M. Tech. Scheme &Syllabus

(Power System Specialization)

W. E. F. 2012-13

Department of Electrical Engineering

National Institute of Technology, Kurukshetra

FIRST SEMESTER

Course No.	Title	Schedule of Teaching				Credit Point
		Lecturer	Tutorial	Practical	Total	
EE 531T	Advanced Power System Analysis	3	-	-	3	3
EE 533T	Extra High Voltage AC Transmission	3	-	-	3	3
EE 535T	Power System Dynamics and Stability	3	-	-	3	3
	Elective-I	3	-	-	3	3
	Elective-II	3	-	-	3	3
EE 545P	Power System Lab	-	-	2	2	1
EE 547P	Programming Lab.-I	-	-	2	2	1
EE 549P	SEMINAR-I	-	-	2	2	1
	Total	15	-	6	21	18

Weightage for Theory Courses:
During Semester Evaluation Weightage – 50%
End Semester Examination Weightage – 50%

Weightage for Lab. Courses:
During Semester Evaluation Weightage – 60%
End Semester Examination Weightage – 40%

List of Electives (Any two electives are to be studied selecting one from each group).
Elective-I

1. EE 537T Power System Planning(Elective with PED)
2. EE 539T Transients in Power System
3. EE 509T Optimization Theory (Elective in CS, PS, & PED)
4. EE 511T Information Security (Elective in CS, PS, & PED)
5. EE 519T Digital Signal Processing (Elective in CS, PS, & PED)

Elective-II

1. EE 503T Digital Control Systems (Core in CS & Elective with PED)
2. EE 505T Identification and Estimation(Core in CS & Elective with PED)
3. EE 513T Reliability Engineering. (Elective in CS, PS, & PED)
4. EE 541T Power quality Monitoring, Analysis & Control.
5. EE 543T Power System Operation in Restructured Environment
6. EE 563T Advanced Theory of Electric Machinery(Core in PED)

NOTE:

i) A program may have one or two laboratory courses spread over four periods
ii) Sufficient number of electives to be offered subject to the condition that each elective should have at least five students.

SECOND SEMESTER

Course No.	Title	Schedule of Teaching				Credit Point
		Lecturer	Tutorial	Practical	Total	
EE 532T	Power System Operation and Control	3	-	-	3	3
EE 534T	Reactive power control and FACTS Devices	3	-	-	3	3
	Elective-I	3	-	-	3	3
	Elective-II	3	-	-	3	3
	Elective-III	3	-	-	3	3
EE 548P	Programming Lab.-II	-	-	2	2	1
EE 550P	Software Lab.	-	-	2	2	1
EE 552P	SEMINAR-II	-	-	2	2	1
	Total	15	-	6	21	18

Weightage for Theory Courses:
During Semester Evaluation Weightage – 50%
End Semester Examination Weightage – 50%

Weightage for Lab. Courses:
During Semester Evaluation Weightage – 60%
End Semester Examination Weightage – 40%

List of Electives(Any three electives are to be studied selecting one from each group).
Elective-I

1. EE 536T Advanced Power System Protection (Elective with PED)
2. EE 544T Power System Communication
3. EE 566T Computer Aided Design of Electrical Machines(Elective IN PED)
4. EE 568T Renewable Energy Resources (Elective with CS and PS)
5. EE 502T Non-linear and Adaptive control (Core in CS and Elective in PED)

Elective-II

6. EE 538T Electrical Power Distribution and Automation
7. EE 540T Advanced stability Analysis
8. EE 570T Wind Energy in Power System (Elective in CS, PS, & PED)
9. EE 572T Energy Management (Elective in CS, PS, & PED)
10. EE 508T Intelligent Control (Elective in CS, PS, & PED)

Elective-III

11. EE 542T HVDC transmission (Elective with PED)
12. EE 546T Distributed Generation and Control (Elective IN PED)
13. EE 516T Virtual Instrumentation (Elective in CS, PS, & PED)
14. EE 518T Cryptography (Elective in CS, PS, & PED)
15. EE 520T Functional Analysis in Systems and Control (Elective in CS)

NOTE:

i) A program may have one or two laboratory courses spread over four periods.
ii) Sufficient number of electives to be offered subject to the condition that each elective should have at least five students.

THIRD SEMESTER

Course No.	Title	Schedule of Teaching				Credit Point
		Lecturer	Tutorial	Practical	Total	
EE 611P	Preparatory Work for Dissertation	0	0	20	20	10
					20	10

NOTE: The Preparatory Work for Dissertation shall be evaluated by a committee comprising the following {on the basis of one mid semester seminar and one end semester seminar presented and one end semester report submitted by the candidate}.

1. HOD or faculty nominee proposed by HOD.
2. Dissertation Supervisor (and co-supervisor).
3. Two senior most faculty members of the department.

FOURTH SEMESTER

Course No.	Title	Schedule of Teaching				Credit Point
		Lecturer	Tutorial	Practical	Total	
EE 612P	Dissertation	0	0	32	32	16
					32	16

NOTE:

I. The Dissertation shall be evaluated by a committee comprising the following through
presentation cum viva-voce examination.

1. HOD or faculty nominee proposed by HOD.
2. Dissertation Supervisor (and co-supervisor).
3. One external expert appointed by the department.

II. For award of grade, following criteria to be used.

Grade	Conditions to be fulfilled
A+	One paper accepted/published in SCI Journal
A	One good quality paper accepted/published in non-paid journal or two good quality papers presented in International/National Conference.*
B	One good quality paper presented in International Conference
C/D	In other cases

* Conference organized by IIT/NIT/a premier R & D organization.

Non-Credit Based Dissertation Evaluation

SEMESTER-I

MASTER OF TECHNOLOGY (ELECTRICAL ENGINEERING)
POWER SYSTEM SPECIALIZATION
W.E.F. 2012-13

Course No. EE-531T **ADVANCED POWER SYSTEM ANALYSIS**
(Elective in PED)

L	T	P	Total	
3	0	0	3	**Credits-3**

Duration of Exam- Three hours
During Semester Evaluation Weightage- 50%
End Semester Examination Weightage- 50%

Bus Impedance Algorithm: Partial network, building algorithm for bus impedance matrix, Addition of links, addition of branches, (considering mutual coupling) removal of links, modification of bus impedance matrix for network changes, Formation of bus admittance matrix and modification, Gauss elimination, Node elimination (Kron reduction), LU factorization, Schemes of Ordering, Sparsity, Calculation of Z bus elements for Y bus, Numerical examples

Balanced and unbalanced network elements: Representation of three phase network elements, representation under balanced and unbalanced excitation, transformation matrices, symmetrical components, sequence impedances, unbalanced elements, three phase power invariance.

Short circuit studies: Network representations for single line to ground fault, line to line fault, LL-G fault, and 3-phase faults, network short circuit studies using Z bus, Short circuit calculations for various types of faults in matrix form, numerical examples.

Load flow studies: Load flow and its importance. classification of buses, load flow techniques, Iterative solutions and computer flow charts using Gauss-Seidel and Newton-Raphson methods, Decoupled and fast decoupled methods, representation of regulating and off nominal ratio transformers and modification of Ybus, comparison of methods, numerical examples.

Introduction to AC-DC load flow problems: formation and solutions.

Power system security: Introduction to Power system security, Adding removing multiple lines, piece-wise solution of interconnected systems, analysis of single and multiple contingencies, analysis with sensitivity factors, system reduction for contingency and fault analysis.

REFERENCES:

1. G.W. Stagg & A.H EI-Abaid, 'Computer methods in Power system analysis', McGraw Hill, New York.
2. M. A. Pai, 'Computer Techniques in Power System Analysis', 2nd Edi., TMH-New Delhi.
3. Kusic., 'Computer-Aided Power System Analysis', Prentice Hall of India, New Delhi.
4. John J.Grainger and W.D.Stevenson, 'Power System Analysis', McGraw Hill, New York, 1994.
5. A.J. Wood & W.F. Wollenberg, 'Power Generation, Operation, and Control', 2nd Edn, John Wiley & Sons, New York, 1996.
6. O.I. Elgerd, 'Electric Energy Systems Theory: An Introduction', McGraw Hill, New York, 1982.
7. J. Arrillaga, C.P Arnold & Harker, 'Computer Modeling of Electrical Power Systems', John Wiley & Sons.
8. Enrique Acha et al., 'FACTS: Modeling and Simulation in Power Networks', John Wiley and Sons Ltd., 2004.
9. Kothari and Dhillon, 'Power Systems Optimization', PHI, 2004.

MASTER OF TECHNOLOGY (ELECTRICAL ENGINEERING)
POWER SYSTEM SPECIALIZATION
W.E.F. 2012-13

Course No. EE-533T Extra High Voltage AC Transmission

L	T	P	Total	
3	0	0	3	

Credits-3
Duration of Exam- Three hours
During Semester Evaluation Weightage- 50%
End Semester Examination Weightage- 50%

Introduction: Role of EHV AC Transmission, Standard transmission voltages, Average values of line parameters.

Line Parameters- Properties of bundled conductors, Resistance, inductance and capacitance of bundled conductor lines, calculation of sequence inductances and capacitances Temperature rise of conductors and it's current carrying capacity.

Voltage Gradient: Charge potential relations for multi-conductor lines, Surface voltage gradient on conductors, Distribution of voltage gradient on sub-conductors of bundle.

Corona: Corona loss, Audible noise, Day –night equivalent noise level, Radio interference, Excitation function.

Over Voltages: Origin of over voltages and their types, over voltage problems, Over voltages due to interruption of low inductive current and interruption of capacitive currents, Problems regarding power frequency over voltages, Reduction of switching surges and static reactive compensating schemes.

REFERENCES:-

1. Rakosh Das Begamudre, "Extra High Voltage AC Transmission Engineering", (Third edition) Newage International (P) Ltd., New Delhi, 2006.
2. Power Engineer's Handbook, Revised and Enlarged 6th Edition, TNEB Engineers' Association, October 2002.
3. Rudenberg, "Transient performance of electric power systems"' Mc Graw Hill.

MASTER OF TECHNOLOGY (ELECTRICAL ENGINEERING)
POWER SYSTEM SPECIALIZATION
W.E.F. 2012-13

Course No. EE-535T Power System Dynamics and Stability

L	T	P	Total	
3	0	0	3	

Credits-3
Duration of Exam- Three hours
During Semester Evaluation Weightage- 50%
End Semester Examination Weightage- 50%

Introduction of Power System Dynamics and stability,
Modeling of Synchronous machine , Exciter Systems and Prime Movers,
Dynamics of synchronous Generator connected to Infinite Bus, , Power system stabilizers, Multi-machine Systems
Analysis of Steady State stability, Sub Synchronous resonance, Transient Stability Evaluation
Basic concept of Voltage stability

REFERENCES:

1. K R padiyar, "Power system Dynamics Stability" ,B S.Publications
2. P. Kundur, "Power system Dynamics Stability and Control",Mc Graw Hill
3. P.M.Anderson and A.A FFouad, "Power system Dynamics Control and Stability", Galgotia

MASTER OF TECHNOLOGY (ELECTRICAL ENGINEERING)
POWER SYSTEM SPECIALIZATION
W.E.F. 2012-13

Course No. EE-537T **Power System Planning**
(Elective in PS and PED)

L	**T**	**P**	**Total**	**Credits-3**
3	**0**	**0**	**3**	**Duration of Exam- Three hours**
				During Semester Evaluation Weightage- 50%
				End Semester Examination Weightage- 50%

General power system planning issues, economic analysis, load forecasting, production cost modeling, generation expansion planning, substation expansion planning, network expansion planning, reactive power planning.
Power System Reliability evaluation of above aspects
Deregulation of power systems, power system planning under uncertainty, risk based power system planning.

REFERENCES:

1. "Electric Power System Planning: Issues, Algorithms and Solutions" , by Hossein Seifi, Mohammad Sadegh Sepasian, Springe –Verlag, Berlin, 2011.
2. "Economic Market Design and Planning for Electric Power Systems". By James Momoh, Lamine Mili, John Wiley and Sons, New Jersey, 2010.
3. "Electrical Power Systems Planning", by A. S. Pabla, McMillan Publishers, India, 1998.
4. "Modern Power System Planning" , Ed. by X. Wang and J. R. McDonald, McGraw Hill, London, 1994.
5. "Power System Planning", by R. Sullivan, McGraw Hill, 1977.
6. "Reliability Evaluation of Power System" Roy Billinton and Ronald Norman Allan

MASTER OF TECHNOLOGY (ELECTRICAL ENGINEERING)
POWER SYSTEM SPECIALIZATION
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Course No. EE-539T **TRANSIENTS IN POWER SYSTEMS**
(ELECTIVE in PS)

L	T	P	Total	
3	0	0	3	

Credits-3
Duration of Exam- Three hours
During Semester Evaluation Weightage- 50%
End Semester Examination Weightage- 50%

Travelling Waves On Transmission Line: Lumped and 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. Computation of Power System Transients: Statistical approach for transients calculations, principle of digital computation – Matrix method of solution, Modal analysis, Z-transforms, Computation using EMTP – Simulation of switches and non-linear elements.

Lightning, Switching And Temporary Over-voltages Lightning: Physical phenomena of lightning – Interaction between lightning and power system – Factors contributing to line design – Switching: Short line or kilometric fault – Energizing transients - closing and re-closing of lines - line dropping, load rejection - Voltage induced by fault – Very Fast Transient Overvoltage (VFTO)

Behaviour of Winding Under Transient Condition: Initial and Final voltage distribution - Winding oscillation - traveling wave solution - Behaviour of the transformer core under surge condition – Rotating machine – Surge in generator and motor

Insulation Co-Ordination: Principle of insulation co-ordination in Air Insulated substation (AIS) and Gas Insulated Substation (GIS), insulation level, statistical approach, co-ordination between insulation and protection level –overvoltage protective devices – lightning arresters, substation earthing, Protection of Power Systems against transients.

REFERENCES:

1. I.V. Begley, 'Traveling waves in Transmission Systems', John Wiley (1933,51), Dover.
2. R. Rudenberg. 'Electric Stroke waves in Power Systems', Harvard University Press, Cambridge, Massachusetts.
3. Allan Greenwood, 'Electric Transients in Power Systems', Wiley Interscience.
4. CS Indulkar and DP Kothari, 'Power System Transients, A Statistical Approach', Prentice-Hall of India Pvt Ltd., New Delhi. 110 001.
5. VA Venikov, 'Transient phenomena in Electrical Power Systems', Pergamon Press, London.
6. Klaus Ragaller, "Surges in High Voltage Networks", Plenum Press, New York, 1980..
7. Pritindra Chowdhari, "Electromagnetic transients in Power System", John Wiley and Sons Inc., 1996.
8. Naidu M S and Kamaraju V, "High Voltage Engineering", Tata McGraw-Hill Publishing Company Ltd., New Delhi, 2004.
9. Working Group 33/13-09 (1988), 'Very fast transient phenomena associated with Gas Insulated System', CIGRE, 33-13, pp. 1-20.

MASTER OF TECHNOLOGY (ELECTRICAL ENGINEERING)
POWER SYSTEM SPECIALIZATION
W.E.F. 2012-13

Course No. EE-541T **Power Quality Monitoring: Analysis and Control**
(Elective in PS)

L	T	P	Total	
3	0	0	3	

Credits-3
Duration of Exam- Three hours
During Semester Evaluation Weightage- 40%
End Semester Examination Weightage- 60%

Overview and definition of power quality (PQ): Sources of pollution, and regulations, Power quality problems: rapid voltage fluctuations voltage unbalance, Voltage dips and voltage swells, Short duration outages,

Definitions Voltage sag analysis and mitigation: Sag caused by motor starting, Sag caused by utility fault clearing, Sag mitigation, Sag magnitude and duration calculations, RMS voltage, peak Examples of sag magnitude, calculation in 1-phase systems,
Harmonics: Effects-within the power system, Interference with communication Harmonic measurements. Harmonic elimination

Harmonic distortion: Power system harmonics: harmonic analysis, Harmonic sources-the static converters, Transformer magnetization and non-linearities, Rotating machines, arc furnaces, Fluorescent lighting. Introduction to power converters, Fourier analysis, Total harmonic distortion, rms and average value calculations, Arcing and saturable devices, Effects of harmonic distortion, System response characteristics.

Monitoring power quality: Monitoring essentials, Power quality measuring equipment, Current industry trends.

Power Conditioning: Electric power conditioning, Active and passive filters.

REFERENCES:

1. Ghosh,A. and Ledwich,G., Power Quality Enhancement Using Custom Power Devices, Kluwer Academic Publishers (2005).
2. Dugan R.C. , Mcgranaghan, Electrical Power Systems Quality, McGraw Hill.
3. Sankaran C., Power Quality, CRC Press.
4. Bollen H. J. and Gu Y.H., Signal Processing of Power Quality Disturbances, IEEE Press

MASTER OF TECHNOLOGY (ELECTRICAL ENGINEERING)
POWER SYSTEM SPECIALIZATION
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Course No. EE-543T Operation of Restructured Power System Protection
(Elective in PS)

L	T	P	Total	
3	0	0	3	

Credits-3
Duration of Exam- Three hours
During Semester Evaluation Weightage- 50%
End Semester Examination Weightage- 50%

Deregulation of Electricity Supply Industries: Introduction to deregulation, different entities in deregulated electricity markets, background of deregulation around the world, benefits from competitive electricity markets, different key issues of competitive electricity markets, market Clearing Price(MCP) - Market operations: Day-ahead and Hour-Ahead Markets, Elastic and Inelastic demand, technical challenges, Power System Restructuring and electricity reforms in India, key features of electricity act 2003.

Market Models: Market Models based on energy trading, contractual agreement: Pool & Bilateral models, different independent models, role of ISO, market power, Bidding and auction mechanisms, optimal power flow, economical load dispatch and unit commitment in deregulated environment, market models in Indian market context, and power trading in India.

Transmission Open Access and pricing issues: Power wheeling, transmission open access, cost component in transmission pricing, basic objectives, different methods of transmission pricing, Short run and long run marginal transmission price structure, development in international transmission pricing, reactive power pricing structure, and its calculation for generator's reactive support, numerical examples, impact of FACTS devices on transmission pricing.

Transmission congestion management:, Transmission congestion, impact of transmission congestion, different methods of congestion management, financial transmission right, flow gate rights, market power and congestion issues, numerical examples, international experiences of transmission congestion management, security management: spinning reserves, interruptible load options.

Available transfer capability determination: Definitions, principles of ATC determination, factors affecting ATC, static and dynamic ATC, static ATC determination using DC power transfer distribution factors, AC power transfer distribution factors, ATC with line outage contingencies, LODFs with DC and AC, dynamic ATC and its determination, ATC enhancement with FACTS controllers, numerical examples.

Ancillary Services management: Description of ancillary services, types of ancillary services, ancillary service management in US, UK, Austrailia, Sweden etc., reactive power as an ancillary service and its management, AGC as an ancillary service, AGC pricing, spinning reserve, black start capability, ancillary services auction.

REFERENCES:

1. Lio Lee Lai, Power System restructuring and deregulation. John Wiley and Sons, UK. 2001.
2. K. Bhattacharya, MHT Bollen and J.C Doolder, Operation of Restructured Power Systems, Kluwer Academic Publishers, USA, 2001.
3. M. Shahidehpour et al., 'Market Operations in Electric Power Systems', John Wiley and Sons,
4. M. Shahedehpor, 'Restructured Electric Power Systems,: Operation, trading and volatility', Marcel Dekker, Inc.
5. M. Ilic, 'Power Systems Restructuring-Engineering and Economics', Kluwer Int. Series, 2000.
6.A.J Wood and B.F Wollenberg. Power System Operation and Control, John Wiley and Sons.
7.S.A Soman, S.A Khaperde, Shubha Pandit, Computational Methods for large Sparse Power System Analysis: An Object Oriented Approach. Kluwer Academic Publishers.
8.Understanding electric utilities and de-regulation, Lorrin Philipson, H. Lee Willis, Marcel Dekker Pub., 1998.
9.Power system economics: designing markets for electricity Steven Stoft, John Wiley & **Sons, 2002**

MASTER OF TECHNOLOGY (ELECTRICAL ENGINEERING)
POWER SYSTEM SPECIALIZATION
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Course No. EE-563T **Advanced Theory of Electric Machinery**
(Core in PED Elective in PS)

L	**T**	**P**	**Total**	**Credits-3**
3	**0**	**0**	**3**	**Duration of Exam- Three hours**
				During Semester Evaluation Weightage- 50%
				End Semester Examination Weightage- 50%

Induction Machines: Analysis with nonrated voltage, nonrated frequency & unbalanced supply, De-rating/Rerating, modelling of magnetization characteristics, capacitor self-excitation of induction machines and its applications, Energy efficient motors, Air gap field space harmonics (parasitic torques, radial forces and noise), slip power recovery. Special Machines: Servomotors, stepper motors, BLDC motors. Transient theory: Analysis of Kron's primitive model, development of transformations. Transformers: Multi Circuit transformers, Parallel operation of dissimilar transformers, analysis of inrush magnetizing current.

REFERENCES:

1. L.F Blume, 'Transformer Engineering', John Wiley & Sons, Inc, New York, 1967
2. Fitzgerald & Kingsley, 'Electric Machinery' McGraw Hill Co. New Delhi, 2004.
3. A .Langsdorf, 'Theory of Alternating Current Machinery', McGraw Hill Co. New Delhi, 2004.
4. I.Boldea & S.A.Nasar, 'Induction Machine Handbook', CRC Press, New York, 2002.
5. C.M.Ong, 'Dynamic Simulation of Electric Machinery using Matlab/Simulink',Prentice Hall PTR, New Jercy, 1998.

MASTER OF TECHNOLOGY (ELECTRICAL ENGINEERING)
POWER SYSTEM SPECIALIZATION
W.E.F. 2012-13

Course No. EE-503T **Digital Control System.**
(Core in CS Elective in PED and PS)

L	**T**	**P**	**Total**	**Credits-3**
3	**0**	**0**	**3**	**Duration of Exam- Three hours**
				During Semester Evaluation Weightage- 50%
				End Semester Examination Weightage- 50%

Review of Z-transform.
Representation of discrete time systems: Pulse Transfer Functions & State Space models.
Issues of sampling and discretization.
Models of Digital control devices and systems: Z-domain description & digital filters.
Analysis of Discrete time systems, Controllability and Observability.
Stability analysis: Jury's Test, Routh's test.
Design of Digital controller: Classical & State-space techniques.
Realization of Discrete time controller, Quantization errors.

REFERENCES:

1. Digital Control Systems – by P.N. Paraskevopoulos, Prentice Hall, 1996,
2. Digital Control & State variable methods – by M. Gopal, TMH 1997.
3. Digital Control Systems by M. Gopal, McGraw Hill, 2003

MASTER OF TECHNOLOGY (ELECTRICAL ENGINEERING)
POWER SYSTEM SPECIALIZATION
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Course No. EE-505T **Identification & Estimation**
(Core in CS, Elective in PS and PED)

L T P Total **Credits-3**
3 0 0 3 **Duration of Exam- Three hours**
During Semester Evaluation Weightage- 50%
End Semester Examination Weightage- 50%

Review of probability theory; Random variables and process, stochastic processes, properties and terminology; mean, variance, correlation, spectral density, ergocity etc.
Problem formation for identification and Estimation
Models: Review of continuous and discrete, state space and input-output, disturbance models.
Identification: Impulse response and transfer function apporach (only nonparametric methods).
Parameter Estimation: Introduction.
Linear regressions and least-squares methods and properties
Prediction error approach
Non- recursive and recursive methods
Kalman filter, Extended Kalman Filter for nonlinear estimation
Maximum likelihood method
Mean square method
Convergence, computational and implementational issues
Application examples

REFERENCES:

1. Lennart Ljung. "System Identification: Theory for the user", Prentice Hall Inc, NJ 1991.
2. B.N Chatterji and K.K. Parmer, "System Identification Techniques" Oxford & IBH Pub. New Delhi. 1989.
3. A. Papoulis & S U pillai "Probability, Random Varriables and Stochastic Process" 4th edition MC Graw Hill, 2002.

MASTER OF TECHNOLOGY (ELECTRICAL ENGINEERING)
POWER SYSTEM SPECIALIZATION
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Course No. EE-509T **Optimization Theory**
(Elective in PS, PED and CS)

L	T	P	Total	
3	0	0	3	

Credits-3
Duration of Exam- Three hours
During Semester Evaluation Weightage- 50%
End Semester Examination Weightage- 50%

Introduction to optimization theory , Importance in solving system engg. Problems
Convex sets & functions,supporting & separating hyperplanes, dual cones and generalized inequalities
Linear programming problem
Formulation,simplx method,two phase simplex method,dual simplex method,, Duality in linear programming,sensitivity analysis
Integer linear programming,cutting plane method, linear programming approach to game theory,dyanamic programming problems
Multi objective optimization
Intoduction to nonlinear programming
Unconstrained optimization—formulation of quadratic optimization problem,Newton raphson metmhod,gradient method
Constrained optimization—quadratic programming, saparable programming
Convex optimization problem---
Linear optimization problem, quadratic optimization problem, complexity of convex programming

REFERENCES:

1. SS Rao ,Optimization theory & applications , Wiley Eastern Ltd.
2. Convex optimization by Boyd &Vandenberghe
3. Operational research by Hamdy A.Taha

MASTER OF TECHNOLOGY (ELECTRICAL ENGINEERING)
POWER SYSTEM SPECIALIZATION
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Course No. EE-511T **Information Security**
(Elective in PS, PED and CS)

L T P Total **Credits-3**
3 0 0 3 **Duration of Exam- Three hours**
During Semester Evaluation Weightage- 50%
End Semester Examination Weightage- 50%

Introduction to Information Security and privacy, Security levels, Security aims.

System Security – Security models, Security functions and Security Mechanisms, Privacy enhancing Mechanisms, Access control: role based attribute based, Data base Security, Secure programming, Security evaluation criteria.

Network Security – Security Threats and vulnerabilities, Firewalls, IDS, Router Security, Viruses, Worms, DoS, DDos attacks, OS Security, Security protocols, Security management, Audit and Assurance, Standards, Introduction to disaster recovery and Forensics.

Indian initiatives to information security
Information Security Standards.

REFERENCES:

1. B. Matt, "Computer Security", Pearson Education., New Delhi, 2003.
2. W. Stallings, "Cryptography and Network Security", Pearson Education., New Delhi, 2003.
3. Rolf Oppliger, "Secrets technologies for world wide web", 2nd Edition, Artech House, 2003.

MASTER OF TECHNOLOGY (ELECTRICAL ENGINEERING)
POWER SYSTEM SPECIALIZATION
W.E.F. 2012-13

Course No. EE-513T **Reliability Engineering**
(Elective in PS,PED and CS)

L T P Total **Credits-3**
3 0 0 3 **Duration of Exam- Three hours**
During Semester Evaluation Weightage- 50%
End Semester Examination Weightage- 50%

Review of basic concepts in reliability engineering, reliability function, different reliability models etc., and reliability evaluation techniques for complex system: Non path set and cutest approaches, path set and cut set approaches, different reliability measures and performance indices, modeling and reliability evaluation of system subjected to common cause failures.
Reliability improvement, Reliability allocation/apportionment and redundancy optimization techniques
Fault tree analysis
Maintainability Analysis: measure of system performance, types of maintenance, reliability centered maintenance, reliability and availability evaluation of engineering systems using Markov models.
Reliability testing
Design for reliability and maintainability
Applications of fuzzy theory and neural networks to reliability engineering
Typical reliability case studies

REFERENCES:

1. M.L Shooman, "Probabilistic reliability- an engineering approach" RE Krieger Pub, 1990.
2. K.K Aggarwal, "Reliability Engineering" Springer Pub, 1993.
3. E Balaguruswamy, "Reliability Engineering" McGraw hill, 2002.
4. R. Ramakumar, "Engineering Reliability" Prentice, NJ, 1993.

MASTER OF TECHNOLOGY (ELECTRICAL ENGINEERING)
POWER SYSTEM SPECIALIZATION
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Course No. EE-519T **Digital Signal Processing**
(Elective in PS, CS and PED)

L	T	P	Total	
3	0	0	3	**Credits-3**

Duration of Exam- Three hours
During Semester Evaluation Weightage- 50%
End Semester Examination Weightage- 50%

Digital Signal Processing Applications; Filter Design, FIR & IIR Digital Filter Design, filter Design programs using MATLAB , Fourier Transform: DFT, FFT programs using MATLAB

Real Time Implementation: Implementation usingDSP of (i) Digital filters (ii) FFT applications.

Multirate DSP : The basic sample rate alteration, time – domain characterization & frequency domain characterization, Cascade equivalences, filters in sampling rate alteration systems, digital filter banks and their analysis and applications; multi level filter banks, estimations of spectra from finite – duration observation of signals.
linear prediction and optimum linear filters : forward and backward linear prediction, AR Lattice and ARMA lattice – ladder filters, Wieners filters for filtering on prediction**.**
Introduction to Digital Signal Processors, Architecures of TMS-320 series, Instruction Set, Programming and Interfacing

REFERENCES:

1. P.P. Vaidhyanathan, Multirate systems and filter banks, Prentice Hall, 1993.
2. Emmanuel Ifeachor and Barrie Jervis, Digital Signal Processing: A Practical
3. J.G Proakis and D.G Manolakis - Digital Signal Processing: Principles, Algorithms and Applications, PHI, 2004.
4. A.V. Oppehein and R.W. Schafer, Discrete time signal processing, PHI, 1992
5. Haykins, Adaptive Filter Theory, Prentice Hall, 1986
6. Orfanidis Sophocles J, Optimum Signal Processing, McGraw Hill, 1988
7. Theory and applications of digital signal processing by Lawrence R. Rabiner and Bernard Gold, PHI
8. Digital Signal Processing, A Computer – Based approach, by Sanjit K. Mitra, Tata McGraw-Hill, 2008
9. Reference Manual of TMS-320 Digital Signal Processor.

SEMESTER-II

MASTER OF TECHNOLOGY (ELECTRICAL ENGINEERING)
POWER SYSTEMS SPECIALIZATION
W.E.F. 2012-13

Course No. EE-532T **Power System Operation and Control**
(CORE IN PS, ELECTIVE IN CS & PED)

Credits-3

L	**T**	**P**	**Total**	**Duration of Exam- Three hours**
3	**0**	**0**	**3**	**During Semester Evaluation Weight age-50%**
				End Semester Examination Weight age - 50%

Characteristics of power generation units, Economic dispatch of thermal units, security constrained economic dispatch, hydrothermal coordination.
Optimal power flow and its applications, Reactive power optimization, Unit commitment.
Automatic generation control- Single area and Multi-area.
Power system security, contingency analysis, state estimation, optimal load shedding.

References:

1. A. J. Wood and B. F. Wollenberg, Power Generation Operation and Control, Wiley.
2. O. I. Elgerd, Electric Energy Systems Theory: An Introduction, TMH.
3. Jizhong Zhu, Optimization of Power System Operation, IEEE – Wiley.
4. R. H. Miller, J. H. Maliwski, Power System Operation, TMH.
5. James Momoh, Electric Power System Application of Optimization, CRC Press.

MASTER OF TECHNOLOGY (ELECTRICAL ENGINEERING)
POWER SYSTEMS SPECIALIZATION
W.E.F. 2012-13
REACTIVE POWER CONTROL AND FLEXIBLE AC TRANSMISSION SYSTEMS (FACTS) DEVICES
(CORE IN PS, ELECTIVE IN CS & PED)

Course No. EE-534T **Credits-3**

L	**T**	**P**	**Total**
3	**0**	**0**	**3**

Duration of Exam- Three hours
During Semester Evaluation Weight age-50%
End Semester Examination Weight age - 50%

Reactive Power Control in Electric Transmission Systems, Loading Capability and Stability Considerations, Introduction to related concepts and systems requirements.

Flexible AC Transmission Systems (FACTS) Devices: Configuration of FACTS devices, Principles of operation and control techniques.

Application of FACT devices in: Power System Satiability analysis, Reactive power control, Optimal power flow analysis, Wide area monitoring.

References:

1. Understanding FACTS: NG Hingorani, J Gyugi (JEEE Press)
2. Flexible AC Transmission Systems (FACTS), Y.H. Song (JEEE Series)
3. Thyristor Based FACTS Controller for Electric Transmission systems- R Mathur & PK Verma, IEEE Press (Wiley)
4. Reactive Power Control in Power Systems TJE Miller (Johan Wiley and Sons)
5. Reactive Power Control and Voltage stability in Power Transmission Systems, , Abhijit Chakrabarti, D P Kothari, AK Mukhopadhyay, Abhinandan De, (PHI)
6. Flexible AC Transmission: Modelling and Control, X-P. Zhang, C.Rehtanz, B.Pal, (Springer)

MASTER OF TECHNOLOGY (ELECTRICAL ENGINEERING)
POWER SYSTEMS SPECIALIZATION
W.E.F. 2012-13

Course No. EE-536T **Advanced Power System Protection**
(Elective in PED & PS)

L	**T**	**P**	**Total**	**Credits-3**
3	**0**	**0**	**3**	**Duration of Exam- Three hours**
				During Semester Evaluation Weightage-50%
				End Semester Examination Weightage- 50%

Introduction: Need for protective systems, nature of fault & statistics, Zones of protection, local & remote back up, classification or protective relays and protective schemes, comparison of conventional relays with modern relays, salient features of current transformers and potential transformers for protection purpose. Static Relays: Over current relays, differential relays, distance relays, impedance relays. Comparators: general equation of comparators, Analysis for amplitude comparator, analysis for phase comparator, duality between amplitude and phase comparators, different types of amplitude and phase comparators.Distance protection: time grading of distance relays, schemes of distance protection, Effect of arc resistance and power swings, selection criterion for distance relays, pilot wire protection, carrier current protection. Analysis of protection schemes for Generators, transformers and motors.Microprocessor based protective relays: Over current relay, impedance relay, directional relay, reactance and mho relay.

REFERENCES:

1. T.S. MadhavaRao, "Power System Protection – Static Relays", Tata McGraw Hill, REPRINT 2008.
2. B. Ravindernath and M. Chander, "Power System Protection and Switchgear", New Age International Ltd, 2005.
3. Badri Ram and Vishwakarma, Power System Protection and Switchgear, TATA McGraw Hill,2007.

MASTER OF TECHNOLOGY (ELECTRICAL ENGINEERING)
POWER SYSTEMS SPECIALIZATION
W.E.F. 2012-13

Course No. EE-538T Electric Power Distribution Automation
(Elective in PS)

Credits-3

L T P Total **Duration of Exam- Three hours**
3 0 0 3 **During Semester Evaluation Weight age-50%**
End Semester Examination Weight age - 50%

Introduction: Basis of distribution automation, power delivery systems, control hierarchy, DA concept, Distribution automation system, basis architectures and implementation strategies for DA.

Central Control and Management: Need of power control, operation environment of distribution networks, evolution of Distribution management systems, basic distribution management function, basis of a real time control system, outage management, decision support applications, database structures and interfaces.

Distribution Automation and Control Functions: Introduction, Demand side management, Voltage/VAR control, fault detection, restoration function, reconfiguration of distribution systems, power quality.

Intelligent Systems in Distribution Automation: Distribution automation function, artificial intelligent methods, intelligent systems in DA, fault detection, classification and location in distribution systems.

Renewable Energy Options and Technology: Distributed generation, classification of renewable energy, renewable energy options, other non-renewable energy sources, distributed generation concepts and benefits, examples.

Distribution Management Systems: DMS and EMS, function of EMS, SCADA, remote terminal units, distribution management systems, Distribution system analysis, Feeder automation, Load management systems, GIS customer information system, automatic meter reading, advance billiong, Advances in AMR technology, cost benefit analysis in DS.

Communication System for Control and Automation: Communication and distribution automation, DA communication and link options, wireless communication, wire communication, DA communication and control, DA communication architecture, DA communication user interface.

References:

1. James A. Momoh, ”Electric Power Distribution Automation, Protection and Control, CRC Press, Taylor and Francis, 2008”
2. James N-Green and R. Wilson, “Control and Automation of electric Power Distribution Systems”, CRC Press, Taylor and Francis, 2008.

MASTER OF TECHNOLOGY (ELECTRICAL ENGINEERING)
POWER SYSTEMS SPECIALIZATION
W.E.F. 2012-13

Course No. EE-540T ADVANCE STABILITY ANALYSIS

Credits-3

L	**T**	**P**	**Total**
3	**0**	**0**	**3**

Duration of Exam- Three hours
During Semester Evaluation Weight age-50%
End Semester Examination Weight age - 50%

Real time stability control in power system, Dynamics security assessment, Wide area stability control, Sensitivity analysis of Dynamic stability indicators, Direct stability methods, Energy Function approach, SSR problem and remedies, Criteria and Methods for on-line voltage security assessment.

References:

1. P. Kundu, 'Power System Stability and Control', Mc Graw Hill.
2. K.R. Padiyar, 'Power System Dynamics' BS Publications.
3. T.V. Cutsem, 'Voltage stability of Electric Power system', Kluwer Academic Publisher.
4. S.C. Savulescu. ' Real Time Stability in Power System' , Springer.

MASTER OF TECHNOLOGY (ELECTRICAL ENGINEERING)
POWER SYSTEM SPECIALIZATION
W.E.F. 2012-13

Course No. EE-542T **H V D C Transmission**
(Elective in PS &PED)

Credits-3

L T P Total	**Duration of Exam- Three hours**
3 0 0 3	**During Semester Evaluation Weight age-50%**
	End Semester Examination Weight age - 50%

Introduction: Comparison of AC and DC transmission, Application of DC transmission, Planning of HVDC transmission.
Graetz Circuit, Analysis of Twelve-pulse converter.

HVDC System control: Principles of Dc link control, Converter control characteristics, Firing angle control, Current and extinction angle control, Starting and stopping of DC link, Power control.

Reactive Power Control: Sources of reactive power, Static VAR systems, Reactive power control during transients.

Harmonics and Filters: GENERATION Of harmonics, Methods of Harmonics reduction, AC and DC filters used for Harmonic Elimination.

Converter Fault and protection: Converter faults, Protection against over currents and over voltages.

References:

1. EW Kimbark,'Direct current Transmission,' Vol. I, Wiley Interscience.
2. J. Arrillaga,' High Voltage Direct Current Transmission', Peter Peregrines.
3. KR Padiyar,'HVDC Power Transmission Systems', New Age International (P) Ltd., Publishers, 3rd Edition.

MASTER OF TECHNOLOGY (ELECTRICAL ENGINEERING)
POWER SYSTEM SPECIALIZATION
W.E.F. 2012-13

Course No. EE-544T **Power System Communication**
(Elective in PS)

Credits-3

L	**T**	**P**	**Total**
3	**0**	**0**	**3**

Duration of Exam- Three hours
During Semester Evaluation Weight age-50%
End Semester Examination Weight age - 50%

Communication Systems: Fiber Optical Technique, Fiber Optical Networks, WAN based on Fiber Optical Networks, XML, Technique, IP based Real Time Data Transmission.
Control System: Central Control Center, Area Control Center, SCADA/EMS, Distributed Web Based SCADA Systems, Distributed Energy Management Systems.
Information Systems for Control Centers: ICCS configuration, CCAPI for ICCS, User Interfaces, ICCS communication networks, time synchronization, utility communication architecture, communication services, data exchange and processing.
Common Information Model (CIM): Introduction, CIM packages and classes, specifications and applications.
Geographical Information Systems (GIS) and their applications, Global Positioning System (GPS) and applications, Power trading systems.

References:

1. Mohamamad Shahidehpour and Yaoyu Wang, Communication and Control in Electric Power Systems: Application of Parallel and Distributed Processing, IEEE-Wiley Interscience.
2. Akhtar Kalam, D.P. Kothari, Power System Protection and Communication, New Age Science Lim.
3. Cobus Strauss, Practical Electrical Network Automation and Communication Systems, Newnes.

MASTER OF TECHNOLOGY (ELECTRICAL ENGINEERING)
POWER SYSTEMS SPECIALIZATION
W.E.F. 2012-13

Course No. EE-546T **DISTRIBUTEED GENERATION AND CONTROL**
(ELECTIVE IN PS & PED)

Credits-3

L	**T**	**P**	**Total**	**Duration of Exam- Three hours**
3	**0**	**0**	**3**	**During Semester Evaluation Weight age-50%**
				End Semester Examination Weight age - 50%

Photo-voltaic, Fuel cells Powered generation: Distributed generation versus traditional power systems, Basic characteristics of sunlight - solar energy resource - photovoltaic cell - cell efficiency – characteristics - equivalent circuit – photo voltaic for battery charging – charge regulators – PV modules – battery backup – limitations – equipments and systems – types of fuel cells – losses in fuel cells – solar- thermal power generation.

Wind Turbines and Embedded Generation: Wind Source- Wind statistics- energy in the wind- aerodynamics- rotor types- forces developed by blades- aerodynamic models- braking systems- tower- control and monitoring systems- power performance – wind driven induction generators – power circle diagram- steady state performance- modeling- integration issues- impact on central generation- transmission and distribution systems- wind farm.

Isolated generation and Energy storage for Distributed Generation: Wind- diesel systems- fuel savings- permanent magnet alternators- modeling- steady state equivalent circuit- self excited induction generators- integrated wind- solar systems, battery energy storage, SMES, capacitor and other energy storage systems.

Gas turbine powered Distributed generators and other Renewable Sources: Gas turbine types, mini and micro gas turbine generators, micro- hydel electric systems- power potential- scheme layout- generation efficiency and turbine power flow, isolated and parallel operation of generators- tidal and other sources and applications.

References:

1. John F. Walker & Jenkins, N., “Wind Energy Technology,” John Wiley and sons, Chichester, U.K., 1997.
2. Van Overstraeton R. J and Mertens R P., “Physics, Technology and use of photovoltaic”, Adem Hilger, Bristol, 1996.
3. Sukhatme, S.P.,”Solar energy- Principles of Thermal Collection and Storage” Tata McGraw-Hill, New Delhi.
4. S.L Soo,” Direct Energy Conversion”, Prentice Hall Publication.
5. Freries L.L, ‘Wind Energy Conversion systems’, Prentice Hall U.K., 1990.
6. Kreith, F., and Kreider, J.F,’Principles of Solar Engineering’, Mc- Graw- Hill, Book Co.
7. Imamura M. S.et.al, ’Photo voltaic system technology, European hand Book’, H.S., Stephen and Associate, 1992.
8. James Larminie, Andrew Dicks, FUEL Cell Systems’, John Wiley and Sons Ltd.
9. Chapman and E.J. Womack. ‘MHD Power Generation Engineering Aspects’, Hall Publication.
10. H. Lee Willis and W.G. Scott, ‘Distributed Power Generation’, Marcel Dekker, Inc. 2000.

MASTER OF TECHNOLOGY (ELECTRICAL ENGINEERING)
POWER SYSTEM SPECIALIZATION
W.E.F. 2012-13

Course No. EE-566T **Computer Aided Design of Electrical Machines**
(Elective in PED & PS)

L	T	P	Total	
3	0	0	3	

Credits-3
Duration of Exam- Three hours
During Semester Evaluation Weightage- 50%
End Semester Examination Weightage- 50%

Importance of magnetic and insulating materials, objectives & limitations of design, Review of design processes of transformer and rotating electrical machines,

Computer aided design: Advantages, limitation, analysis and synthesis methods, selection of input data, design variables and flow charts for the design of transformer and rotating electrical machines, introduction of optimization techniques, optimal design of electrical machines.

References:

1. M. Ramamoorthy,'Computer Aided Design of Electrical Equipment', East West Press, New Delhi.
2. Cyril G. Veinott,'Computer Aided Design of Electric Machinery', MIT Press, UK
3. A.K. Sawhney, 'A Course in Electrical Machine Design', DhanpatRai& Co., Delhi
4. Upadhyay K.G., 'Conventional and Computer aided design of electrical machines', Galgotia Publications, New Delhi

MASTER OF TECHNOLOGY (ELECTRICAL ENGINEERING)
POWER SYSTEM SPECIALIZATION
W.E.F. 2012-13

Course No. EE-568T **Renewable Energy Resources**
(Elective in PED, PS&CS)

L	**T**	**P**	**Total**	**Credits-3**
3	**0**	**0**	**3**	**Duration of Exam- Three hours**
				During Semester Evaluation Weightage- 50%
				End Semester Examination Weightage- 50%

Introduction: types, advantages, limitations & scope of renewable energy resources. Wind energy: basic principles & energy conversion schemes, major components, electrical generators used & their analysis.

Solar Energy: Basic Principles & Energy Conversion Schemes.

Hydro power: site selection, types of power stations, major components & their working. Biomass energy: biogas generation, types of biogas plants.

Geothermal energy: Origin and nature of geothermal energy; classification of geothermal resources; schematic of geothermal power plants.

Ocean energy: wave energy conversion devices, advantages and disadvantages of wave energy, basic principles of tidal energy, tidal power generation systems.

References :

1. 'Renewable energy – power for sustainable future'.Edited by Godfrey Boyle.Oxford University Press, 2010.
2. 'Renewable energy sources and their environmental impact'.S.A.Abbasi and NaseemaAbbasi.Prentice-Hall of India, 2010.
3. 'Non-conventional sources of energy'. G.D. Rai. Khanna Publishers, 2000.
4. 'Renewable energy sources and emerging technologies' D.P.Kothari, K.C.Singal andRakeshRanjan, PHI Publishers, 2009.

MASTER OF TECHNOLOGY (ELECTRICAL ENGINEERING)
POWER SYSTEM SPECIALIZATION
W.E.F. 2012-13

Course No. EE-570T **Wind Energy in Power System**
(Elective in PED, PS & CS)

L	T	P	Total	
3	0	0	3	

Credits-3
Duration of Exam- Three hours
During Semester Evaluation Weightage- 50%
End Semester Examination Weightage- 50%

Introduction: Historical developments and current status of wind power, Energy and power in wind, Wind energy conversion system, basic integration issues related to wind power.
Wind Turbines: Technological developments, Types, Aerodynamics of wind turbines.
Variable Speed Generators: Construction and working of asynchronous & permanent magnet synchronous generators, steady state performance, exponential modeling of magnetization curve, d-q axis modeling of induction and permanent magnet generators.
Static Control: Control modeling, various control schemes for cage and wound rotor induction generators.
Impact of Power Generation: regulatory framework, impact of constant and variable speed wind turbines on transient stability of power system, effects of switching capacitors and other operations of wind farms on power quality, wind system economic components, economic analysis methods.

References:

1. 'Wind power in power system', edited by Thomas Ackermann, John Wiley & Sons Ltd., 2005.
2. 'Variable Speed Generators', Ion Boldea, CRC Press, 2006.
3. 'Renewable energy – Power for Sustainable Future'.Edited by Godfrey Boyle.Oxford University Press, 2010.

MASTER OF TECHNOLOGY (ELECTRICAL ENGINEERING)
POWER SYSTEM SPECIALIZATION
W.E.F. 2012-13

Course No. EE-572T **Energy Management**
(Elective in PED,PS &CS)

L	**T**	**P**	**Total**	**Credits-3**
3	**0**	**0**	**3**	**Duration of Exam- Three hours**
				During Semester Evaluation Weightage- 50%
				End Semester Examination Weightage- 50%

Introduction, need of energy management, importance of energy audit and its types, financial analysis techniques, energy monitoring and targeting.
Energy efficiency control of boilers, furnaces, cogeneration, HVAC, cooler tower and lighting systems.
Energy demand analysis and forecast: energy data management, energy demand analysis, energy control and forecast methods.
Energy management of drive systems: industrial systems, measurements, performance estimation, energy efficient motors, planning and saving analysis.
Intelligent buildings: energy saving opportunities, measurement and control.
Smart grid and its role in energy management.

References:

1. "Energy Management Principles, Applications, Benefits, Savings", Craig B. Smith, Peragamon Press, New York, 1981.
2. "Energy Management of Drive System", Office of Industrial Technology, Energy Efficiency and Renewable Energy, US Department of Energy.
3. "Energy Management Systems", Edited by P. Giridhar Kini, InTech, Publication, 2011.

MASTER OF TECHNOLOGY (ELECTRICAL ENGINEERING)
POWER SYSTEMS SPECIALIZATION
W.E.F 2012-2013

Course No. EE-502T **Non-Linear and Adaptive Control**.
(Core in CS & Elective in PED,PS)

L	**T**	**P**	**Total**	**Credits-3**
3	**0**	**0**	**3**	**Duration of Exam- Three hours**
				During Semester Evaluation Weightage- 50%
				End Semester Examination Weightage- 50%

Introduction to nonlinear systems and their behavior.
Analysis of nonlinear systems using perturbation theory, phase plane trajectories, Describing functions, Lyapunov& Pupov's methods.

Nonlinear control design techniques; Feedback linearization, input-state and input-output linearization, design issues for MIMO nonlinear systems.
Variable structure control, sliding surface design, approximation of switching laws.
Adaptive control:
Need for adaptive control, MIT rule, Model reference and self tuning adaptive control techniques, Auto tuning, Gain scheduling.
Stability, convergence and robustness issues in adaptive control.
Adaptive control of nonlinear systems.
Practical aspects, implementation and applications of adaptive control.

References:

1. Slotine J.J.E and W. Li, "Applied nonlinear control", Prentice Hall Inc., 1991.
2. Mohler R.R., "Nonlinear systems: Dynamics and Control", Prentice Hall Inc., 1991.
3. M. Vidyasagar, "Nonlinear system analysis", Prentice Hall, 1993
4. K.J. Astrom "Adaptive Control", Addison Wesley.
5. Astrom K.J. and B. Wittenmark, "Computer Controlled Systems: Theory and Design", Prentice Hall of India, 1994.

MASTER OF TECHNOLOGY (ELECTRICAL ENGINEERING)
POWER SYSTEMS SPECIALIZATION
W.E.F 2012-2013

Course No. EE 508T **Intelligent Control**
(Elective in PED,PS &CS)

L T P Total **Credits-3**
3 0 0 3 **Duration of Exam- Three hours**
During Semester Evaluation Weightage- 50%
End Semester Examination Weightage- 50%

Introduction to Intelligent Control, Soft Computing Methodologies – Artificial Neural Networks, Fuzzy Logic, Genetic Algorithm. Need for intelligent control, Introduction to intelligent system modeling using ANN and Fuzzy logic.

Basic Fuzzy Logic System, Fuzzy Logic based system modeling, Fuzzy Logic based Controller Design. Theoretical and implementation issues.

Artificial Neural Networks, types of ANN architectures, ANN learning techniques, ANN based system modeling, ANN based controller design, theoretical and implementation issues.

Introduction to neurofuzzy systems and their application to control of complex systems.

References:

1. Fuzzy Logic Control by T.J. Ross TM.H. Publications.
2. Fuzzy Logic Control by Drinnkov, Narosa Publishers.
3. Comprehensive Neural Networks by Simon Hekins, Pearson Publications.
4. Neuro Fuzzy and Soft Computing by J.S.R. Jang, C.T. Sun, E. Mizutani, P.H.I. Publishers.

MASTER OF TECHNOLOGY (ELECTRICAL ENGINEERING)
POWER SYSTEMS SPECIALIZATION
W.E.F. 2012-13

Course No. EE-516T **Virtual Instrumentation**
(Elective in PED,PS &CS)

L	T	P	Total	
3	0	0	3	**Credits-3**
				Duration of Exam- Three hours
				During Semester Evaluation Weightage- 50%
				End Semester Examination Weightage- 50%

Virtual Instrumentation: Historical perspective, advantages, block diagram and architecture of a virtual instrument, data flow techniques, graphical programming in data flow, comparison with conventional programming. Development of virtual instrument using GUI, real time systems.

VI Programming Techniques: VIS and sub VIS, loops and charts, arrays, clusters and graphs, case and sequence structures, formula nodes, local and global variables, string and file I/O, instrument drivers, publishing measurement data in web.

Data Acquisition basics: Introduction to data acquisition in PC, sampling fundamentals, input/output techniques and buses. ADC, DAC, Digital I/O, counters and timers, DMA,Software and Hardware installation,calibration,Resolution,Data acquisition interface requirement

LabView hardware: VI Chassis requirement,common instrument interface:current loop,RS232C/RS485,GPIB.Bus interfaces,GPIB,PCI Card.

VI toolsets and application of Virtual Instrumentation

References:

1. Gary Johnson,LABVIEW graphical programming,Second edition,mcgraw hill,NY,1997.
2. Lisa K.Wells&Jeffrey travis,Labview for every one,Prentice Hall,new jersey,1997.
3. Virtual Instrumentation using labview by Sanjay Gupta and Joseph John,(TMH)
4. LAB VIEW Advanced Programming Techniques2nd edition by Rick Bitter,Taqi mohd,Mah Nawrock(CRC Press)
5. Kevin James,PC Interfacing and data acquisition: Techniques for measurement, Instumentationand Control,newness,2000.

MASTER OF TECHNOLOGY (ELECTRICAL ENGINEERING)
POWER SYSTEMS SPECIALIZATION
W.E.F. 2012-13

Course No. EE518T **Cryptography**
(Elective in PED,PS &CS)

L	**T**	**P**	**Total**	
3	**0**	**0**	**3**	**Credits-3**
				Duration of Exam- Three hours
				During Semester Evaluation Weightage- 50%
				End Semester Examination Weightage- 50%

Introduction to Cryptography and information Security
Mathematical Foundation
Introduction to groups, rings and fields, Congruences and residue classes, quadratic residues and square roots modulo integer. Theory of computational complexity, fundamentals of probability theory.

Basic Cryptographic techniques – Classical techniques, Symmetric techniques (AES & DES), Asymmetric techniques – Discrete log problem, Deffie Hellman Key exchange, RSA algorithm.

Message authentications, Cryptographic Hash Functions, Hash algorithms,Digital Signatures and authentication.

References:-

1. W. Stallings, "Cryptography and Network Security", Pearson Education., New Delhi, 2003.
2. W. Mao, "Modern Cryptography: Theory and practice", Pearson Education., New Delhi, 2004

MASTER OF TECHNOLOGY (ELECTRICAL ENGINEERING)
POWER SYSTEM SPECIALIZATION
W.E.F. 2012-13

Course No. EE-520T Functional Analysis in system and control

(Elective in PS &CS)

L	T	P	Total	
3	0	0	3	

Credits-3
Duration of Exam- Three hours
During Semester Evaluation Weightage- 50%
End Semester Examination Weightage- 50%

Introduction to functional analysis, function spaces, linear vector spaces, normed spaces, inner product spaces, Banach spaces, Hilbert spaces, orthogonality, linear operators, different types of orthogonal functions, applications in orthogonal functions' system – BPF, WF, FT, DCT, Haar wavelet, basis functions, least square approximation of signals, piecewise constant approximation of different basis functions.

Introduction to operational methods, piecewise constant approximation of linear mathematical operators, computer implementation and computational consideration, review of linear algebraic methods, applications in system analysis and control engineering.

Introduction to optimal control of linear systems using operational methods.

References:

1. A course of applied functional analysis, Arthur Wouk, John Wiley
2. A functional analysis framework for modeling, estimation and control in science and engineering, H. T. Banks, Chapman and Hall/CRC
3. Functional analysis and linear control theory, James R. Leigh, Academic Press
4. Functional analysis and control theory: linear systems, S. Rolewicz, Springer
5. Orthogonal functions in systems and control, K B Datta and B M Mohan, World Scientific