb, Programmable Logic Controllers Principles & Applications, Prentice Hall of India, 1st Edition, 2013.
2. Principles of Industrial Instrumentation and Control Systems by Chennakesava R Alavala, Cenegage Learing Publishers, 2009.
3. Kevin Co
4. D. Patranabis, Principles of Process Control, Tata Mcgraw Hill, 3rd Edition, 2017.

5. Industrial Automation: Circuit Design and Components by Pessen and David W, John Wiley & Sons, 1989

B. Tech. III year (Electrical Engineering with Honors), Semester- V

Power Electronics Systems and Electrical Drives

L	T	P	CREDIT
3	1	0	04

EE391 **Scheme**

1. **Course Outcomes (Cos):**

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

CO1	Explain the basic concept of PESs
CO2	Apply various power electronic converters to DC and AC drives
CO3	Devise different control techniques for DC and AC drives
CO4	Compare the performance of various methods of drive control
CO5	Decide the suitability of PESs for applications in emerging areas.

2. **Syllabus:**

- **INTRODUCTION TO DRIVES AND DC DRIVES** **(10 Hours)**

Introduction to drives, Fundamental torque equation, speed-torque convention and multi quadrant operation, dynamics of motor load combination, nature and classification of load torque, calculation of acceleration time in transient operation, acceleration time for specific nature of motor and load torque, stability of electrical drives, Selection of Motor Power Rating.

DC Drives: Phase controlled DC-Drives: Operation with continuous and discontinuous modes, Supply Harmonics, Power Factor and Ripple in motor current; Chopper Controlled DC Drives, Sources current harmonics in chopper, Converter Ratings and closed loop control scheme.

- **AC DRIVES** **(12Hours)**

Induction Motor Drives: Speed control techniques: Stator voltage control, Variable frequency control, Open loop V/f control, Static rotor resistance control and Slip power recovery control schemes, Slip compensation technique.

Synchronous Motor Drives: Self-controlled schemes, Variable frequency control of multiple synchronous motor, Permanent magnet AC motor drives, Control of Brushless DC Motor Drives and its applications.

- **ADVANCED POWER ELECTRONICS CONVERTERS** **(10 Hours)**

Isolated DC-DC Converters: Fly-back, Forward, Push-Pull converter, Half and Full bridge converter, topologies, control and design; Active Front End Converter and its control for unity power factor operation; Multilevel Inverters; Modulation techniques: SPWM and SVM, Design of Inductor and Transformer.

- **APPLICATIONS OF POWER CONVERTERS** **(10 Hours)**

Applications of DC-DC converters for MPPT techniques, Electric Vehicles (EVs) and Power Supply Design; Uninterruptible Power Supply; Application of PESs in Distribution system for Power Conditioning, PESs applications in Distributed Energy System such as Solar, Diesel Engine, Wind based isolated and grid connected system.

Tutorials will be conducted separately for 14 hours **Total Hours: 45**

3. List of Experiments:

1. Study of Speed Control of DC Shunt Motor Using Single Phase Fully Controlled Converter.
2. Controlling of DC Motor with Single Phase Dual Converter.
3. Study of Speed Control of Three Phase AC Induction Motor (V/F Control).
4. Experimental investigation of a 5 HP Induction Motor Drive.
5. Study of DSP Controlled Induction Motor Drive.
6. Study of DSP Controlled BLDC Motor Drive.
7. Simulation of V/F control of 3 phase induction motor using MATLAB.
8. Simulation of speed control of three phase induction motor using stator voltage control (AC Voltage controller) in MATLAB.

4. Books Recommended:

1. Rashid M. H., "Power Electronics Circuits, Devices, and Applications", Prentice-Hall of India Pvt. Ltd., New Delhi, 4th Edition, 2014.
2. Ned Mohan et al, "Power Electronics: Converters, Applications, and Design", John Wiley & Sons. Inc., 3rd Edition, 2003.
3. Bin Wu, High-Power Converters and AC Drives, A John Wiley and Sons, Inc., Publication, 2nd Edition, 2017.
4. B. K. Bose, "Modern Power Electronics & AC Drives", Pearson, 1st Edition, 2002.
5. Dubey G.K, "Fundamentals of Electrical Drives", Narosa Publishing House, 2nd Edition, 2002.
6. R. Krishnan "Electric motor drives Modeling, Analysis and Control" PHI-India, 1st Edition, 2015.

B. Tech. III year (Electrical Engineering with Honors), Semester- V	L	T	P	CREDIT
Restructuring and Deregulation of Power System	3	1	0	04

EE392 **Scheme**

1. Course Outcomes (Cos):

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

CO1	Explain the basics and benefits of restructuring and deregulations
CO2	Evaluate the market scenario and completion in deregulated environment
CO3	Judge the pricing and agreements associated with deregulation policies.
CO4	Explore the contingency and ancillary service management restructured and deregulated system.
CO5	Explore the impact of availability and unavailability in terms of reliability indices

2. Syllabus:

- **DEREGULATION OF THE ELECTRICITY SUPPLY INDUSTRY** **(06 Hours)**
  Deregulation, Reconfiguring Power systems, unbundling of electric utilities, Background to deregulation and the current situation around the world, benefits from a competitive electricity market, after-effects of deregulation.
- **POWER SYSTEM OPERATION IN COMPETITIVE ENVIRONMENT** **(11 Hours)**
  Role of the independent system operator, Operational planning activities of ISO: ISO in Pool markets, ISO in Bilateral markets, Operational planning activities of a GENCO: Genco in Pool and Bilateral markets, market participation issues, competitive bidding.
- **TRANSMISSION OPEN ACCESS AND PRICING ISSUES** **(08 Hours)**
  Power wheeling, Transmission open access, pricing of power transactions, security management in deregulated environment, congestion management in deregulation.
- **ANCILLARY SERVICES MANAGEMENT** **(08 Hours)**
  General description of some ancillary services, ancillary services management in various countries, reactive power management in deregulated electricity markets
- **RELIABILITY AND DEREGULATION** **(12 Hours)**
  Reliability analysis: interruption criterion, stochastic components, component models, calculation methods, Network model: stochastic networks, series and parallel connections, minimum cut sets, reliability costs, Generation, transmission and distribution reliability, Reliability and deregulation: conflict, reliability analysis, effects on the actual reliability, regulation of the market.

Tutorials will be conducted separately for 15 hours **Total Hours: 45**

3. Books Recommended:

1. K. Bhattacharya, MHT Bollen and J.C Doolder, Operation of Restructured Power Systems, Kluwer Academic Publishers, USA, 2001.
2. Lei Lee Lai, Power System Restructuring and Deregulation, John Wiley and Sons, UK. 1st Edition, 2001.
3. Fred I Denny and David E. Dismukes, Power System Operations and Electricity Markets, CRC Press, LLC, 1st Edition, 2002.
4. Mohammad Shaidehpur, Muwaffaq Alomoush, Restrctured electrical Power Systems, Operation, Trading and Volatility, Marcel Dekker Publications.
5. Xiao Ping Zhang, Restructured electrical Power Systems with equilibrium Models, John Wiley & Sons, 1st Edition, 2010.

B. Tech. III year (Electrical Engineering with Honors) **Semester- V**	**L**	**T**	**P**	**CREDIT**
Discrete-time Control Systems	**3**	**1**	**0**	**04**

EE393 **Scheme**

1. **Course Outcomes (Cos):**

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

CO1	Classify various Discrete-Time control systems
CO2	Analyze the Discrete-Time control systems with Z transformation
CO3	Design Discrete-Time control systems and to assess the stability of DTCS
CO4	Obtain and analyze State-space representations of discrete-time systems
CO5	Design various discrete-time systems control schemes

2. **Syllabus:**

- **INTRODUCTION TO DISCRETE-TIME CONTROL SYSTEMS** **(04 Hours)**

Introduction, digital control systems, quantizing and quantization error, data acquisition, conversion, and distribution systems.

- **THE Z TRANSFORMATION** **(08 Hours)**

The z transform, transforms of elementary functions, important properties and theorems of the z transform, the inverse z transform, z transform method for solving difference equations.

- **Z-PLANE ANALYSIS OF DISCRETE-TIME CONTROL SYSTEMS** **(08 Hours)**

Impulse sampling and data hold, obtaining the z transform by the convolution integral method, reconstructing original signals from sampled signals, the pulse transfer function, realization of digital controllers and digital filters.

- **DESIGN OF DISCRETE-TIME CONTROL SYSTEMS** **(10 Hours)**

Introduction, mapping between the S plane and the z plane, stability analysis of closed-loop systems in the z plane, transient and steady-state response analysis, design based on the root-locus method, design based on the frequency-response method, analytical design method.

- **STATE-SPACE ANALYSIS** **(10 Hours)**

State-space representations of discrete-time systems, solving discrete-time state-space equations, pulse-transfer-function matrix, discretization of continuous-time state-space equations, Lyapunov stability analysis.

- **POLE PLACEMENT AND OBSERVER DESIGN** **(05 Hours)**

Controllability, observability, useful transformations in state-space analysis and design, via pole placement, state observers, servo systems.

Tutorials will be conducted separately for 15 hours **Total Hours: 45**

3. **Books Recommended:**

1. K. Ogata, Discrete Time Control System, Pearson Education, Inc., 2nd Edition, 2015.
2. B. C. Kuo, Discrete Data Control System, Prentice-Hall, 2nd Edition, 1992.

3. I. J. Nagrath and M. Gopal, Control System Engineering" New Age International Publishers, 3rd Edition, 2001.
4. M. Gopal, Digital control System, McGraw-Hill Education, 4th Edition, 2017.
5. B. C. Kuo, Automatic Control System, Prentice Hall of India, 7th Edition, 1995.

B. Tech. III year (Electrical Engineering with Honors)
Semester- VI

Flexible AC Transmission Controllers

L	T	P	CREDIT
3	1	0	04

EE394 **Scheme**

1. **Course Outcomes (Cos):**

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

CO1	Explain the basic principle of power transmission and reactive power control.
CO2	Analyze shunt compensation and its requirement.
CO3	Evaluate series compensation and its requirement
CO4	Analyze of shunt-series compensation and its requirement.
CO5	Design of controllers for FACTS devices.

2. **Syllabus:**

- **LOAD COMPENSATION** **(08 Hours)**

Requirement and objectives of load compensations, Practical considerations, power factor and voltage regulations, balancing of unsymmetrical loads, Active filters: : Principle of operation, Analysis, Configurations, Control system, Applications.

- **REACTIVE POWER COMPENSATION** **(08 Hours)**

Analysis of uncompensated AC line, Passive reactive power compensation, Compensation by a series capacitor connected at the mid-point of the line, Effect on Power Transfer capacity, Compensation by STATCOM and SSSC

- **STATIC SHUNT COMPENSATORS** **(10 Hours)**

Static Var Compensators (TCR, FC-TCR, TSC-TCR): Principle of operation, Analysis, Configurations, Control system, Applications, protection aspect. STATCOM: Principle of operation, Analysis of six pulse and multi-pulse converters, Control systems, Applications.

- **STATIC SERIES COMPENSATORS** **(10 Hours)**

Concept of controlled series compensation, (TCSC, GCSC): Principle of operation, Analysis, Configurations, Control system, Applications. SSSC: Principle of operation, Analysis, Configurations, Control system, Applications.

- **COMBINED COMPENSATORS** **(09 Hours)**

(UPFC,IPFC) Principle of operation, Analysis, Configurations, Control system, Applications.

Tutorials will be conducted separately for 15 hours **Total Hours: 45**

3. **Books Recommended:**

1. K. R. Padiyar, FACTS Controller in Power Transmission and Distribution, New Age international, 1st Edition, 2007.
2. N.G. Hingorani, Understanding FACTS, IEEE Press, Standard Publishers Distributor, 2001.
3. T. J. E. Miller, Reactive Power Control in Electric Systems, John Wiley, 2010.
4. R. Mathur, N. Mohan and R. K. Varma, Thyristor–based FACTS Controllers for Electrical Transmission System, Wiley Inter-Science, 2011.
5. Acha E., Agelidis V. G., Anaya-Lara O., T.J.E. Miller, Power Electronics Control in Electrical System, Newnes Power Engineering Series, 2002.

B. Tech. III year (Electrical Engineering with Honours in Control and Automation), Semester- VI	**L**	**T**	**P**	**CREDIT**
Optimal Control	**3**	**1**	**0**	**04**

EE395 **Scheme**

1. Course Outcomes (Cos):

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

CO1	Formulate optimal control problem
CO2	Solve optimal control problems using calculus of variation approach
CO3	Apply Linear Quadratic Regulator for the state space control
CO4	Formulate robust control problem
CO5	Solve H_2 and H_∞ control problems

2. Syllabus:

- **INTRODUCTION TO OPTIMAL CONTROL** **(10 Hours)**

  Introduction, Optimization, Optimal control, Plant model, Performance index, Constraints, Formulating an optimal control problem with examples.

- **CALCULUS OF VARIATIONS** **(10 Hours)**

  Concept of functional, Optimum of a functional, The basic variational problem Fixed end point problem, Free end point problem, Extrema of functionals with constraints, Variation approach to optimal control systems, Hamiltonian approach.

- **LINEAR QUADRATIC OPTIMAL CONTROL SYSTEMS** **(25 Hours)**

  Finite time linear quadratic regulator problem formulation, Analytical solution of Matrix Differential Riccati Equation (Similarity transformation approach), Infinite horizon regulator problem, Analytical solution of the Algebraic Riccati equation, Frequency domain interpretation of LQR, LQR with a specified degree of stability, Time optimal control systems, Problem formulation, Solution of the time optimal control system.

Total Hours: 45

3. Books Recommended:

1. Donald E. Kirk, Optimal Control: an introduction, Dover Publications, 2006.
2. DesineniSubbaram Naidu, Optimal Control Systems, CRC Press, 2003.
3. Geir E. Dullerud, Fernando Paganini, A Course in Robust Control Theory, Springer, 2010.
4. K. Zhou, J.C. Doyle and K. Glover, Robust & Optimal Control, Prentice Hall Inc. NY 1998.

B. Tech. IV year(Electrical Engineering with Honors), Semester- VII

Advanced Power Electronics

L	T	P	CREDIT
3	1	0	04

EE491 **Scheme**

1. **Course Outcomes (Cos):**

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

CO1	Distinguish the power devices and their driver circuits
CO2	Analyze the CCM and DCM operation switched-mode dc-dc converters
CO3	Estimate the power quality indices and improve it using power electronics
CO4	Apply power electronics for field applications
CO5	Use simulation tools like PSIM and MATLAB

2. **Syllabus:**

- **MODERN SEMICONDUCTOR DEVICES (04 Hours)**

Power Diodes, Power BJT, Power MOSFETs, Thyristor, GTOs, IGBT, MCT – Basic characteristics and controlling, Emerging devices and circuits, Power Integrated Circuits.

- **PRACTICAL DESIGN CONSIDERATION (06 Hours)**

Gate and Base drive circuits – Design Consideration for different Devices, DC-Coupled Circuits, Isolated Drive Circuits, and Protection in Drive Circuits. Snubber circuits Designing, Temperature control and Heat sink design consideration, Design of Magnetic Components.

- **DC-DC SWITCHED MODE CONVERTERS (08 Hours)**

Introduction, Step-Down (Buck) Converter, Step-Up (Boost) Converter, Buck-Boost Converter, Cuk Converter, Control Principles, Applications of DC-DC Converters.

- **SWITCHING DC POWER SUPPLIES (08 Hours)**

Introduction, Linear Power Supplies, Switching Power Supplies, DC-DC Converter with isolation – Fly-back converters, Half Bridge Converters, Full Bridge converters, Forward Converter, Push-pull converter, Protection, Isolation and Design criteria for SMPS.

- **STATIC POWER ELECTRONICS APPLICATIONS (06 Hours)**

Electronic Ballasts, UPSs, Power Electronics in Capacitor Charging Applications, Power Electronics for Renewable Energy Sources HVDC Transmission, Automotive Applications of Power Electronics.

- **POWER ELECTRONICS IN POWER QUALITY (08 Hours)**

Power Quality, Reactive Power and Harmonic Compensation, IEEE Standards, Static VAR Compensator, Thyristor Controlled Reactor (TCR), Thyristor Switched Capacitors (TSC), Principle of Active Filters, Types of Active Power Filters, Shunt Active Power Filters, Series Active Power Filters.

- **SIMULATION OF POWER ELECTRONIC CONVERTERS AND VARIOUS CONTROL STRATEGIES USING PSIM SOFTWARE (05 Hours)**

Introduction, Use of Simulation Tools for Design and Analysis, Simulation of Power Electronics Circuits with , PSIM, State-Space Averaged Models and their simulation using PSIM software.

Tutorials will be conducted separately for 15 hours **Total Hours: 45**

3. **Books Recommended:**

1. Rashid, M. H., Power Electronics Handbook, Elsevier Academic Press, 2nd revised Edition, 2006
2. Ned Mohan, Tore M. Undeland and William P. Robbins, Power Electronics Conve Applications,
   and Design, John Willey & Sons, Inc., 2nd Edition, 1995.
3. Agrawal, J. P., Power electronic systems: Theory and design, Addison Wesley Longman (Singap Pte. Ltd. New Delhi, 2001.
4. Robert W. Erickson and Dragan Maksimovic, Fundamentals of Power Electronics, Springer international Edition.
5. L. Umanand, Power Electronics – Essentials & Applications, Wiley India Pvt. Ltd, 2009.

B. Tech. IV year(Electrical Engineering with Honors),
Semester- VII
Power System Transients

L	T	P	CREDIT
3	1	0	04

EE492 **Scheme**

1. **Course Outcomes (Cos):**
At the end of the course students will be able to:

CO1	Recall the fundamentals of transient analysis of RLC circuit and circuit breaker operation
CO2	Identify the source and characteristics of lightning, switching, and temporary over voltages
CO3	Interpret the concept of travelling wave propagation on transmission lines
CO4	Analyze switching transients in electric equipment like transformer, generator and motor
CO5	Evaluate different protection schemes for power system equipment against travelling wave

2. **Syllabus:**

- **OVERVOLTAGES IN POWER SYSTEMS** **(13 Hours)**
Transient over voltages due to lightning, Theory of ground wires, Direct stroke to a tower, Effect of reflection up and down the tower, Tower grounding and counterpoises, Switching transients, Single and double frequency transients, Abnormal switching transients, Capacitance switching, Kilometric fault, Line dropping and load ejection, Closing and reclosing of lines, High charging currents, Over voltages induced by faults, Ferro-resonance, Switching transients in integrated systems, Peaking switching over voltages in EHV lines and cables.
- **TRAVELLING WAVES IN TRANSMISSION LINES** **(13 Hours)**
Origin and nature of power system transients, Traveling waves on transmission lines, General wave equation, Attenuation and distortion of waves, Reflection and refraction of traveling waves at different line terminations, Bewley Lattice Diagram, Traveling waves in multi-conductor systems, Transition points on multi-conductor circuits.
- **PROTECTION AGAINST TRAVELLING WAVES** **(06 Hours)**
Rod gap, Arcing Horn, Lightning Arresters, Surge Absorber, Insulation Coordination.
- **TRANSIENT IN TRANSFORMERS AND ROTATING ELECTRICAL MACHINES** **(13 Hours)**
High frequency transients and voltage distribution in windings of transformer and rotating electrical machines, Surge impedance.

Tutorials will be conducted separately for 15 hours **Total Hours: 45**

3. **Books Recommended:**

1. I.V. Begley, Traveling waves in Transmission Systems, John Wiley (1933, 51), Dover.
2. R. Rudenberg., Electric Stroke waves in Power System, Harvard Unive rsity Press and Cambridge, Massachusetts.
3. Allan Greenwood, Electric Transients in Power Systems, Wiley Inter science 2nd Edition, 2010.
4. C.S. Indulkar and D.P. Kothari, Power System Transients, A Statistical Approach, Prentice Hall of India Pvt. Ltd., New Delhi. 110001, 2nd Edition, 2010.
5. V.A. Venikov, Transient phenomena in Electrical Power Systems, Pergamon Press, London, 2014.

B. Tech. IV year(Electrical Engineering with Honors), Semester- VII

Advanced Industrial Instrumentation

L	T	P	CREDIT
3	1	0	04

EE493 **Scheme**

1. **Course Outcomes (Cos):**

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

CO1	Classify Various types of Digital Measurement techniques and explain working principle of various types of digital instruments
CO2	Explain working principle of various sensors used in industrial applications
CO3	Understand the working principle of various types of Instrumentation amplifiers, multiplexers, demultiplexers, converters and data acquisition systems
CO4	Understand the basic architecture of PLC and its functionalities
CO5	Develop Ladder logic diagrams/ programs for PLC for various industrial applications

2. **Syllabus:**

- **DIGITAL MEASUREMENT TECHNIQUES** **(10 Hours)**

Digital measurement techniques for voltage, current, power, energy, resistance, capacitance and loss angle (TAN ∂), impedance and quality factor, Frequency counter, period duration meter, pulse width meter, frequency ratio meter, error in digital instruments

- **SENSORS** **(10 Hours)**

Principle and applications of photosensitive, fiber optic sensors, Ultrasonic Sensors, Synchro, Oxygen Sensors and Smart Sensors.

- **SIGNAL CONDITIONING, DATA ACQUISITION AND CONVERSION** **(10 Hours)**

Instrumentation amplifiers, isolation techniques, sample and hold circuits, multiplexers and demultiplexers, digital to analog converters, data acquisition systems, encoders, grounding and shielding techniques.

- **AN OVER VIEW OF PLC** **(06 Hours)**

Introduction, definitions and history of PLC, manufacturing and assembly processes, PLC advantages and disadvantages, overall PLC system, CPU, PLC, input and output modules, program recording devices

- **PROGRAMMING OF PLC** **(09 Hours)**

Ladder diagrams, programming ON/OFF inputs to produce ON/OFF outputs, digital gate logic and contact coil logic, creating ladder diagrams from process control descriptions ,register, timer function, counter function, arithmetic functions, comparison functions

Tutorials will be conducted separately for 15 hours **Total Hours: 45**

3. **Books Recommended:**

1. Helfrick A D; Cooper W. D. , "Modern electronic Instrumentation and Measurement techniques", PHI ,Edition 1997
2. Rangan; Sarma; Mani , "Instrumentation devices and systems", TMH , 2nd edition
3. Doebelin E.O, "Measurement Systems - Application and Design", Fourth edition, McGraw-Hill, New York, 1992.
4. T.S Rathore, "Digital Measurement Technique", Narosa publishing house, 2nd edition

5. Curtis Johnson, “Process control instrumentation technology”, PHI, 6th edition
6. John. W .Webb Ronald A Reis , “Programmable Logic Controllers - Principles and Applications”, Fourth edition, Prentice Hall Inc., New Jersey, 1998.
7. D. Patranabis, “Principle of Industrial Instrumentation”, Tata McGraw Hill, 2nd Edition.
8. Petruzella, “Industrial Electronics”, McGraw-Hill, ISE Editions