SYLLABUS

FOR

SEMESTER SECOND

SEMESTER-2

Course Code	**PCCPSC201**			**Semester**	**Second**
Category	**Professional Core Course**				
Course Title	**Power Quality**				
Scheme & Credits	**L**	**T**	**P**	**Credits**	**Max Marks: 100**
	3	**1**	**0**	**4**	
Prerequisites	**Power Electronics**				

Course Objectives: -

1. Understand the different power quality issues to be addressed
2. Understand the recommended practices by various standard bodies like IEEE,IEC, etc on voltage & frequency, harmonics
3. Understanding Compensators for power quality problems.

Unit	Content
1.	Introduction-power quality-voltage quality-overview of power quality phenomena, classification of power quality issues-power quality measures and standards-IEEE guides, standards and recommended practices. Causes of Power Quality Problems, Effects of Power Quality Problems on Users, Classification of Mitigation Techniques for Power Quality Problems , Power Quality Monitoring, Load Causes Power quality Problems
2.	Power factor improvement- Passive Shunt Compensation, Passive series compensation. Classification, principle of operation, analysis and design of passive shunt compensators. Loads causing power quality problems. Analysis of non-linear loads.
3.	Load current compensation, Zero voltage regulation, Reactive power compensation Active Shunt Compensation: DSTATCOM (Principle of operation and control of DSTATCOM, Modeling and simulation performance of DSTATCOM.
4.	Dynamics of sags and swells, Active series compensation, Dynamic Voltage Restorers for sag , swell and flicker problems.
5.	Combined Compensation- Unified Power Quality Conditioner (UPQC), Classification, principle of operation and control of UPQC, Modeling and simulation performance of UPQC.

Textbooks:

1. Power Quality Problems and Mitigation Techniques by Bhim Singh and Ambrish Chandra, Wiley.
2. Math H. Bollen, “Understanding Power Quality Problems”, IEEE Press, 2000
3. J. Arrillaga, “Power System Quality Assessment”, John wiley, 2000
4. J. Arrillaga, B.C. Smith, N.R. Watson & A. R.Wood ,”Power system Harmonic Analysis”, Wiley, 1997

Course Code	**PCCPSC202**			**Semester**	**Second**
Category	**Professional Core Course**				
Course Title	**Power System Dynamics**				
Scheme & Credits	**L**	**T**	**P**	**Credits**	**Max Marks: 100**
	3	**1**	**0**	**4**	
Prerequisites	**Power System**				

Course Objectives:-

1. Study of system dynamics and its physical interpretation
2. Development of mathematical models for synchronous machine
3. Modeling of induction motor

Unit	Content
1.	Basic Concepts of dynamical systems and stability, Modelling of power system components for stability studies: generators, transmission lines, excitation and prime mover controllers, motors, flexible AC transmission (FACTS) controllers.
2.	Analysis of single machine and multi-machine systems, Small signal angle instability (low frequency oscillations): damping and synchronizing torque analysis, eigenvalue analysis
3.	Small signal angle instability (sub-synchronous frequency oscillations): analysis and counter-measures.
4.	Transient Instability: Analysis using digital simulation and energy function method. Transient stability controllers
5.	Introduction to voltage Instability, Analysis of voltage Instability.

Textbooks:

1. P. M. Anderson & A. A. Fouad “Power System Control and Stability”, Galgotia , New Delhi, 1981
2. J Machowski, J Bialek & J. R W. Bumby, “Power System Dynamics and Stability”, John Wiley & Sons, 1997
3. P.Kundur, “Power System Stability and Control”, McGraw Hill Inc., 1994.
4. E.W. Kimbark, “Power system stability”, Vol. I & III, John Wiley & Sons, New York 2002

Course Code	**PCCPSC203**			**Semester**	**Second**
Category	**Professional Core Course**				
Course Title	**Nonlinear Systems And Control**				
Scheme & Credits	**L**	**T**	**P**	**Credits**	**Max Marks: 100**
	3	**1**	**0**	**4**	
Prerequisites	**Nil**				

Course Objectives:-

1. Study of system dynamics and its physical interpretation
2. Development of mathematical models for nonlinear phenomena
3. Control of nonlinear systems

Unit	Contents
1.	Mathematical preliminaries involving open and closed sets, compact set, dense set, Continuity of functions, Lipschitz condition, smooth functions, Vector space, norm of a vector, normed linear space, inner product space.
2.	Well-posedness of ordinary differential equations, Lipschitz continuity and contraction mapping theorem.
3.	Notions of degree of freedom, configuration space, configuration variables; Euler-Lagrange formulation; equilibrium points and operating points; linearized models based on Jacobian linearization.
4.	Second-order nonlinear systems; vector field, trajectories, vector field plot, phase-plane portrait and positively invariant sets; classification of equilibrium points
5.	Periodic solutions and the notion of limit cycles; Bendixson's theorem and Poincar´e-Bendixson criterion
6.	Various notions of stability: Lagrange stability, Lyapunov stability, asymptotic stability, global asymptotic stability, exponential stability and instability;Lyapunov's direct and indirect method and La Salle's invariance property.
7.	Control design techniques using on Lyapunov function and sliding mode
8.	Optimal Control Systems; Nonlinear Adaptive Control Systems

Textbooks:-

1. Vidyasagar, M. (1993). Nonlinear Systems Analysis (2nd ed.). Englewood Cliffs: Prentice Hall.
2. Khalil, H. K. (2002). Nonlinear Systems (3rd ed.). Upper Saddle River: Prentice Hall.
3. Isidori, A. (1995). Nonlinear Control Systems (3rd ed.). Berlin: Springer.
4. Selected conference and journal papers.

Course Code	**PEC1PSC204**			**Semester**	**Second**
Category	**Professional Core Course(PEII)**				
Course Title	**Restructured Power Systems**				
Scheme & Credits	**L**	**T**	**P**	**Credits**	**Max Marks: 100**
	3	**1**	**0**	**4**	
Prerequisites	**Power System**				

Course Objectives: -

1. Understand what is meant by restructuring of the electricity market
2. Understand the need behind requirement for deregulation of the electricity market
3. Understand the money, power & information flow in a deregulated power system

Unit	Content
1.	Fundamentals of restructured system, Market architecture, Load elasticity, Social welfare maximization
2.	OPF: Role in vertically integrated systems and in restructured markets, Congestion management; ATC calculations
3.	Optimal bidding, Risk assessment, Hedging, Transmission pricing and Allocation, Tracing of power
4.	Ancillary services, Standard market design, Distributed generation in restructured markets
5.	Developments in India: historical, legal, and regulatory, IT applications in restructured markets
6.	Working of restructured power systems, Recent trends in Restructuring; Acts and Bills in India

Textbooks:-

1. Lorrin Philipson, H. Lee Willis, “Understanding electric utilities and deregulation”, Marcel Dekker Pub.,1998.
2. Steven Stoft, “Power system economics: designing markets for electricity”, John Wiley and Sons, 2002.
3. Kankar Bhattacharya, Jaap DE. Daadler, Math H.J. Bollen, “Operation of restructured power systems, Kluwer Academic Pub., 2001.
4. Mohammad Shahidehpour, MuwaffaqAlomoush, “Restructured electrical power systems: operation, trading and volatility”, Marcel Dekker.

Course Code	**PEC2PSC204**			**Semester**	**Second**
Category	**Professional Elective Course(PEII)**				
Course Title	**Advanced Digital Signal Processing**				
Scheme & Credits	**L**	**T**	**P**	**Credits**	**Max Marks: 100**
	3	**1**	**0**	**4**	
Prerequisites	**Nil**				

Course Objectives: -

1. To understand the difference between discrete-time and continuous-time signals
2. To understand and apply Discrete Fourier Transforms (DFT)

Unit	Content
1.	Discrete time signals, Linear shift invariant systems- Stability and causality, Sampling of continuous time signals- Discrete time Fourier transform- Discrete Fourier series- Discrete Fourier transform, Z transform-Properties of different transforms
2.	Linear convolution using DFT, Computation of DFT Design of IIR digital filters from analog filters, Impulse invariance method, Bilinear transformation method
3.	FIR filter design using window functions, Comparison of IIR and FIR digital filters, Basic IIR and FIR filter realization structures, Signal flow graph representations Quantization process and errors Coefficient quantisation effects in IIR and FIR filters
4.	A/D conversion noise- Arithmetic round-off errors, Dynamic range scaling, Overflow oscillations and zeroInput limit cycles in IIR filters, Linear Signal Models
5.	All pole, All zero and Pole-zero models, Power spectrum estimation- Spectral analysis of deterministic signals.Estimation of power spectrum of stationary random signals
6..	Optimum linear filters, Optimum signal estimation, Mean square error estimation
7.	Optimum FIR and IIR Filters

Textbooks:

1. Sanjit K Mitra, “Digital Signal Processing: A computer-based approach “,TataMc Graw-Hill Edition1998
2. Dimitris G .Manolakis, Vinay K. Ingle and Stephen M. Kogon, “Statistical and Adaptive Signal Processing”, Mc Graw Hill international editions. -2000

Course Code	**PEC3PSC204**			**Semester**	**Second**
Category	**Professional Elective Course(PEII)**				
Course Title	**Digital Protection of Power System**				
Scheme & Credits	**L**	**T**	**P**	**Credits**	**Max Marks: 100**
	3	**1**	**0**	**4**	
Prerequisites	**Nil**				

Course Objectives:-

1. Study of numerical relays
2. Developing mathematical approach towards protection
3. Study of algorithms for numerical protection

Unit	Content
1.	Evolution of digital relays from electromechanical relays, Performance and operational characteristics of digital protection
2.	Mathematical background to protection algorithms, Finite difference techniques
3.	Interpolation formulae Forward, backward and central difference interpolation, Numerical differentiation, Curve fitting and smoothing, Least squares method, Fourier analysis, Fourier series and Fourier transform Walsh function analysis
4.	Basic elements of digital protection, Signal conditioning: transducers, surge protection, analog filtering, analog multiplexers, Conversion subsystem: the sampling theorem, signal aliasing Error, sample and hold circuits, multiplexers, analog to digital conversion Digital filtering concepts, The digital relay as a unit consisting of hardware and software
5.	Sinusoidal wave based algorithms, Sample and first derivative (Mann and Morrison) algorithm. Fourier and Walsh based algorithms
6.	Fourier Algorithm: Full cycle window algorithm, fractional cycle window algorithm. Walsh function based algorithm.Least Squares based algorithms. Differential equation based algorithms.Traveling Wave based Techniques.Digital Differential Protection of Transformers. Digital Line Differential Protection. Recent Advances in Digital Protection of Power Systems.

Textbooks:

1. A.G. Phadke and J. S. Thorp, “Computer Relaying for Power Systems”, Wiley/Research studies Press, 2009
2. A.T. Johns and S. K. Salman, “Digital Protection of Power Systems”, IEEE Press,1999
3. Gerhard Zeigler, “Numerical Distance Protection”, Siemens Publicis Corporate Publishing, 2006
4. S.R.Bhide “Digital Power System Protection” PHI Learning Pvt.Ltd.2014

Course Code	**PEC4PSC204**			**Semester**	**Second**
Category	**Professional Elective Course(PEII)**				
Course Title	**Scada System and Applications**				
Scheme & Credits	**L**	**T**	**P**	**Credits**	**Max Marks: 100**
	3	**1**	**0**	**4**	
Prerequisites	**Nil**				

Course Objectives:-

1. To understand what is meant by SCADA and its functions
2. To know SCADA communication
3. To get an insight into its application

Unit	Content
1.	Introduction to SCADA,Data acquisition systems,Evolution of SCADA,Communication technologies
2.	Monitoring and supervisory functions, SCADA applications in Utility Automation Industries SCADA
3.	Industries SCADA System Components, Schemes- Remote Terminal Unit (RTU) Intelligent Electronic Devices(IED), Programmable Logic Controller (PLC) Communication Network, SCADA Server, SCADA/HMI Systems
4.	SCADA Architecture, Various SCADA architectures, advantages and disadvantages of each system single unified standard architecture -IEC 61850.
5.	SCADA Communication, various industrial communication technologies, wired and wireless methods and fiber optics,Open standard communication protocols
6.	SCADA Applications: Utility applications, Transmission and Distribution sector operations, monitoring, analysis and improvement, Industries - oil, gas and water

Textbooks:

1. Stuart A. Boyer: “SCADA-Supervisory Control and Data Acquisition”, Instrument Society of America Publications,USA,2004
2. Gordon Clarke, Deon Reynders: “Practical Modern SCADA Protocols: DNP3, 60870.5 and Related Systems”, Newnes Publications, Oxford, UK,2004
3. William T. Shaw, “Cybersecurity for SCADA systems”, PennWell Books, 2006
4. David Bailey, Edwin Wright, “Practical SCADA for industry”, Newnes, 2003
5. Michael Wiebe, “A guide to utility automation: AMR, SCADA, and IT systems for electric power”, PennWell 1999

Course Code	PEC5PSC204			Semester	Second
Category	Professional Elective Course(PEII)				
Course Title	Electric and Hybrid Vehicles				
Scheme & Credits	L	T	P	Credits	Max Marks: 100
	3	1	0	4	
Prerequisites	Nil				

Course Objectives:-

1. To understand upcoming technology of hybrid system
2. To understand different aspects of drives application
3. Learning the electric Traction

Unit	Content
1.	History of hybrid and electric vehicles, Social and environmental importance of hybrid and electric vehicles Impact of modern drive-trains on energy supplies, Basics of vehicle performance, vehicle power source characterization Transmission characteristics, Mathematical models to describe vehicle performance.
2.	Basic concept of hybrid traction,Introduction to various hybrid drive-train topologies. Power flow control in hybrid drive-train topologies, Fuel efficiency analysis.
3.	Basic concept of hybrid traction, Introduction to various hybrid drive-train topologies Power flow control in hybrid drive-train topologies, Fuel efficiency analysis.
4.	Introduction to electric components used in hybrid and electric vehicle ,Configuration and control of DC Motor drives, Configuration and control of Motor drives configuration and control of Permanent Magnet Motor drives Configuration and control of Switched Reluctance Motor drives, drive system efficiency
5.	Matching the electric machine and the internal combustion engine (ICE), Sizing the propulsion motor, sizing the power electronics Selecting the energy storage technology, Communications, supporting subsystems
6.	Introduction to energy management and their strategies used in hybrid and electric vehicles. Classification of different energy management strategies Comparison of different energy management strategies Implementation issues of energy strategies

Textbooks:

1. Sira -Ramirez, R. Silva Ortigoza, “Control Design Techniques in Power Electronics Devices”, Springer.
2. Siew-Chong Tan, Yuk-Ming Lai, Chi Kong Tse, “Sliding mode control of switching Power Converters”.

Course Code	**PCCPSC205L**			**Semester**	**Second**
Category	**Professional Core Course**				
Course Title	**Power Quality and Renewable Energy Lab**				
Scheme & Credits	**L**	**T**	**P**	**Credits**	**Max Marks: 100**
	0	**0**	**4**	**2**	
Prerequisites	**Nil**				

List of Experiments:

S. No.	**Experiments**
1.	To study the I-V and P-V Characteristics of the Solar Cell
2.	Effect of Temperature on Solar Panel Output
3.	Variables Affecting Solar Panel Output
4.	Effect of Load on Solar Panel Output
5.	To study the MPPT for Solar PV cell
6.	To study the MPPT for wind energy
7.	Wind Turbine Output: The Effect of Load
8.	Test the Capabilities of Solar Panels and Wind Turbines
9.	To study the effect of non linear loads on power quality
10.	To demonstrate the voltage and current distortions experimentally.
11.	To reduce the current harmonics with filters.
12.	To study the voltage sag due to starting of a large induction motor.
13.	To study the capacitor switching transients.
14.	To study the effect of balanced non linear load on neutral current , in a three phase circuit
15.	To study the effect of the ground loop.
16.	To study the effect of voltage flicker .
17.	To calculate the distortion power factor.
18.	Study the effect of harmonics on energy meter reading
19.	Study the effect of harmonics on energy meter reading.
20.	To obtain the current harmonics drawn by power electronics interface using MATLAB
21.	To study renewable sources using MATLAB

<table>
<tr><td>Course Code</td><td colspan="3">PCCPSC206</td><td>Semester</td><td>Second</td></tr>
<tr><td>Category</td><td colspan="5">Professional Core Course</td></tr>
<tr><td>Course Title</td><td colspan="5">Seminar</td></tr>
<tr><td rowspan="2">Scheme & Credits</td><td>L</td><td>T</td><td>P</td><td>Credits</td><td rowspan="2">Max Marks: 100</td></tr>
<tr><td>0</td><td>0</td><td>4</td><td>2</td></tr>
<tr><td>Prerequisites</td><td colspan="5">Nil</td></tr>
<tr><td colspan="6">The students are required to prepare a seminar report and presentation based on the latest trends and technologies in their respective fields of study. The work is to be carried out in the 2nd semester of their course individually. Each student will have to select a topic of study duly approved by the faculty incharge of conducting the seminar. The student will have to prepare a seminar report and deliver a presentation before a panel of experts based on the seminar work carried by him/her.</td></tr>
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