



**UNIVERSITY OF ENGINEERING & MANAGEMENT**  
**Good Education, Good Jobs**

**Syllabus and Course Outline**

**M. TECH.**  
**IN**  
**POWER ELECTRONICS & DRIVES**

**BATCH: 2020-2022**

**DEPARTMENT OF ELECTRICAL ENGINEERING**  
**UNIVERSITY OF ENGINEERING & MANAGEMENT**  
**JAIPUR**

**M.Tech: Power Electronics & Drives**

Department of Electrical Engineering

**1<sup>st</sup> Semester**

**Theory**

Sl. No.	Code	Paper	Contact periods per week			Total contact hours	Credit
			L	T	P		
1	EMM-101	Advanced Engineering Mathematics	3	1	0	4	4
2	PEM-101	Advanced Power Electronics	3	1	0	4	4
3	PEM-102	Electric Drive & Their Control	4	0	0	4	4
4	PEM-103	Elective – I	4	0	0	4	4
5	PEM-104	Elective - II	4	0	0	4	4

**Practical**

Sl. No.	Code	Paper	Contact periods per week			Total contact hours	Credit
			L	T	P		
1	PEM-191	Laboratory I	0	0	3	3	2
2	PEM-192	Laboratory II	0	0	3	3	2
3	PEM-193	Seminar I	0	0	3	3	2
Total of Practical/ Sessional						9	6
Total of Semester			18	2	9	29	26

**Elective I**

- i. Linear System Theory PEM 103(a)
- ii. Power System Planning and Reliability - PEM 103 (b)
- iii. Embedded System Design – PEM 103 (c)

**Elective II**

- i. Optimization Techniques - PSM 104 (a)
- ii. Soft Computing Technique - PSM 104 (b)
- iii. Digital Signal Processing - PSM 104 (c)
- iv. Object Oriented Programming - PSM 104 (d)

**M.Tech: Power Electronics & Drives**

Department of Electrical Engineering

**2<sup>nd</sup> Semester**

**Theory**

Sl. No.	Code	Paper	Contact periods per week			Total contact hours	Credit
			L	T	P		
1	PEM-201	Power Conversion Techniques	3	1	0	4	4
2	PEM-202	Power System Instrumentation	3	1	0	4	4
4	PEM-203	Industrial Control Electronics	4	0	0	4	4
4	PEM-204	Elective – III	4	0	0	4	4
5	PEM-205	Elective - IV	4	0	0	4	4

**Practical**

Sl. No.	Code	Paper	Contact periods per week			Total contact hours	Credit
			L	T	P		
1	PEM-291	Laboratory III	0	0	3	3	2
2	PEM-292	Laboratory IV	0	0	3	3	2
3	PEM-293	Seminar II	0	0	3	3	2
		Total of Practical/ Sessional				9	6
	Total of Semester		17	3	9	29	26

**Elective III**

- i. Intelligent Control Techniques - PEM 204(a)
- ii. Integrated Energy Systems - PEM 204 (b)
- iii. Digital signal processing & applications - PSM 204 (c)

**Elective IV**

- i. Power Quality - PEM 205(a)
- ii. HVDC Transmission - PEM 205(a)
- iii. Renewable Power Generation and Control – PEM 205 (c)

**M.Tech: Power Electronics & Drives**

Department of Electrical Engineering

**3<sup>rd</sup> Semester**

**Theory**

Sl. No.	Code	Paper	Contact periods per week			Total contact hours	Credit
			L	T	P		
1	EMM-301	Introduction to Management	4	0	0	4	4
2	PEM-301	Elective V	3	1	0	4	4
<b>Practical/ Sessional</b>							
Sl. No.	Code	Paper	Contact periods per week			Total contact hours	Credit
			L	T	P		
1	PEM-391	Pre-submission Defense of Dissertation	0	0	0	0	4
2	PEM-392	Dissertation (Part I)	0	0	0	20	10
		Total of Sessional				20	14
	Total of Semester		17	3	9	28	22

**4<sup>th</sup> Semester**

<b>Sessional</b>							
Sl. No.	Code	Paper	Contact periods per week			Total contact hours	Credit
			L	T	P		
1	PEM-491	Dissertation (Completion)	0	0	0	24	14
2	PEM-492	Post submission defense of Dissertation	0	0	0	0	8
3	PEM-294	Comprehensive Viva-Voce	0	0	0	0	4
	Total of Semester					24	26

**Elective V**

- i. Flexible AC Transmission Systems- PEM 301 (a)
- ii. Applications of Power Electronics in Power Systems- PEM 301 (b)
- iii. PWM Converters and Applications- PEM 301(c)

# ADVANCE POWER ELECTRONICS

## PEM 101

### L-T-P=3-1-0

#### Course Outcomes (CO):

Upon successful completion of this course, students should be able to:

**CO1:** To introduce different techniques of dealing with sparse matrix for large scale power systems.

**CO2:** To impart in-depth knowledge on different methods of power flow solutions.

**CO3:** To apply energy function method for analysis of transient stability in power system.

**CO4:** To Illustrate different numeric al integration methods and factors influencing transient stability.

#### Mapping of Course Outcomes (CO) and Program Outcomes (PO):

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓		✓		✓	✓					✓	
CO2	✓		✓		✓	✓			✓			
CO3	✓		✓					✓	✓	✓	✓	
CO4	✓		✓			✓	✓					✓

#### Course Contents:

##### Unit 1

Phase Controlled Converters: Performance measures of single and three-phase converters and Semi converters with discontinuous load current for R, RL and RLE loads. Effect of source inductance for single and three-phase converters.

##### Unit 2

**Choppers:** Basic of choppers configurations, Steady state analysis of different type a Chopper-Minimum and Maximum Currents, Ripple and average load current. Commutation in Chopper Circuits.

##### Unit 3

**Inverters:** Analysis of inverters and its characteristics of Performance parameters, voltage control of different inverters with including three phase inverters-Sinusoidal PWM, Third

Harmonic PWM, 60 degree PWM and 120 degree PWM and Space Vector Modulation, Harmonic reductions.

#### **Unit 4**

**AC Voltage Controllers:** principle of integral cycle control, Single, Three Phase AC Controllers and bi-directional controllers with resistive load. AC Voltage Controller with PWM Control.

#### **Unit 5**

**Cyclo-converters:** Basic of cyclo-converters, output equation, control circuit, Reduction in Output Harmonics. Single phase and three phase cyclo-convertors, Matrix Converter, step up and step down cyclo-converter.

#### **Recommended Books: -**

1. *P.S Bimbhra: Power electronics, Khanna Publishers.*
2. *M.H. Rashid: Power Electronics, Circuits Devices and applications, prentice-Hall, 1988.*
3. *V Subrahmanysm: Power Electronics, New Age Inc.Publishers, New Delhi.*
4. *P.C. Sen: Power Electronics, Tata McGraw-Hill, India.*
5. *C W Lander Power Electronics, Mc Graw-Hill.*
6. *M D Singh and KB Khanchandani Power Electronics, TMH Publishing Company, New Delhi.*

## **ELECTRIC DRIVES AND THEIR CONTROL**

**PEM 102**

**L-T-P=4-0-0**

### **Course Outcomes (CO):**

Upon successful completion of this course, students should be able to:

**CO1:** Acquire the knowledge of selection of drives as per practical operational industrial requirement.

**CO2:** Apply their knowledge to prepare control schemes as per different types of motors used in industries

**CO3:** Estimate & solve harmonic and power factor related problems in controlling AC and DC drives.

**CO4:** Acquire the knowledge of Characteristic of dc motors, three phase induction motors and synchronous motors.

### **Mapping of Course Outcomes (CO) and Program Outcomes (PO):**

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓		✓	✓						
CO2	✓	✓	✓		✓	✓			✓			
CO3	✓	✓	✓					✓	✓			
CO4	✓	✓	✓			✓	✓					

### **Course Contents:**

#### **Unit-1 CHARACTERISTICS OF ELECTRIC MOTORS:**

Characteristic of dc motors, three phase induction motors and synchronous motors.

#### **Unit-2 DYNAMICS OF ELECTRIC DRIVES:**

Fundamental torque equations, speed-torque conventions and multi-quadrant operation, equivalent values of drive parameters, components of load torques, nature and classification of load torques, calculation of time and energy loss in transient operation, steady state stability, load equalization.

#### **Unit-3 INDUCTION DRIVES:**

Induction motor drives: Basic principle of operation, stator voltage control, rotor voltage control, frequency control, voltage and frequency control, current control. Voltage, current and frequency control. Close-loop control.

#### **Unit-4 SYNCHRONOUS DRIVE:**

Synchronous motor drives: Cylindrical rotor, salient pole, reluctance, permanent magnet and switch reluctance motors. Close loop control of synchronous motors. Brushless dc and ac drives.

#### **Unit-5 DC DRIVES:**

study of efficiency, power factor, size and cost starting and speed control of motors. Electric braking, Plugging, Rheostatic braking, regenerative braking. Behaviour of motor during starting, acceleration, braking and reversing operations. Speed-time relations, Load equalization. Use of flywheels. Determination of motor rating for intermittent loads. Drives for machine tools, lift and cranes, paper mills, printing machinery, rolling for intermittent loads.

#### **TEXT/REFERENCES:**

1. G K Dubey Fundamentals of Electrical Drives, Narosa Publishing House, New Delhi, 1995.
2. V Subrahmanyam: Thyristor control of electric Drives, Tata McGraw Hill, New Delhi, 1988.
3. V Subrahmanyam: Electric Drives-Concepts and Applications, Tata McGraw Hill, New Delhi.
4. S K Pillai: A first course on electrical Drives, Wiley Eastern limited, India.
5. B K Bose: Power electronics and A. C. Drives, Prentice Hall.

# LINEAR SYSTEMS THEORY

PEM 103

L-T-P=4-0-0

## Course Outcomes (CO):

Upon successful completion of this course, students should be able to:

**CO1:** Ability to represent the time-invariant systems in state space form as well as analyze, whether the system is stabilizable, controllable, observable and detectable.

**CO2:** Ability to design state feedback controller and state observers

**CO3:** Design a suitable compensator (lead/lag/lead-lag) for the given system

**CO4:** To Illustrate different numerical integration methods and factors influencing transient stability.

## Mapping of Course Outcomes (CO) and Program Outcomes (PO):

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓				✓	✓					✓	
CO2	✓	✓	✓		✓	✓			✓			
CO3	✓	✓	✓					✓	✓		✓	
CO4	✓		✓			✓	✓					✓

## Course Contents:

### Unit 1

**Linear spaces**, linear independence, linear operators, inverse and adjoint of an operator, boundedness, eigenvalues & eigenvectors of an operator, generalized eigenvectors, Functions of a square matrix, range and null space, Concepts of Norms.

### Unit 2

**Input-output and state variable description of systems**, Solution of state equation, properties of state transition matrix, Stability of linear systems, Lyapunov stability, positive and bounded realness, Absolute stability.

### Unit 3

**Controllability and Observability**, grammians, duality, Kalman decomposition, Hidden modes, stabilizability and detectability, Elementary transformations, column & row degrees.

#### **Unit 4**

**Smith-McMillan form**, Transmission and invariant zeros, Rank properties, Singular values, SVD, Functional spaces of rational matrices  $RH_\infty$ ,  $RH_2$ . Linear fractional representation of systems, Basic linear fractional transformations.

#### **Unit 5**

**Model Reduction**, time-domain and frequency domain methods, balanced realization approach, Singular perturbation approach. Linear state feedback, output injection and observers.

#### **Recommended Books**

1. W.J. Rugh, "Linear System Theory", Prentice-Hall Int. Inc. N.J.
2. T. Kailath, "Linear Systems", Prentice Hall Inc., N.J. 1980
3. F.M. Callier & C.E. Desoer, "Linear System Theory", Narosa Publications, 1991.
4. C.T. Chen, "Linear System Theory & Design", Oxford University Press, 1984.

## **ADVANCE POWER ELECTRONICS LAB**

**PEM 191**

**L-T-P=0-0-3**

### **Course Outcomes (CO):**

Upon successful completion of this course, students should be able to:

CO1: Ability in understanding semi and full converters.

CO2: Know-how of control mechanism utilized in DC-DC converters.

CO3: Proficiency in understanding inverters using semiconductor devices.

CO4: Competency in Designing AC-AC converters.

### **Mapping of Course Outcomes (CO) and Program Outcomes (PO):**

<b>CO</b>	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>	<b>PO6</b>	<b>PO7</b>	<b>PO8</b>	<b>PO9</b>	<b>PO10</b>	<b>PO11</b>	<b>PO12</b>
<b>CO1</b>	✓	✓	✓			✓					✓	
<b>CO2</b>	✓	✓	✓			✓					✓	
<b>CO3</b>	✓	✓	✓			✓					✓	
<b>CO4</b>	✓	✓	✓			✓					✓	

### **Course Contents:**

1. Study the single-phase inverter.
2. Study ac regulator using triac, anti parallel thyristor and triac & diac.
3. Study single-phase PWM inverter.
4. Study buck, boost and buck-boost regulators.
5. Study the forced commutated circuits.
6. Determine the dv/dt limitation of given SCR.
7. Study and test the triggering circuit of three phase half controlled bridge converter.
8. Study and test three phase half controlled bridge converter.
9. Study and test the triggering circuit of three-phase fully controlled bridge converter.
10. Study and test three-phase fully controlled bridge converter.

# POWER CONVERSION TECHNIQUES

## PEM 201

### L-T-P=3-1-0

#### Course Outcomes (CO):

Upon successful completion of this course, students should be able to:

**CO1:** Select and design dc-dc converter topologies for a broad range of power conversion applications.

**CO2:** Analyze various single phase and three phase power converters.

**CO3:** Develop improved power converters for any stringent application requirements.

**CO4:** Comprehend the concepts of AC-AC power converters and their applications

#### Mapping of Course Outcomes (CO) and Program Outcomes (PO):

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓			✓	✓					✓	
CO2	✓	✓	✓		✓				✓			
CO3	✓	✓						✓		✓	✓	
CO4	✓	✓				✓	✓					

#### Course Contents:

##### Unit 1

Analysis of switched circuits-thyristor controlled half wave rectifier – R, L, RL, RC load circuits, classification and analysis of commutation

##### Unit 2

Single-Phase and Three-Phase AC to DC converters- half controlled configurations- operating domains of three phase full converters and semi-converters – Reactive power considerations.

##### Unit 3

Analysis and design of DC to DC converters- Control of DC-DC converters, Buck converters, Boost converters, Buck-Boost converters, Cuk converters Single phase and Three phase inverters, Voltage source and Current source inverters, Voltage control and harmonic minimization in inverters.

#### **Unit 4**

AC to AC power conversion using voltage regulators, choppers and cyclo-converters, consideration of harmonics.

#### **References:**

1. Ned Mohan, Undeland and Robbin, "Power Electronics: converters, Application and design", John Wiley and sons.Inc, Newyork, 1995.
2. Rashid M.H., "Power Electronics Circuits, Devices and Applications", Prentice Hall India, New Delhi, 1995.
3. P.C Sen., "Modern Power Electronics", Wheeler publishing Co, First Edition, New Delhi, 1998.

# POWER SYSTEM INSTRUMENTATION

## PEM 202

### L-T-P=3-1-0

#### Course Outcomes (CO):

Upon successful completion of this course, students should be able to:

**CO1:**To Differentiate the various types of thermodynamic cycles, Draw block diagram and describe the operation of thermal power plant with auxiliary equipments.

**CO2:** Clarify the operation of hydro power plants with layout, Select and Governing the water turbines.

**CO3:** To understand system load variations and get an overview of power system operations.

**CO4:**To attain knowledge about hydrothermal scheduling.

#### Mapping of Course Outcomes (CO) and Program Outcomes (PO):

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓		✓	✓						
CO2	✓	✓	✓		✓	✓			✓			
CO3	✓	✓	✓					✓	✓			
CO4	✓	✓	✓			✓	✓					

#### Course Contents:

##### Unit I

Introduction: Power generating Station – Thermal, Hydel, Nuclear, Wind – Their functional characteristics as processes, Components of power Grid – interdependency between different blocks, Review of Mechanical, Electrical, Electronics, Thermal, Optical, Pneumatic, fluidics

##### Unit II

- a) Coal handling plant – coal feed rate measurement, determination of calorific value.
- b) Water treatment
- c) Boiler – Feed water, pressure, temperature, steam flow rate, flue gas analysis, optical pyrometer
- d) Turbine – Speed, shaft eccentricity, temperature
- e) Condenser – pressure, temperature
- f) Generator – Speed, hydrogen leakage
- g) Control and protection systems of a thermal power plant.
- h) Thermal power generation from nuclear reactor.
- i) Ash handling and pollution control

### **Unit III**

Hydel Power Plant: Types - flow rate, Water pressure

Wind Power: Principles – synchronization with grids

Transformer: Transformer oil, hot spot, moisture detection,

Transmission Lines: Fiber optics meter for high voltage and high current measurement,

Transmission line sag measurement using triangulation technique.

### **Unit IV**

Tariff: Objective, Available based tariff, Digital energy meter, Remote terminal unit (RTU)

Local Dispatch Centre: Data handling – Processing, Logging, Acquisition, Accounting, Display and Storage, SCADA, Techniques of Data acquisition at Central Load Dispatch Centres for coordinated control of the grid.

Computer Control of Power Plant:

IS specification: Introduction, Application and Relevancy of IS specification in perspective of power system instrumentation

### **Text Book:**

1. Modern Power Station Practice – Vol: C, Vol: D, Pergamon Press
2. Principles of Industrial Instrumentation - D Patranabish, TMH, New Delhi

### **Reference Book:**

1. Industrial Instrumentation Control and Automation – S Mukhopadhyay, S.Sen, A. Deb – Jaico Publishing House, Mumbai.
2. B. G. Liptak, Instrument Engineers Handbook, Chilton Book Co. Philadelphia

# INDUSTRIAL CONTROL ELECTRONICS

## PEM 203

### L-T-P=4-0-0

#### Course Outcomes (CO):

Upon successful completion of this course, students should be able to:

CO1: Ability in understanding atomization in the Industrial Sector.

CO2: Know-how of control mechanism utilized in Industrial Devices.

CO3: Proficiency in signal conditioning & processing in automated systems.

CO4: Competency in Designing automated industrial control systems.

#### Mapping of Course Outcomes (CO) and Program Outcomes (PO):

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓	✓	✓	✓					✓	✓
CO2	✓	✓	✓	✓	✓	✓					✓	✓
CO3	✓	✓	✓	✓	✓	✓					✓	✓
CO4	✓	✓	✓	✓	✓	✓					✓	✓

#### Course Contents:

##### Unit 1

Review of switching regulators and switch mode power supplies-Uninterrupted power supplies- OFF-LINE AND ON-LINE TOPOLOGIES-Analysis of UPS topologies-solid state circuit breakers-solid-state tap-changing of transformer.

##### Unit 2

Analog Controllers - Proportional controllers, Proportional – Integral controllers, PID controllers, derivative overrun, integral windup-cascaded control-Feed forward control-Digital control schemes- control algorithms-programmable logic controllers.

##### Unit 3

Signal conditioners-Instrumentation amplifiers – voltage to current, current to voltage, voltage to frequency, frequency to voltage converters; Isolation circuits – cabling; magnetic and electro static shielding and grounding.

#### **Unit 4**

Opto-Electronic devices and control , electronic circuits for photo-electric switches-output signals for photo-electric controls; Applications of opto-isolation, interrupter modules and photo sensors – Fibre optics – Bar code equipment, application of barcode in industry. Stepper motors – types, operation, control and applications; servo motors- types, operation, control and applications – servo motor controllers – servo amplifiers – linear motor applications-selection of servo motor.

#### **References:**

1. Michael Jacob, "Industrial Control Electronics – Applications and Design", Prentice Hall, 1988.
2. Thomas, E. Kissel, "Industrial Electronics" PHI, 2003.
3. James Maas, "Industrial Electronics", Prentice Hall, 1995.

# INTELLIGENT CONTROL TECHNIQUES

PEM 204

L-T-P=4-0-0

## Course Outcomes (CO):

Upon successful completion of this course, students should be able to:

**CO1:** Will be knowledgeable to use Fuzzy logic for modeling and control of non-linear systems.

**CO2:** Will be capable of developing ANN based models and control schemes for non-linear system.

**CO3:** Stability analysis of Neural-Network interconnection systems; Implementation of fuzzy logic controller.

**CO4:** Handle, Solve and analyze problems using linear programming and other mathematical programming algorithms.

## Mapping of Course Outcomes (CO) and Program Outcomes (PO):

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓		✓		✓	✓					✓	
CO2	✓		✓		✓	✓			✓			
CO3	✓		✓						✓	✓	✓	
CO4	✓		✓			✓	✓					

## Course Contents:

**Introduction:** Approaches to intelligent control; Architecture for intelligent control; Symbolic reasoning system; rule-based systems; AI approach; Knowledge representation; Expert systems.

**Fuzzy Logic Control System:** Motivation and basic definitions; Fuzzy arithmetic and Fuzzy relations; Fuzzy logic modeling and control; Fuzzy knowledge and rule bases; Fuzzy modeling and control schemes for nonlinear systems; Self-organizing fuzzy logic control; Fuzzy logic control for nonlinear time-delay system; Stabilization using fuzzy models; Fuzzy estimators; Adaptive fuzzy control.

**ANN based Controllers and Estimators:** Concept of Artificial Neural Networks and its basic mathematical model; McCulloch-Pitts neuron model; simple perceptron; Adaline and Madaline; Feed-forward Multilayer Perceptron; Learning and Training the neural

network; Data Processing: Scaling; Fourier transformation; principal-component analysis and wavelet transformations; Hopfield network; Self-organizing network and Recurrent network; Neural Network based controllers and estimators.

**Genetic Algorithm:** Basic concept of Genetic algorithm and detail algorithmic steps; Adjustment of free parameters; Solution of typical control problems using genetic algorithm; Concept on some other search techniques like tabu search and ant-colony search techniques for solving optimization problems; Evolutionary Fuzzy logic controllers.

**Case Studies:** Identification and control of linear and nonlinear dynamic systems using Matlab-Neural network toolbox; Stability analysis of Neural-Network interconnection systems; Implementation of fuzzy logic controller using Matlab fuzzy-logic toolbox; Stability analysis of fuzzy control systems.

**References:**

1. Padhy.N.P.; "Artificial Intelligence and Intelligent System"; Oxford University Press.
2. KOSKO;B. "Neural Networks and Fuzzy Systems"; Prentice-Hall of India Pvt. Ltd.
3. Jacek.M.Zurada; "Introduction to Artificial Neural Systems";Jaico PublishingHouse.
4. KLIR G.J. & FOLGER T.A. "Fuzzy sets; uncertainty and Information"; Prentice-Hall of India Pvt. Ltd.

## **POWER QUALITY**

### **PEM 205**

#### **L-T-P=4-0-0**

#### **Course Outcomes (CO):**

Upon successful completion of this course, students should be able to:

**CO1:** Discuss the various types of power quality problem.

**CO2:** Analyze the sources, types and mitigation of over voltage issues and model of over voltage problem with computer software tools.

**CO3:** Evaluate the effects of harmonics on power system equipments and analyze the methods of controlling of harmonics.

**CO4:** Explain the principle of operation of various types of power quality monitoring devices.

#### **Mapping of Course Outcomes (CO) and Program Outcomes (PO):**

<b>CO</b>	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>	<b>PO6</b>	<b>PO7</b>	<b>PO8</b>	<b>PO9</b>	<b>PO10</b>	<b>PO11</b>	<b>PO12</b>
<b>CO1</b>	✓	✓			✓	✓					✓	
<b>CO2</b>	✓	✓				✓						
<b>CO3</b>	✓	✓						✓		✓	✓	
<b>CO4</b>	✓	✓				✓						✓

#### **Course Contents:**

##### **Unit I**

Electric power quality phenomena: Impacts of power quality problems on end users, Power quality standards, power quality monitoring.

##### **Unit II**

Power quality disturbances:- transients, short duration voltage variations ,long duration voltage variations, voltage imbalance, wave-form distortions, voltage fluctuations, power frequency variations, power acceptability curves.

##### **Unit III**

Power quality problems: poor load power factor, loads containing harmonics, notching in load voltage, dc offset in loads, unbalanced loads, disturbances in supply voltage.

#### **Unit IV**

Transients: Origin and classification- capacitor switching transient-lighting-load switching- impact on users-protection- mitigation

#### **Unit V**

Harmonics: harmonic distortion standards, power system quantities under non sinusoidal conditions-harmonic indices-source of harmonics-system response characteristics-effects of harmonic distortion on power system apparatus –principles for controlling harmonics, reducing harmonic currents in loads, filtering, modifying the system frequency response- Devices for controlling harmonic distortion, inline reactors or chokes, zigzag transformers, passive filters, active filters.

#### **Unit VI**

Power quality conditioners: Shunt and series compensators, Dstatcom-dynamic voltage restorer, unified power quality conditioners

#### **Text Book:**

1. Arindam and Ledwich Gerard, 'Power quality enhancement using custom power devices' Springer
2. Arrillaga J., Watson N. R. and Chen S., 'Power System Quality Assessment' Wiley.

#### **Reference Book:**

1. Angelo Baghini 'Handbook of Power Quality' – Wiley

## **POWER ELECTRONICS & DRIVES LAB**

**PEM 291**

**L-T-P=0-0-3**

### **Course Outcomes (CO):**

Upon successful completion of this course, students should be able to:

**CO1:** Estimate & solve harmonic and power factor related problems in controlling AC and DC drives.

**CO2:** To impart in-depth knowledge on computer simulation of different Drives.

**CO3:** Analyze simulation results and effective documentation.

**CO4:** Acquire expertise in usage of modern tools.

### **Mapping of Course Outcomes (CO) and Program Outcomes (PO):**

<b>CO</b>	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>	<b>PO6</b>	<b>PO7</b>	<b>PO8</b>	<b>PO9</b>	<b>PO10</b>	<b>PO11</b>	<b>PO12</b>
<b>CO1</b>	✓		✓		✓	✓						
<b>CO2</b>	✓		✓		✓	✓			✓			
<b>CO3</b>	✓		✓					✓	✓			
<b>CO4</b>												

### **Course Contents:**

1. Experiments and computer simulations on:
2. Single phase, three phase Semi converters and Full converters,
3. DC-DC Choppers using SCRs and Self communicating Devices.
4. Single phase and three phase inverters using IGBTs,
5. AC-AC voltage regulators.
6. DC and AC drives

## APPLICATIONS OF POWER ELECTRONICS IN POWER SYSTEM

PEM 301 (B)

L-T-P=3-0-2

### Course Outcomes (CO):

Upon successful completion of this course, students should be able to:

**CO1:** Establish the understanding of the basics of FACTS.

**CO2:** Understand the conceptual details of Modeling and Analysis of FACTS controllers.

**CO3:** Demonstrate the working of the SVC, TCSC, STATCON, SSSC, UPFC.

**CO4:** Analysis the Harmonics creating loads, modeling, harmonic propagation, Series and parallel resonances, harmonic power flow, Mitigation of harmonics, filters.

### Mapping of Course Outcomes (CO) and Program Outcomes (PO):

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓		✓		✓	✓					✓	
CO2	✓		✓		✓	✓			✓			
CO3	✓		✓					✓	✓	✓	✓	
CO4	✓		✓			✓	✓					✓

### Course Contents:

#### **Unit 1: Steady state and dynamic problems in AC systems: (8 Hours)**

Flexible AC transmission systems (FACTS), Principles of series and shunt compensation, Description of static VAR compensators (SVC), Thyristor Controlled series compensators (TCSC), Static phase shifters (SPS), Static condenser (STATCON), Static synchronous series compensator (SSSC) and Unified power flow controller (UPFC),

#### **Unit 2: Modeling and Analysis of FACTS controllers: (7 Hours)**

Control strategies to improve system stability, Power Quality problems in distribution systems

#### **Unit 3: Harmonics: (5 Hours)**

Harmonics creating loads, modelling, harmonic propagation, Series and parallel resonances, harmonic power flow, Mitigation of harmonics, filters, passive filters, Active filters, shunt, series hybrid filters, voltage sags & swells, voltage flicker, Mitigation of power quality problems using power electronic conditioners, IEEE standards, HVDC Converters and their characteristics, Control of the converters (CC and CEA), Parallel and series operation of converters.

**Text Book:**

1. N.G. Hingorani & Laszlo Gyugyi, Understanding FACTS, IEEE Press, 2000.
2. E. F. Fuchs & Mohammad A.S. Masoum, Power Quality in Power Systems and Electrical Machines, Elsevier Academic Press 2008.
3. K.R. Padiyar, FACTS controllers in power transmission and distribution, New Age International publishers, New Delhi, 2007.
1. K.R. Padiyar, HVDC Power Transmission Systems, New Age International publishers, New Delhi, 1999.