SYLLABUS
FOR
M.TECH. PROGRAMME
IN
POWER SYSTEM AND CONTROL

DEPARTMENT OF ELECTRICAL ENGINEERING
UNIVERSITY OF KASHMIR
SRINAGAR

NOVEMBER – 2021
(Applicable to Batch 2021 & Onwards)

M.TECH IN POWER SYSTEM AND CONTROL
UNDER THE CHOICE BASE CREDIT SYSTEM (CBCS)

Code	Nomenclature
PCC	Professional Core Course
PEC	Professional Elective Course
OEC	Open Elective Course
ISE	Internal Semester Evaluation
MSE	Mid Semester Evaluation (35 Marks)
ESE	End Semester Evaluation

Code	Nomenclature
L	Lecture
T	Tutorial
P	Practical
IA	Internal Assessment (Assignment + Quiz/ Viva Voce (10 Marks) + Attendence (5 Marks)

COURSE STRUCTURE

Semester-1 (One)						**Examination Scheme (Distribution of Marks)**			
Course Code	**Course Title**	**L**	**T**	**P**	**Credits**	**ISE**		**ESE**	**Total**
						MSE	**IA**		
PCCPSC101	Power System Analysis	3	1	0	4	35	15	50	100
PCCPSC102	Power System Operation, Control and Optimization	3	1	0	4	35	15	50	100
PCCPSC103	Dynamics Of Linear Systems	3	1	0	4	35	15	50	100
PEC*PSC104	Professional Elective- I	3	1	0	4	35	15	50	100
PCCPSC105	Research Methodolgy and IPR	2	0	0	2	35	15	50	100
PCCPSC106L	Advanced Power System Lab	0	0	4	2	50		50	100
Total		14	4	4	20				600

Semester-2 (Two)						**Examination Scheme (Distribution of Marks)**			
Course Code	**Course Title**	**L**	**T**	**P**	**Credits**	**ISE**		**ESE**	**Total**
						MSE	**IA**		
PCCPSC201	Power Quality	3	1	0	4	35	15	50	100
PCCPSC202	Power System Dynamics	3	1	0	4	35	15	50	100
PCCPSC203	Nonlinear Systems and Control	3	1	0	4	35	15	50	100
PEC*PSC204	Professional Elective- II	3	1	0	4	35	15	50	100
PCCPSC205L	Power Quality and Renewable Energy Lab	0	0	4	2	35	15	50	100
PCCPSC206	Seminar	0	0	4	2	50		50	100
Total		12	4	8	20				600

Semester-3 (Three)						**Examination Scheme (Distribution of Marks)**			
Course Code	**Course Title**	**L**	**T**	**P**	**Credits**	**ISE**		**ESE**	**Total**
						MSE	**IA**		
PEC*PSC301	Professional Elective- III	3	1	0	4	35	15	50	100
OEC*PSC302	Open Elective	3	1	0	4	35	15	50	100
PCCPSC303L	Python Lab	0	0	4	2	50		50	100
PCCPSC304	Phase – I Dissertation	0	0	16	8	50		50	100
Total		6	2	20	18				400

Semester-4 (Four)						**Examination Scheme (Distribution of Marks)**			
Course Code	**Course Title**	**L**	**T**	**P**	**Credits**	**ISE**		**ESE**	**Total**
						MSE	**IA**		
PCCPSC401	Phase – II Dissertation	0	0	32	16	50		50	100
Total		0	0	32	16				100

* 1to 6

Total Credits=74

Professional Elective Courses

Course Code	Course Title	Elective	Semester
PEC1PSC104	Renewable Energy Systems	I (PEI)	1st
PEC2PSC104	Smart Grid		
PEC3PSC104	High Power Converters		
PEC4PSC104	Electrical Power Distribution System		
PEC5PSC104	Mathematical and Computational Methods for Power Engineering		
PEC1PSC204	Restructured Power Systems	II (PEII)	2nd
PEC2PSC204	Advanced Signal Processing		
PEC3PSC204	Digital Protection of Power Systems		
PEC4PSC204	SCADA System and Applications		
PEC5PSC204	Electric and Hybrid Vehicles		
PEC1PSC301	Artificial Intelligence	III (PEIII)	3rd
PEC2PSC301	Power System Transients		
PEC3PSC301	FACTS		
PEC4PSC301	Industrial Load Modelling		
PEC5PSC301	Optimal Control		
PEC6PSC301	HVDC Systems		

Open Elective Courses

Course Code	Course Title	Elective	Semester
OEC1PSC302	Python Data Analytics	I (OE)	3rd
OEC2PSC302	Waste to energy		
OEC3PSC302	Composite Materials		
OEC4PSC302	Cost Management of Engineering Projects		

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.

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>
</table>

SYLLABUS

FOR

SEMESTER THIRD

Course Code	**PEC1PSC301**			**Semester**	**Third**
Category	**Professional Core Course(PEIII)**				
Course Title	**Artificial Intelligence**				
Scheme & Credits	**L**	**T**	**P**	**Credits**	**Max Marks: 100**
	3	**1**	**0**	**4**	
Prerequisites	**Nil**				

Course Objectives:-

1. Understanding fuzzy logic, ANN
2. Understanding GA & EP

Unit	Content
1.	Biological foundations to intelligent Systems, Artificial Neural Networks, Single layer and Multilayer Feed Forward NN, LMS and Back Propagation Algorithm, Feedback networks and Radial Basis Function Networks
2.	Fuzzy Logic, Knowledge Representation and Inference Mechanism, Defuzzification Methods
3.	Fuzzy Neural Networks, some algorithms to learn the parameters of the network like GA
4.	System Identification using Fuzzy and Neural Network
5.	Genetic algorithm, Reproduction crossover, mutation, Introduction to evolutionary program
6.	Applications of above mentioned techniques to practical problems

Textbooks:

1. J M Zurada , “An Introduction to ANN”,Jaico Publishing House
2. Simon Haykins, “Neural Networks”, Prentice Hall
3. Timothy Ross, “Fuzzy Logic with Engg.Applications”, McGraw. Hill
4. Driankov, Dimitra, “An Introduction to Fuzzy Control”, Narosa Publication
5. Golding, “Genetic Algorithms”, Addison-Wesley Publishing Com

Course Code	PEC2PSC301			Semester	Third
Category	Professional Core Course(PEIII)				
Course Title	Power System Transients				
Scheme & Credits	L	T	P	Credits	Max Marks: 100
	3	1	0	4	
Prerequisites	Power System				

Course Objectives:

1. Learn the reasons for occurrence of transients in a power system
2. Understand the change in parameters like voltage & frequency during transients
3. To know about the lightning phenomenon and its effect on power system

Unit	Content
1.	Fundamental circuit analysis of electrical transients, Laplace Transform method of solving simple Switching transients, Damping circuits-Abnormal switching transients, Three-phase circuits and transients,Computation of power system transients
2.	Principle of digital computation – Matrix method of solution, Modal analysis- Z transform-Computation using EMTP, Lightning, switching and temporary over voltages, Lightning, Physical phenomena of lightning.
3.	Interaction between lightning and power system, Influence of tower footing resistance and Earth Resistance, Switching: Short line or kilometric fault Energizing transients - closing and Re-closing of lines, line dropping, load rejection – over voltages induced by faults
4.	Switching HVDC lineTravelling waves on transmission line, Circuits with distributed Parameters Wave Equation, Reflection, Refraction, Behaviour of Travelling waves at the line terminations, Lattice Diagrams – Attenuation and Distortion Multi-conductor system and Velocity wave
5.	Insulation coordination: Principle of insulation coordination in Air Insulated substation (AIS) and Gas Insulated Substation (GIS) Co- ordination between insulation and protection level, Statistical approach
6.	Protective devices: Protection of system against over voltages, lightning arresters, substation earthing

Textbooks:

1. Allan Greenwood, “Electrical Transients in Power System”, Wiley & Sons Inc. New York, 1991

Course Code	PEC3PSC301			Semester	Third
Category	Professional Core Course(PEIII)				
Course Title	FACTS				
Scheme & Credits	L	T	P	Credits	Max Marks: 100
	3	1	0	4	
Prerequisites	Nil				

Objectives:-

1. To learn the active and reactive power flow control in power system
2. To understand the need for static compensators
3. To develop the different control strategies used for compensation

Unit	Content
1.	Introduction to FACTS Technology, Types of FACTS controller, FACTS vs. HVDC, Benefits of FACTS Technology,Performance Equations and Parameters of Transmission Lines,Transfer of Active and Reactive Power over a Transmission Line,Uncompensated Transmission, Need for Compensation, Definition and Functions of compensation.
2.	Compensation Techniques: Ideal Shunt compensation, Ideal Series compensation, Phase-Angle control (Regulator),Advantages of Series compensation (voltage support, Transient stability improvement, Power oscillation damping), Advantages of shunt compensation, Thyristor Controlled Reactor (TCR), Thyristor-Switched Capacitor (TSC).
3.	Analysis of various types of Static Var compensators (SVC),Static Synchronous Compensator (STATCOM): Analysis and comparison with SVC, STATCOM convertors (Multi-level VSIs for STATCOM applications),Series compensators: GTO-Controlled Series Capacitor (GCSC),Thyristor-Switched Series Capacitor (TSSC), Thyristor-Controlled Series Capacitor (TCSC),Static Synchronous Series Compensator (SSSC).
4.	Voltage & Phase-Angle Regulation,Thyristor-Controlled Voltage Regulator (TCVR), Thyristor Controlled Phase-Angle Regulator (TCPAR)
5.	Series-Shunt compensator: Unified Power Flow Controller (UPFC),Series-Series compensator: Interline Power Flow Controller (IPFC) ,Thyristor Controlled Braking Resistor (TCBR), Modeling of some FACTS controllers.

Textbooks:

1. K R Padiyar, “FACTS Controllers in Power Transmission and Distribution”, New Age International Publishers, 2007
2. X P Zhang, C Rehtanz, B Pal, “Flexible AC Transmission Systems- Modelling and Control”, SpringerVerlag, Berlin, 2006
3. N.G. Hingorani, L. Gyugyi, “Understanding FACTS: Concepts and Technology of Flexible AC Transmission Systems”, IEEE Press Book, Standard Publishers and Distributors, Delhi, 2001.
4. K.S.Sureshkumar ,S.Ashok , “FACTS Controllers & Applications”, E-book edition, Nalanda DigitalLibrary, NIT Calicut,2003

Course Code	PEC4PSC301			Semester	Third
Category	Professional Core Course(PEIII)				
Course Title	Industrial Load Modeling and Control				
Scheme & Credits	L	T	P	Credits	Max Marks: 100
	3	1	0	4	
Prerequisites	Nil				

Course Objectives:-

1. To understand the energy demand scenario
2. To understand the modeling of load and its ease to study load demand industrially
3. To know Electricity pricing models
4. Study Reactive power management in Industries

Unit	Content
1.	Electric Energy Scenario-Demand Side Management-Industrial Load Management Load Curves-Load Shaping Objectives, Methodologies-Barriers, Classification of Industrial Loads, Continuous and Batch processes -Load Modeling
2.	Electricity pricing – Dynamic and spot pricing -Models, Direct load control- Interruptible load control, Bottom up approach- scheduling- Formulation of load Models,Optimization and control algorithms - Case studies
3.	Reactive power management in industries, controls-power quality impact, application of filters Energy saving in industries
4.	Cooling and heating loads
5.	load profiling, Modeling- Cool storage, Types-Control strategies, Optimal operation,Problem formulation- Case studies
6.	Captive power units, Operating and control strategies, Power Pooling- Operation models, Energy banking, Industrial Cogeneration

Textbooks:

1. C.O. Bjork " Industrial Load Management - Theory, Practice and Simulations", Elsevier, the Netherlands,1989
2. C.W. Gellings and S.N. Talukdar,. Load management concepts. IEEE Press, New York, 1986, pp. 3-28
3. Y. Manichaikul and F.C. Schweppe ," Physically based Industrial load", IEEE Trans. on PAS, April 1981
4. H. G. Stoll, "Least cost Electricity Utility Planning", Wiley Interscience Publication, USA, 1989.
5. I.J. Nagarath and D.P.Kothari, .Modern Power System Engineering., Tata McGraw Hillpublishers, NewDelhi, 1995
6. IEEE Bronze Book- "Recommended Practice for Energy Conservation and cost effective planning in Industrial facilities", IEEE Inc, USA

Course Code	**PEC5PSC301**			**Semester**	**Third**
Category	**Professional Core Course(PEIII)**				
Course Title	**Optimal Control**				
Scheme & Credits	**L**	**T**	**P**	**Credits**	**Max Marks: 100**
	3	**1**	**0**	**4**	
Prerequisites	**Nil**				

Course Objectives:-

1. To know the operation of closed and open loop optimal control.
2. Understand the adaptive control strategies.
3. Learn dynamic programming methods.

Unit	Content
1.	Introduction and Review of Basic Concepts,Introduction, Motivation and Overview Overview of SSApproach and Matrix Theory, Review of Numerical Methods
2.	Static Optimization
3.	Optimal Control through Calculus of Variation
4.	Classical Numerical Techniques for Optimal Control
5.	Linear Quadratic Regulator (LQR) Theory
6.	Optimal Missile Guidance, Linear Optimal Missile Guidance using LQR
7.	LQ Observer and Kalman Filter Design, Linear Quadratic Observer & An Overview of State Estimation, Review of Probability Theory and Random Variables, Kalman Filter Design

Textbooks:

1. Donald E. Kirk, “Optimal Control Theory, An introduction”, Prentice Hall Inc., 2004
2. A.P. Sage, “Optimum Systems Control”, Prentice Hall, 1977
3. HSU and Meyer , “Modern Control, Principles and Applications”, McGraw Hill, 1968
4. Yoan D. Landu, “Adaptive Control (Model Reference Approach)”, Marcel Dekker. 1981
5. K.K.D.Young, “Design of Variable Structure Model Following Control Systems”, IEEE Transactions on Automatic Control, Vol. 23, pp 1079-1085, 1978.

Course Code	PEC6PSC301			Semester	Third
Category	Professional Core Course(PEIII)				
Course Title	HVDC				
Scheme & Credits	L	T	P	Credits	Max Marks: 100
	3	1	0	4	
Prerequisites	Nil				

Course Objectives:-

1. Understand the advantages of dc transmission over ac transmission.
2. Understand the operation of Line Commutated Converters and Voltage Source Converters.
3. Understand the control strategies used in HVDC transmission systems.
4. Understand the improvement of power system stability using an HVDC system

Unit	Content
1.	Evolution of HVDC Transmission,Comparison of HVAC and HVDC systems,Type of HVDC Transmission systems, Components of HVDC transmission systems
2.	Analysis of simple rectifier circuits, Required features of rectification circuits for HVDC transmission, Analysis of HVDC converter. a. Different modes of converter operation. b. Output voltage waveforms and DC voltage in rectification. c. Output voltage waveforms and DC in inverter operation. d. Thyristor voltages.
3.	HVDC system control features. Control Modes. Control Schemes. Control comparisons.
4.	Converter mal-operations.Commutation failure. Starting and shutting down the converter bridge. Converter protection.
5.	Smoothing reactor.Reactive power requirements. Harmonic analysis. Filter design.
6.	Power flow analysis of AC-DC systems.
7.	Multi-terminal HVDC system. Advances in HVDC transmission.

Textbooks:

1. HVDC Power Transmission Systems, K.R. Padiyar, New Age International
2. Power System Stability and control, Prabha Kundur, Tata McGraw-Hill

Course Code	**OEC1PSC302**			**Semester**	**Third**
Category	**Professional Core Course(OE)**				
Course Title	**Python Data Analytics**				
Scheme & Credits	**L**	**T**	**P**	**Credits**	**Max Marks: 100**
	3	**1**	**0**	**4**	
Prerequisites	**Nil**				

Course Objectives:-

1. To understand the importance of data science
2. To experience and apply Python's diverse array of packages

Unit	Content
1.	Introduction to data analytics, Python Fundamentals, Central Tendency and Dispersion Probability and Probability Distributions, Sampling and Sampling Distribution Confidence interval estimation
2.	Hypothesis Testing; Errors in Hypothesis Testing, ANOVA, Post Hoc Analysis, Randomized block design (RBD),Two Way ANOVA
3.	Linear Regression,Estimation, Prediction of Regression Model Residual Analysis MULTIPLE REGRESSION MODEL; Categorical variable regression
4.	Maximum Likelihood Estimation, LOGISTIC REGRESSION,Linear Regression Model Vs Logistic Regression Model, Confusion matrix and ROC, Performance of Logistic Model Regression Analysis Model Building
5.	Chi - Square Test of Independence, Chi-Square Goodness of Fit Test, Cluster analysis Energy banking, Industrial Cogeneration
6.	K- Means Clustering, Hierarchical method of clustering, Classification and Regression Trees, Measures of attribute selection

Textbooks:

1. Grus, Joel, "Data Science from Scratch: First Principles with Python ", O'Reilly Media, 2019
2. Wes Kinney, "Python for Data Analysis", O'Reilly Media, 2018
3. Abhishek Thakur, "Approaching (Almost) Any Machine Learning Problem", 2020
4. Trevor Hastie, Robert Tibshirani, Jerome Friedman, "The Elements of Statistical Learning: Data Mining, Inference, and Prediction", Springer, 2013

Course Code	OEC2PSC302			Semester	Third
Category	Professional Core Course(OE)				
Course Title	Waste to Energy				
Scheme & Credits	L	T	P	Credits	Max Marks: 100
	3	1	0	4	
Prerequisites	Nil				

Course Objectives:-

1. How waste can be used as fuel
2. Uses of Biomass

Unit	Content
1.	Introduction to Energy from Waste: Classification of waste as fuel – Agro based, Forest residue, Industrial waste - MSW – Conversion devices – Incinerators, gasifiers, digestors
2.	Biomass Pyrolysis: Pyrolysis – Types, slow fast – Manufacture of charcoal – Methods - Yields and application – Manufacture of pyrolytic oils and gases, yields and applications.
3.	Biomass Gasification: Gasifiers – Fixed bed system – Downdraft and updraft gasifiers – Fluidized bed gasifiers – Design, construction and operation – Gasifier burner arrangement for thermal heating – Gasifier engine arrangement and electrical power – Equilibrium and kinetic consideration in gasifier operation.
4.	Biomass Combustion: Biomass stoves – Improved chullahs, types, some exotic designs, Fixed bed combustors, Types, inclined grate combustors, Fluidized bed combustors, Design, construction and operation - Operation of all the above biomass combustors.
5.	Biogas: Properties of biogas (Calorific value and composition) - Biogas plant technology and status - Bio energy system - Design and constructional features - Biomass resources and their classification - Biomass conversion processes - Thermo chemical conversion - Direct combustion - biomass gasification - pyrolysis and liquefaction - biochemical conversion - anaerobic digestion - Types of biogas Plants – Applications - Alcohol production from biomass - Biodiesel production - Urban waste to energy conversion - Biomass energy programme in India.

Textbooks:-

1. Non Conventional Energy, Desai, Ashok V., Wiley Eastern Ltd., 1990.
2. Biogas Technology - A Practical Hand Book - Khandelwal, K. C. and Mahdi, S. S., Vol. I & II, Tata McGraw Hill Publishing Co. Ltd., 1983.
3. Food, Feed and Fuel from Biomass, Challal, D. S., IBH Publishing Co. Pvt. Ltd., 1991.
4. Biomass Conversion and Technology, C. Y. WereKo-Brobby and E. B. Hagan, John Wiley & Sons, 1996.

Course Code	OEC3PSC302			Semester	Third
Category	Professional Core Course(OE)				
Course Title	Composite Material				
Scheme & Credits	L	T	P	Credits	Max Marks: 100
	3	1	0	4	
Prerequisites	Nil				

Course Objectives:-

1. Have a deep understanding of composite materials
2. Understand about Manufacturing of polymer & metal matrix composites

Unit	Content
1.	INTRODUCTION: Definition – Classification and characteristics of Composite materials. Advantages and application of composites. Functional requirements of reinforcement and matrix. Effect of reinforcement (size, shape, distribution, volume fraction) on overall composite performance.
2.	REINFORCEMENTS: Preparation-layup, curing, properties and applications of glass fibers, carbon fibers, Kevlar fibers and Boron fibers. Properties and applications of whiskers, particle reinforcements. Mechanical Behavior of composites: Rule of mixtures, Inverse rule of mixtures. Isostrain and Isostress conditions.
3.	Manufacturing of Metal Matrix Composites: Casting – Solid State diffusion technique, Cladding – Hot isostatic pressing. Properties and applications. Manufacturing of Ceramic Matrix Composites: Liquid Metal Infiltration – Liquid phase sintering. Manufacturing of Carbon – Carbon composites: Knitting, Braiding, Weaving. Properties and applications.
4.	Manufacturing of Polymer Matrix Composites: Preparation of Moulding compounds and prepregs – hand layup method – Autoclave method – Filament winding method – Compression moulding – Reaction injection moulding. Properties and applications.
5.	Manufacturing of Polymer Matrix Composites: Preparation of Moulding compounds and prepregs– hand layup method – Autoclave method – Filament winding method – Compression moulding – Reaction injection moulding. Properties and applications.

Textbooks:

1. Non Conventional Energy, Desai, Ashok V., Wiley Eastern Ltd., 1990.
2. Biogas Technology - A Practical Hand Book - Khandelwal, K. C. and Mahdi, S. S., Vol. I & II, Tata McGraw Hill Publishing Co. Ltd., 1983.
3. Food, Feed and Fuel from Biomass, Challal, D. S., IBH Publishing Co. Pvt. Ltd., 1991.
4. Biomass Conversion and Technology, C. Y. WereKo-Brobby and E. B. Hagan, John Wiley & Sons, 1996.

Course Code	OEC4PSC302			Semester	Third
Category	Professional Core Course(OE)				
Course Title	Cost Management and Engineering Projects				
Scheme & Credits	L	T	P	Credits	Max Marks: 100
	3	1	0	4	
Prerequisites	Nil				

Course Objectives:-

1. Understand about the process of strategic cost management
2. Decision making , role of project teams in projects, cost behaviour & profit planning

Unit	Content
1.	Introduction and Overview of the Strategic Cost Management Process
2.	Cost concepts in decision-making; Relevant cost, Differential cost, Incremental cost and Opportunity cost. Objectives of a Costing System; Inventory valuation; Creation of a Database for operational control; Provision of data for Decision-Making.
3.	Project: meaning, Different types, why to manage, cost overruns centres, various stages of project execution : conception to commissioning. Project execution as a conglomeration of technical and non technical activities. Detailed Engineering activities. Pre project execution main clearances and documents
4.	Project team : Role of each member. Importance Project site : Data required with significance. Project contracts. Types and contents. Project execution Project cost control. Bar charts and Network diagram. Project commissioning: mechanical and process
5.	Cost Behavior and Profit Planning Marginal Costing; Distinction between Marginal Costing and Absorption Costing; Break-even Analysis, Cost-Volume-Profit Analysis. Various decision-making problems. Standard Costing and Variance Analysis. Pricing strategies: Pareto Analysis. Target costing, Life Cycle Costing. Cost of service sector. Just-in-time approach, Material Requirement Planning, Enterprise Resource Planning, Total Quality Management and Theory of constraints. Activity-Based Cost Management,
6.	Benchmarking; Balanced Scorecard and Value-Chain Analysis. Budgetary Control; Flexible Budgets; Performance budgets; Zero-based budgets. Measurement of Divisional profitability pricing decisions including transfer pricing. Quantitative techniques for cost management, Linear Programming, PERT/CPM, Transportation problems, Assignment problems, Simulation, Learning Curve Theory

Textbooks:

1. Cost Accounting A Managerial Emphasis, Prentice Hall of India, New Delhi
2. Charles T. Horngren and George Foster, Advanced Management Accounting
3. Robert S Kaplan Anthony A. Alkinson, Management & Cost Accounting
4. Ashish K. Bhattacharya, Principles & Practices of CostAccounting A. H. Wheeler publisher
5. N.D. Vohra, Quantitative Techniques in Management, Tata McGraw Hill Book Co. Ltd.

Course Code	**PCCPSC303**			**Semester**	**Third**
Category	**Professional Core Course**				
Course Title	**PYTHON LAB**				
Scheme & Credits	**L**	**T**	**P**	**Credits**	**Max Marks: 100**
	0	**0**	**4**	**2**	
Prerequisites	**Nil**				

List of Experiments:

S. No.	Experiment
1.	Introduction to Python:Plotting, Saving Scripts, Numpy Arrays, IPython Notebooks
2.	Basic Data Types, Control Flow, Core Data Structures
3.	Functions; Files and Modules; Exceptions
4.	Pandas experiments
5.	Data visualisation
6.	Case studies on classification
7.	Case studies on regression
8.	Text mining and modelling
9.	Case studies and experiments on social media sentiment analysis
10.	Experiments on browser automation and office-work optimisation

Course Code	**PCCPSC304**			**Semester**	**Third**
Category	**Programme Core Course**				
Course Title	**Phase – I Dissertation**				
Scheme & Credits	**L**	**T**	**P**	**Credits**	**Max Marks: 100**
	0	**0**	**16**	**8**	
Prerequisites	**All core courses**				

The Phase – I Dissertation work is carried out by an individual student. In this work, students shall choose a specific topic/area for the project. The selected areas shall encompass recent and emerging trends in technologies that prove beneficial for society in general and humanity in particular. Supervisors will be assigned to each student in the beginning of the 3rd semester of their course. Each student at the end of the course will submit a Project report and a working prototype or simulation regarding the project and the same will be evaluated for final award of the course. The Phase – I Dissertation can be a full-fledged project or a part of a Phase – II Dissertation.

SYLLABUS

FOR

SEMESTER FOURTH

<table>
<tr><td>Course Code</td><td colspan="3">PCCPSC401</td><td>Semester</td><td>Fourth</td></tr>
<tr><td>Category</td><td colspan="5">Programme Core Course</td></tr>
<tr><td>Course Title</td><td colspan="5">Phase – II Dissertation</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>32</td><td>16</td></tr>
<tr><td>Prerequisites</td><td colspan="5">All core courses</td></tr>
<tr><td colspan="6">In the Phase – II Dissertation, the students are required to extend the Phase – I Dissertation for the final submission of the course. The final work is to be carried out in the last semester of their respective fields of study. The supervisors will guide the students from the beginning of the Phase – I Dissertation in 3rd semester to its accomplishment as a final project in the 4th semester.
The students will be asked to submit a project report. These reports will be evaluated in partial fulfilment for the award of the degree of masters of Technology in their branches of study.</td></tr>
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