SYLLABUS

FOR

SEMESTER FIRST

Course Code	**PCCPSC101**			**Semester**	**First**
Category	**Professional Core Course**				
Course Title	**Power System Analysis**				
Scheme & Credits	**L**	**T**	**P**	**Credits**	**Max Marks: 100**
	3	**1**	**0**	**4**	
Prerequisites	**Nil**				

Course Objectives:

1. Study various methods of load flow and their advantages and disadvantages
2. Understand how to analyze various types of faults in power system
3. Understand power system security concepts and study the methods to rank the contingencies
4. Understand need of state estimation and study simple algorithms for state estimation Study voltage instability phenomenon

Unit	Content
I	Load flow **:**Overview of Newton-Raphson ,Gauss-Seidel fast decoupled methods, convergence properties, sparsity techniques, handling Q- max violations in constant matrix, inclusion in frequency effects AVR in load flow, handling of discrete variables in load flow.
II	Fault Analysis, Z - matrix for short circuit studies
III	Security Analysis: Security state diagram, contingency analysis, generator shift distribution factors line outage distribution factor, multiple line outages, overload index ranking
IV	Power System Equivalents **:** WARD REI.equivalents
V	State Estimation : Sources of errors in measurement, Virtual and Pseudo, Measurement, Observability, Tracking state estimation, WSL method, bad data correction.
VI	Unit Commitment, Load frequency control, Optimal hydro-thermal scheduling, AI applications

Textbooks:

1. J.J. Grainger &W.D.Stevenson, “Power system analysis ”, McGraw Hill ,2003.
2. A. R. Bergen & Vijay Vittal , “Power System Analysis” ,Pearson , 2000.
3. L.P. Singh , “Advanced Power System Analysis and Dynamics”, New Age International, 2006.
4. G.L. Kusic, “Computer aided power system analysis” ,Prentice Hall India, 1986.
5. A.J. Wood, “ Power generation, operation and control” , John Wiley, 1994.
6. P.M. Anderson, “Faulted power system analysis” , IEEE Press , 1995.

Course Code	**PCCPSC102**			**Semester**	**First**
Category	**Professional Core Course**				
Course Title	**Power System Operation, Control And Optimization**				
Scheme & Credits	**L**	**T**	**P**	**Credits**	**Max Marks: 100**
	3	**1**	**0**	**4**	
Prerequisites	**Nil**				

Course Objectives:

1. Recognize and formulate problems for operation and investments in power systems
2. Describe the basic principles of Linear programming, Quadratic programming, Nonlinear programming, and Semidefinite programming
3. Formulate the dual of an optimization problem and the optimality conditions (KKT)
4. Explain what locational marginal price is in electricity markets
5. Design and solve optimal power flow problems (DC-OPF, AC-OPF)
6. Understand and apply convex relaxations (e.g. semidefinite programming)

Unit	Content
1.	Modern Power Systems: interconnections and operating states. Equipment and Stability Constraints in System Operation Generator Constraints, Transmission Line constraints, Numerical Solution of Differential Equations, Large disturbance Angle stability, Voltage Instability
2.	Frequency Control in a Power System
3.	Voltage and Power Flow Control, Real Life Examples and Case Studies, Real and Reactive Power Scheduling
4.	Preventive, Emergency and Restorative Control, Power System State Estimation, Normal and Alert State in a Power System; Emergency Control: Blackouts and Restoration
5.	Operation and Investments in Power Systems, Basic Principles of Linear programming, Quadratic programming, Nonlinear programming, and Semidefinite programming, Economic Dispatch and DC Optimal Power Flow
6.	Economic Dispatch and DC Optimal Power Flow, AC Optimal Power Flow, Semidefinite Programming and Convex Relaxations
7.	Lagrangian, KKT, and Constrained Optimization, QP DC-OPF, PTDF, and LMPs,Duality, Electricity Markets

Textbooks:

1. P. Kundur, “Power System Stability and Control”, McGraw Hill Inc, 1994
2. J. Machowski, Bialek, Bumby, “Power System Dynamics and Stability”, John Wiley & Sons, 1997
3. L. Leonard Grigsby (Ed.); “Power System Stability and Control”, Second edition, CRC Press, 2007
4. V. Ajjarapu, “Computational Techniques for voltage stability assessment & control”; Springer, 2006

Course Code	**PCCPSC103**			**Semester**	**FIRST**
Category	**Professional Core Course**				
Course Title	**Dynamics of Linear Systems**				
Scheme & Credits	**L**	**T**	**P**	**Credits**	**Max Marks: 100**
	3	**1**	**0**	**4**	
Prerequisites	**Nil**				

Course Objectives:-

1. To understand the linear system and its functions
2. To understand the stability analysis of linear systems and implement the same in MATLAB

Unit	Content
1.	State variable representations of systems, transfer function and transfer function matrix solutions of state equations
2.	Observability and controllability,minimal realization of MIMO systems, analysis of linear time varying systems the concepts of stability
3.	Lyapunov stability analysis,Lyapunov function and its properties controllability by state variable feedback
4.	Ackerman's Formula - stabilisation by output feedback, asymptotic observers for state measurement observer design
5.	State space representation of discrete systems, solution of state equations, controllability and observability stability analysis using Lyapunov method
6.	State feedback of linear discrete time systems, design of observers - MATLAB Exercises

Textbooks:

1. Thomas Kailath, "Linear Systems", Prentice Hall Inc., Englewood Cliffs, N.J. 1980.
2. K. Ogata, "State Space Analysis of Control Systems", Prentice Hall Inc., Englewood Cliffs, N.J., 1965.
3. K. Ogata, "Modern Control Engineering, (second edition)" , Prentice Hall Inc., Englewood Cliffs, N.J., 1990
4. M.Gopal, "Digital Control and State Variable Methods", Tata McGraw Hill Publishing Company Ltd., New Delhi, 1997
5. C.T. Chen, "Linear System Theory and Design", New York: Holt Rinehart and Winston ,1984
6. R.C. Dorf, and R. T. "Bishop, Modern Control Systems", Addison Wesley Longman Inc., 1999.

Course Code	PEC1PSC104			Semester	FIRST
Category	Professional Elective Course (PEI)				
Course Title	Renewable Energy System				
Scheme & Credits	L	T	P	Credits	Max Marks: 100
	3	1	0	4	
Prerequisites	Nil				

Course Objectives:-

1. To learn various renewable energy sources
2. To gain understanding of integrated operation of renewable energy sources
3. To understand Power Electronics Interface with the Grid

Unit	Content
1.	Introduction, Distributed vs Central Station Generation, Sources of Renewable Energy.
2.	Introduction to Solar Energy, Wind Energy, Hydro Energy, Tidal Energy, Wave Energy Geothermal Energy, Biomass and energy storage systems.
3.	Standalone renewable energy systems: design, operation and control
4.	Grid connected renewable systems: Power Electronic Interface with the Grid, design, operation and control
5.	Impact of Distributed Generation on the Power System, Power Quality Disturbances

Textbooks:

1. Ranjan Rakesh, Kothari D.P, Singal K.C, “Renewable Energy Sources and Emerging Technologies”,2nd Ed. Prentice Hall of India ,2011
2. Math H.Bollen, Fainan Hassan, “Integration of Distributed Generation in the Power System”, July 2011,Wiley –IEEE Press
3. Loi Lei Lai, Tze Fun Chan, “Distributed Generation: Induction and Permanent Magnet Generators” October 2007, Wiley-IEEE Press.
4. Roger A.Messenger, Jerry Ventre, “Photovoltaic System Engineering”, 3rd Ed, 2010
5. James F.Manwell, Jon G.McGowan, Anthony L Rogers, “Wind energy explained: Theory Design and Application”, John Wiley and Sons 2nd Ed, 2010
6. B.H.Khan, “Non-conventional energy sources”, Tata McGraw Hill.

Course Code	PEC2PSC104			Semester	FIRST
Category	Professional Elective Course (PEI)				
Course Title	Smart Grids				
Scheme & Credits	L	T	P	Credits	Max Marks: 100
	3	1	0	4	
Prerequisites	Nil				

Course Objectives:-

1. Understand the concept of smart grid and its advantages over conventional grid.
2. Know smart metering techniques
3. Learn wide area measurement techniques
4. Understanding the problems associated with integration of distributed generation & its solution through smart grid

Unit	Content
1.	Introduction to Smart Grid, Evolution of Electric Grid, Concept of Smart Grid, Definitions, Need of Smart Grid, Concept of Robust & Self Healing Grid Present development & International policies in Smart Grid
2.	Introduction to Smart Meters, Real Time Pricing, Smart Appliances, Automatic Meter Reading(AMR), Outage Management System(OMS), Plug in Hybrid Electric Vehicles(PHEV), Vehicle to Grid, Smart Sensors, Home & Building Automation, Smart Substations, Substation Automation, Feeder Automation.
3.	Geographic Information System(GIS), Intelligent Electronic Devices(IED) & their application for monitoring & protection, Smart storage like Battery, SMES, Pumped Hydro, Compressed Air Energy Storage, Wide Area Measurement System (WAMS), Phase Measurement Unit(PMU)
4.	Concept of micro-grid, need & applications of micro-grid, formation of micro-grid, Issues of interconnection, protection & control of micro-grid. Plastic & Organic solar cells, Thin film solar cells, Variable speed wind generators, fuel- cells, micro-turbines, Captive power plants, Integration of renewable energy sources
5.	Power Quality & EMC in Smart Grid, Power Quality issues of Grid connected Renewable Energy Sources, Power Quality Conditioners for Smart Grid, Web based Power Quality monitoring, Power Quality Audit
6.	Advanced Metering Infrastructure (AMI), Home Area Network (HAN),Neighborhood Area Network (NAN), Wide Area Network (WAN), Bluetooth, ZigBee, GPS, Wi-Fi, Wi-Max based communication,Wireless Mesh Network, Basics of CLOUD Computing & Cyber Security for Smart Grid Broadband over Power line (BPL), IP based protocols

Textbooks:

1. Ali Keyhani, “Design of smart power grid renewable energy systems”, Wiley IEEE, 2011
2. Clark W. Gellings, “The Smart Grid: Enabling Energy Efficiency and Demand Response”, CRC Press , 2009
3. JanakaEkanayake, Nick Jenkins, KithsiriLiyanage, “Smart Grid: Technology and Applications”, Wiley 2012
4. Stuart Borlase, “Smart Grid: Infrastructure, Technology and solutions “ CRC Press 5.A.G.Phadke, “Synchronized Phasor Measurement and their Applications”, Springer

Course Code	PEC3PSC104			Semester	FIRST
Category	Professional Elective Course(PEI)				
Course Title	High Power Converters				
Scheme & Credits	L	T	P	Credits	Max Marks: 100
	3	1	0	4	
Prerequisites	Power Electronics				

Course Objectives:-

1. Understand the requirements of high power rated converters
2. Understand the different topologies involved for these converters
3. Able to understand the design of protection circuits for these converters

Unit	Content
1.	Power electronic systems, An overview of PSDs, multipulse diode rectifier, multipulse SCR rectifier.
2.	Phase shifting transformers, multilevel voltage source inverters: two level voltage source inverter, cascaded H bridge multilevel inverter.
3.	Diode clamped multilevel inverters, flying capacitor multilevel inverter
4.	PWM current source inverters,DC to DC switch mode converters
5.	AC voltage controllers : Cyclo-converters, matrix converter,Power conditioners and UPS.
6.	Design aspects of converters, protection of devices and circuits

Textbooks:

1. N. Mohan, T. M. Undeland and W. P. Robbins, “Power Electronics: Converter, Applications and Design”,John Wiley and Sons, 1989
2. M.H. Rashid, “Power Electronics”, Prentice Hall of India, 1994
3. B. K .Bose, “Power Electronics and A.C. Drives”, Prentice Hall, 1986
4. Bin Wu, “High power converters and drives”, IEEE press, Wiley Enter science

Course Code	PEC4PSC104			Semester	FIRST
Category	Professional Elective Course (PEI)				
Course Title	Electric Power Distribution System				
Scheme & Credits	L	T	P	Credits	Max Marks: 100
	3	1	0	4	
Prerequisites	Nil				

Course Objectives:-

1. Learning about power distribution system
2. Learning of SCADA System
3. Understanding Distribution Automation

Unit	Content
1.	Distribution of Power, Management, Power Loads,Load Forecasting Short-term & Long-term, Power System Loading, Technological Forecasting.
2.	Advantages of Distribution Management System (D.M.S.) Distribution Automation: Definition, Restoration / Reconfiguration of Distribution Network, Different Methods and Constraints, Power Factor Correction
3.	Interconnection of Distribution,Control & Communication Systems, Remote Metering,Automatic Meter Reading and its implementation
4.	SCADA: Introduction, Block Diagram,SCADA Applied To Distribution Automation. Common Functions of SCADA,Advantages of Distribution Automation through SCADA
5.	Calculation of Optimum Number of Switches, Capacitors, Optimum Switching Device Placement in Radial, Distribution Systems, Sectionalizing Switches – Types, Benefits,Bellman's Optimality Principle,Remote Terminal Units,Energy efficiency in electrical distribution & Monitoring
6.	Maintenance of Automated Distribution Systems,Difficulties in Implementing Distribution.Automation in Actual Practice, Urban/Rural Distribution, Energy Management, AI techniques applied to Distribution Automation

Textbooks:

1. A.S. Pabla, " Electric Power Distribution", Tata McGraw Hill Publishing Co. Ltd., Fourth Edition.
2. M.K. Khedkar, G.M. Dhole, "A Text Book of Electrical power Distribution Automation", University Science Press, New Delhi
3. Anthony J Panseni, "Electrical Distribution Engineering", CRC Press
4. James Momoh, "Electric Power Distribution, automation, protection & control", CRC Press

Course Code	PEC5PSC104			Semester	FIRST
Category	Professional Elective Course (PEI)				
Course Title	Mathematical and Computational Methods for Power Engineering				
Scheme & Credits	L	T	P	Credits	Max Marks: 100
	3	1	0	4	
Prerequisites	Nil				

Course Objectives: -

1. To understand the relevance of mathematical methods to solve engineering problems.
2. To understand how to apply these methods for a given engineering problem.

Unit	Content
1.	Vector spaces, Transformations, and Operators, Ordinary Differential Equations Signal Analysis
2.	Errors, Stability, Algorithmic Complexity
3.	Matrix Computations
4.	Non-Linear Equations
5.	Regression and Interpolation, Numerical Integration and Differentiation, Ordinary Differential Equations: IVP and BVP
6.	Numerical Optimization,Monte-Carlo Methods

Textbooks:

1. Erwin Kreyszig, Herbert Kreyszig, Edward J. Norminton, "Advanced Engineering Mathematics", 10th Edition, Wiley, 2011
2. Richard L. Burden, J. Douglas Faires, Annette M. Burden, "Numerical Analysis", 10th Edition, Cengage Learning, 2016
3. Walter Gander, Martin J. Gander, Felix Kwok, "Scientific Computing - An Introduction using Maple and MATLAB", Springer, 2014
4. John A. Trangenstein, "Scientific Computing", 3 vols., Springer, 2018
5. A Papoulis, “Probability, Random Variables And Stochastic Processes”, 3rd Edition, McGraw Hill, 2002
6. John B Thomas, “An Introduction to Applied Probability and Random Processes”, John Wiley, 2000
7. Hillier F S and Lieberman G J, “Introduction to Operations Research”, 7th Edition, McGraw Hill, 2001
8. Simmons D M, “NonLinear Programming for Operations Research”, PHI, 1975

Course Code	**PCCPSC105**			**Semester**	**FIRST**
Category	**Professional Core Course**				
Course Title	**Research Methodology and IPR**				
Scheme & Credits	**L**	**T**	**P**	**Credits**	**Max Marks: 100**
	2	**0**	**0**	**2**	
Prerequisites	**Nil**				

Course Objectives:-

1. Understand research problems
2. Learn about effective literature studies technical writing
3. Learn about patents & patent rights

Unit	Content
1.	Meaning of research problem, Sources of research problem, Criteria Characteristics of a good research problem, Errors in selecting a research problem, Scope and objectives of research problem. Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, Necessary instrumentations
2.	Effective literature studies approaches, analysis Plagiarism, Research ethics,
3.	Effective technical writing, how to write report, Paper, Developing a Research Proposal, Format of research proposal, a presentation and assessment by a review committee
4.	Nature of Intellectual Property: Patents, Designs, Trade and Copyright. Process of Patenting and Development: technological research, innovation, patenting, development. International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under PCT.
5.	Patent Rights: Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications.
6.	New Developments in IPR: Administration of Patent System. New developments in IPR; IPR of Biological Systems, Computer Software etc. Traditional knowledge Case Studies, IPR and IITs

Textbooks:

1. Stuart Melville and Wayne Goddard, “Research methodology: an introduction for science & engineering students’”
2. Wayne Goddard and Stuart Melville, “Research Methodology: An Introduction”
3. Ranjit Kumar, 2nd Edition , “Research Methodology: A Step by Step Guide for beginners”
4. Halbert, “Resisting Intellectual Property”, Taylor & Francis Ltd ,2007.
5. Mayall , “Industrial Design”, McGraw Hill, 1992.
6. Niebel , “Product Design”, McGraw Hill, 1974.
7. Asimov , “Introduction to Design”, Prentice Hall, 1962.
8. Robert P. Merges, Peter S. Menell, Mark A. Lemley, “ Intellectual Property inNew Technological Age”, 2016.
9. T. Ramappa, “Intellectual Property Rights Under WTO”, S. Chand, 2008

Course Code	**PCCPSC106L**			**Semester**	**FIRST**
Category	**Professional Core Course**				
Course Title	**Advanced Power System Lab**				
Scheme & Credits	**L**	**T**	**P**	**Credits**	**Max Marks: 100**
	0	**0**	**4**	**2**	
Prerequisites	**Nil**				

List of Experiments:

S. No.	Experiments
1.	Load flow for AC systems, fast decoupled load flow, optimal power flow
2.	Z - matrix for short circuit studies
3.	State estimation, LO algorithm, fast decoupled state estimation.
4.	Security and contingency studies.
5.	Unit Commitment
6.	Load frequency control.
7.	Optimal hydro-thermal scheduling.
8.	Optimal hydro-thermal scheduling.