M. Tech. Scheme &Syllabus

(Control System)

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 501T	Linear System Theory	3	-	-	3	3
EE 503T	Digital Control System	3	-	-	3	3
EE 505T	Identification & Estimation	3	-	-	3	3
	Elective-I	3	-	-	3	3
	Elective-II	3	-	-	3	3
EE 523P	Simulation LAB.	-	-	4	4	2
EE 525S	SEMINAR-I	-	-	2	2	1
	Total					

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 507T Control System Design
2. EE 509T Optimization Theory (Elective in CS, PS, & PED)
3. EE 511T Information Security (Elective in CS, PS, & PED)
4. EE 515T Control Devices
5. EE 519T Digital Signal Processing (Elective in CS, PS, & PED)

Elective II

6. EE 513T Reliability Engineering. (Elective in CS, PS, & PED)
7. EE 517T Industrial Process Control(Elective in PED)
8. EE 521T Biomedical Instrumentation.
9. EE 565T PLC and microcontrollers(Core in PED & Elective in PS)
10. EE 567T Drives and Control

NOTE:

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 502T	Non Linear and Adaptive Control	3	-	-	3	3
EE 504T	Optimal and Robust Control	3	-	-	3	3
	Elective-I	3	-	-	3	3
	Elective-II	3	-	-	3	3
	Elective-III	3	-	-	3	3
EE 528P	Control LAB.II	-	-	4	4	2
EE 530P	SEMINAR-II	-	-	2	2	1
	Total					

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 506T Robotics
2. EE 508T Intelligent Control
3. EE 518T Cryptography (Elective in CS, PS, & PED))
4. EE 524T Advances in Control Theory
5. EE 532T Power System Operation & Control (Core in PS & Elective in PED)

Elective II

6. EE 510T Embedded Systems
7. EE 514T Mechatronic
8. EE 520T Functional Analysis in Systems and Control (Elective in PS)
9. EE 568T Renewable Energy Resources (Elective in CS, PS, & PED)
10. EE 534T Reactive Power Control & FACTS Devices (Core in PS & Elective in PED)

Elective III

11. EE 512T Guidance and Control
12. EE 516T Virtual Instrumentation (Elective in PED)
13. EE 522T Advanced Microprocessors
14. EE 570T Wind Energy in Power System (Elective in PED)
15. EE 572T Energy Management (Elective in CS, PS, & PED)

NOTE:

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 601P	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 602P	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)
CONTROL SYSTEMS SPECIALIZATION
W.E.F. 2012-13

Course No. EE-501T Linear Systems Theory

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 spaces, Normed spaces and Hilbert spaces, Concepts of signal and system norms, Properties of operators, Concept of bounded ness, Concepts of Eigen values and Eigenvectors, Jordan Blocks and block diagonalization, Functions of a square matrix, State transition matrix.

Stability of linear systems, Bounded input bounded output stability, Asymptotic Stability, Application of Lyapunov theory for linear systems.

Establishment of the results for Controllability and Observability of linear systems with simple examples, Controllability and observability grammians, concept of duality between observability and controllability, Kalman decomposition, Hidden modes and the concepts stabilizability and detectability, Development of relations for the observers for linear systems.

Input-Output representation of linear systems, MIMO descriptions and Polynomial Fraction Description and Matrix Fraction Descriptions; Elementary transformations, column & row degrees, Smith-McMillan form, Transmission and invariant zeros, Rank properties, Singular values, SVD, Functional spaces of rational matrices RH_∞ , Minimal and Balanced Realizations.

Simulation of standard results using Matlab or SciLab.

REFERENCES:

1. W.J. Rugh, "Linear System Theory", Prentice-Hall Int. Inc. N.J.
2. T. Kailath, "Linear Systems", Prentice Hall Inc., N.J. 1980
3. F.M. Callier & C.E. Desoer, "Linear System Theory", Narosa Publications,1991.
4. C.T. Chen, "Linear System Theory & Design", Oxford University Press, 1984.
5. F. Dean. K and Chow Joe, "Feedback Control Problems using Matlab", Cengage Learning, 2009

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

Course No. EE-505T **Identification & Estimation**
(Core in CS and 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)
CONTROL SYSTEMS SPECIALIZATION
W.E.F. 2012-13

Course No. EE-507T **Control Systems Design**

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%

Stability and Performance Specifications. Limits of performance. Constraints on sensitivity and complementary sensitivity. Recent issues and design trade-offs.

Review of system models. Model simplifications and associated modeling errors. Discrete time and hybrid models. Recent trends.

Design features, limitations, robustness and implementation of classical compensators and PID controllers. Integrator Wind up and Anti-wind up schemes.

Design of Linear State Feedback
Predictive controllers (Smith predictors, Internal Model Control).
Norm-based robust design procedures.
Adaptive robust techniques.
Gain Scheduling.
Non-interacting Control.
Variable Structure Control.
Recent trends in design of control systems. Control design based identification of complex systems.

REFERENCES:

1. Goodwin, G.C. Graebe, S.F. and M.E. Salgado, “Control System Design”, Prentice Hall of India, 2001.
2. Friedland, B “Advanced Control System Design”, Prentice Hall Int. Inc. NY. 1966.
3. Zhou K. Doyle, J.C. and K. Glover. “Robust Control”, Prentice Hall Int. Inc. NY, 1998.

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

Course No. EE-509T **Optimization Theory**
(A elective course 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 hyper planes, dual cones and generalized inequalities
Linear programming problem
Formulation, simplex 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, dynamic programming problems
Multi objective optimization
Introduction to nonlinear programming
Unconstrained optimization—formulation of quadratic optimization problem, Newton raphson method, gradient method
Constrained optimization—quadratic programming, separable 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)
CONTROL SYSTEMS SPECIALIZATION
W.E.F. 2012-13

Course No. EE-511T **Information Security**
(Elective course 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)
CONTROL SYSTEMS SPECIALIZATION
W.E.F. 2012-13

Course No. EE-513T **Reliability Engineering**
(Elective course 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)
CONTROL SYSTEMS SPECIALIZATION
W.E.F. 2012-13

Course No. EE-515T **Control Devices**
(Elective course in 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%

Controllers, Transmitters, Convertors and relays, function generators, computing relays, telemetering systems, thermostat, humidistat, electronic &intelligent transmitters, fiber optic & pneumatic transmitters
Control centers& panels: annunciators and alarms, display devices & recorders
Control valves: Various types of valves
Actuators- digital and hydraulic regulators and other throttling devices, dampers, pumps as control elements ,characteristics and applications
Electric actuators :AC and DC actuating devices
Programmable logic controllers

REFERENCES:

1. Liptak, 'Process control handbook', Instrument society of America
2. C.D.Johnson, 'Instrumentation systems' Prentice Hall.

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

Course No. EE-517T INDUSTRIAL PROCESS CONTROL
(Elective course in 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 systems: Review of first and higher order systems, closed and open loop response. Response to step, impulse and sinusoidal disturbances, interacting and non interacting type of systems. Control valves, types, function, hydraulic, pneumatic actuators, solenoid, stepper motors.

Stability Analysis: Frequency response, design of control system, control modes, definition, characteristics and comparison of P, PI, PD, PID controllers. Dynamic behavior of feedback controlled process for different control modes, control system quality, IAE, ISE, IATE criterion, controller tuning and process identification, Zigler-Nichols and Cohen-Coon tuning methods, Bode-Nyquist Plots - Process modelling.

Special Control Techniques: Principle, analysis and application of, cascade, ratio, feed forward, override, split range, selective controls, computing relays, simple alarms, Smith predictor, internal model control, theoretical analysis of complex processes.

Introduction to adaptive and self tuning control, distributed control systems

REFERENCES:

1. 'Process Systems analysis and Control', D.R. Coughanour, Mc.Graw Hill, II Edition, 1991.
2. 'Process Dynamics and Control', D.E.Seborg, T.F.Edger, and D.A.Millichamp, John Wiley and Sons, II Edition, 2004.
3. 'Principle and Practice of Automatic Process Control', C.A.Smith and A.B.Corripio, John Wiley and Sons, 1985.
4. 'Process control', Peter Herriot, Tata McGraw Hill.
5. 'Process Modelling Simulation and Control for Chemical Engineers**',** W.L.Luyben, McGraw Hill, II Edition, 1990.
6. 'Chemical Process Control – Theory and Practice', Stephanopoulous, Prentice Hall of India India Ltd.,.1984.

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

Course No. EE-519T **Digital Signal Processing**
(Elective course 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%

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 using DSP 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, Architectures 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 Approach (2nd Edition), Prentice Hall, 2004.
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.

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

Course No. EE-521T BIOMEDICAL INSTRUMENTATION

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 the physiology of cardiac, nervous and muscular and respiratory systems.

1. Transducers and Electrodes
Different types of transducers and their selection for biomedical applications, Electrode theory, Different types of electrodes, Hydrogen calomel, Ag-AgCl, pH,PCO2 electrodes, selection criteria of electrodes.

2. RECORDING SYSTEM
Low-Noise preamplifier, main amplifier and driver amplifier, inkjet recorder, thermal array recorder, photographic recorder, magnetic tape recorder, X-Y recorder, medical oscilloscope.

3. BIO-CHEMICAL MEASUREMENT
pH, pO2, pCO2, pHCO3, Electrophoresis, colorimeter, spectro photometer, flame photometer, auto analyser.

4. NON-ELECTRICAL PARAMETER MEASUREMENTS
Respiration, heart rate, temperature, pulse blood pressure, Cardiac output and cardiac rate, Electrocardiography, O2, CO2 measurements.

5. BLOOD FLOW AND BLOOD CELL COUNTING
Electromagnetic and ultrasonic blood flowmeter, indicator dilution method, thermodilution method, manual and automatic counting of RBC, WBC and platelets.

REFERENCES:

1. Leslie Cromwell, "Biomedical Instrumentation and measurement", Prentice hall of India, New Delhi, 1997.
2. John G. Webster, "Medical Instrumentation Application and Design", John Wiley and sons, New York, 1998.
3. Khandpur R.S, "Handbook of Biomedical Instrumentation", Tata McGraw-Hill, New Delhi, 1997.
4. Joseph J.carr and John M. Brown, "introduction to Biomedical equipment technology", John Wiley and sons, New York, 1997.

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

Course No. EE-565T **PLC & Microcontrollers**
(Core in PED and elective in 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%

PLC and PIC Microcontroller

Logic design, Principle of Operation, Controller, Interfacing circuits, Modbus, Programming examples.

Architecture, instruction set, timer, interrupts, I/O port, interfacing A/D converter, I2Cbus operation

REFERENCES:

1. Programmable Logic controllers : Operation, interfacing and programming by Job Den Otter, PHI
2. Design with PIC Microcontrollers by John B.Peatman, Pearson

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

Course No. EE-567T **Drives and Control**
(Elective in 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%

Different Control Schemes of Electric Drives, Transient Analysis of different DC Motor Drives Configurations, Controlled Rectifier-fed DC Drives. Transfer Functions of the Subsystems, Design of Controllers, 12-pulse Converter for DC Motor Drives. Application Considerations of Drives, Chopper-Controlled DC Drives.
Pulse Width Modulation for Electric Power Converters, Control and Estimation of Induction Motor and Synchronous Motor Drives, Applications of Adjustable Speed Drives (ASDs) in Industries and in Electric Utility Power Plants. Harmonic Analysis in ASDs.

REFERENCES:

1. Dubey, G.K, 'Fundamentals of Electrical Drives', Narosa Publishing House, New Delhi.
2. Krishan R. 'Electric Motor Drives: Modeling Analysis and Control', PHI Pvt Ltd. New Delhi-2001.
3. Bose, B.K. 'Power Electronics and Variable Frequency Drives: Technology and Applications', IEEE Press, 1997.
4. Bose B.K., 'Modern Power Electronics and AC Drives', Pearson Educational, Delhi, 2002.

SEMESTER-II

MASTER OF TECHNOLOGY (ELECTRICAL ENGINEERING)
CONTROL 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	
3	0	0	3	**Credits-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)
CONTROL SYSTEMS SPECIALIZATION
W.E.F 2012-2013

Course No. EE 504T **Optimal and Robust Control**
(Core in CS &Elective in 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%

Variational approach to optimal control

Algebraic Riccati equation, Riccati operator and stabilizing solutions, Extreme solutions.

Linear quadratic regulator, return difference inequality and robustness margins, cross product terms, output feedback, Linear quadratic trackers, LQG control and separation principle, simple applications.

Systematic formulation of robust control problem, Uncertainty and robustness, Effect on system stability and performance, Performance limitations.
Review of measures of signals and systems, H2 and H ∞ norm computations. Linear fractional transformations, Parameterization of stabilizing controllers.

Solutions to general H2 and H∞ control problems, H∞ loop shaping, Variable structure control.

References:

1. F.L. Lewis and V.L. Syrmos, "Optimal Control", John Wiley & Sons, NY 1995
2. K. Zhou, J.C. Doyle and K. Glover, "Robust & Optimal Control", Prentice Hall Inc. NY 1998.

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

Course No. EE 506T **Robotics**

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: Definition, Motivation, Historical development,Basic Structure,Classification,Workspace,Grippers.
Robot Arm Kinematics and Dynamics: Rigid motion and frame transformation,D-H parameters, Forward Kinematics, Inverse kinematics,Lagrange formulation of dynamics.
Trajectory generation: Cartesian Scheme, Joint space scheme
Teaching methods: Manual teaching, Lead through teaching
Control Scheme: Position Control, Force control, Hybrid position and force control.

References:

1. J.J. Craig, Introduction to Robotics – Mechanics A Control. Addison Wesley.
2. A.J. Koivo, Fundamentals for Control of Robotic Manipulation, John Wiley Inc. New York.
3. Spong and Vidyasagar, Robot Dynamics and Control, John Wiley and Sons.
4. Sciavicco & Siciliano, Modeling and Control of Robot Manipulators, McGraw Hill International Edition.

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

Course No. EE-510T **Embedded Systems**
(Elective in PED &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%

Components of Embedded Systems, Embedded Processors, Memory Systems, Peripherals, Interfacing, Real Time Operating Systems (RTOS).

Embedded System Software, Concept of Co Design, Wireless Embedded Systems, Performance Issues, Embedded Control Applications, Case Studies.

References:

1. Embedded Systems Design-2nd Edition New Delhi: Newnes 2008,Heath Steve.
2. Embedded System: World Class Design-London: Elsevier 2008-Ganssle,Jack.
3. Embedded System Design: A Unified Hardware/Software Introduction- New York:2003-Vahid,Frank.

MASTER OF TECHNOLOGY (ELECTRICAL ENGINEERING)
CONTROL SYSTEMS SPECIALIZATION

Course No.EE-512T **Guidance and Control**

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%

Fundamentals of guidance and tracking systems, Simple models of aircraft and missiles. Control requirements for guidance Systematic formulation of guidance problems, Guidance using servomechanism formulation, and prefilter design, model following, regulator redesign optimal trackers.

Introduction to filtering, nonlinear filtering, prediction and smoothing, Kalman and Extended Kalman filter.

Method of Intertial navigation, integrated navigation systems, external navigation aids.

Advanced guidance laws, Guidance laws & processing.

References:

1. Ching F. Lin, "Modern Navigation, Guidance and control processing", Prentice Hall, 1991.
2. Chin F. Lin & Ching F. Lin, "Modern Navigation, Guidance and Control Processing", Vol. II, Prentice Hall Inc., 1996.
3. Paul Zarchan, "Tactical and Strategic Missile Guidance", Progress in Astronautics and Aeronautics, Vol. 176.
4. F.L. Lewis and V.L. Syrmos, "Optimal Control", John Wiley & Sons.
5. J.H. Blackelock, "Automatic Control of Aircrafts and Missiles", Wiley Interscience, 1991.

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

Course No. EE-514T **Mechatronics**

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%

Concepts and Components of a Mechatronic System
Review of Analog and Digital Electronics, Microcontrollers
Optical/Electrical/Mechanical/Electromechanical sensors and actuators and interfacing circuits
Control Implementation Basics: Hardware and communication technologies.
Mechatronic System Design; Monitoring and diagnosis, Case studies.

Reference:
1. Mechatronics: Integrated Technologies for intelligent machines; A Smaili and F. Mrad, oup, 2008 New Delhi.

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

Course No. EE-516T **Virtual Instrumentation**
(Elective in PED &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)
CONTROL SYSTEMS SPECIALIZATION
W.E.F. 2012-13

Course No. EE518T **CRYPTOGRAPHY**
(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 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)
CONTROL 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	Credits-3
3	0	0	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

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

Course No. EE-522T **Advanced Microprocessors**

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%

Evolution of Microprocessors and main features in development.

16-bit microprocessor: 8086 processor, architecture, modes of addressing, instruction Set, Assembly language programming, Interrupts, Memory and I/O interface.

Advances in 32-bit and 64 bit microprocessor architectures and programming, RISC & CISC architectures

Control Requirements and applications

References:

1. Liu and Gibson, Microcomputer Systems, 8086/8088 family: Architecture, Programming and Design, PHI.

2. Brey, The Intel Microprocessors: 8086/8088, 80186/80188, 80286, 80386, 80486, Pentium& Pentium Pro Processor-Architecture, Programming and Interfacing, PHI.

3. A.K Ray & K.M. Bhurchandi, Advanced Microprocessors and Peripherals: Architecture, Programming and Interfacing, TMH

4. D. V. Hall, Microprocessors and Interfacing, TMH

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

Course No. EE-524T **Advances in Control Theory**

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%

Consideration of Uncertainty in system modeling: Uncertainty and information, Fuzzy and probabilistic approach, uncertainty measures, modeling of time delay systems.

Analysis of Interval Systems, Polynomial results; Kharitnov results; Analysis of piecewise/jump linear systems, Analysis of Time Delay Systems.

Advanced Control Design Method: QFT, Predictive Control,etc.
Fault detection and Fault tolerant design.

Reference:

1. Bilal M. Ayyub and G J Klir," Uncertainty Modeling and Analysis in Engineering and the Sciences", Chapmen& Hall/CRC, 2006.

MASTER OF TECHNOLOGY (ELECTRICAL ENGINEERING)
CONTROL SYSTEM SPECIALIZATION

W.E.F. 2012-13

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

L	T	P	Total	
3	0	0	3	

Credits-3
Duration of Exam- Three hours
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)
CONTROL SYSTEM 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 SemesterExamination 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)
CONTROL 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)
CONTROL 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**	**Credits-3**
3	**0**	**0**	**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)
CONTROL 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. GiridharKini,InTech, Publication, 2011.