Course Scheme
M. Tech
(Electrical Engineering)

Full-time
(2025)

Course Code and Definition	
Course Code	**Definition**
PC	Program Core
PE	Program Elective
OE	Open Elective
Audit	Audit Courses

SEMESTER I

Scheme for M. Tech. 1st Year

I. Theory Subjects

S. No.	Type	Subject Code	Subject Name	Contact Hours (L:T:P)	Credits (L:T:P)	Total Contact Hours	Total Credit Hours
1	PC	EE501	Power System Analysis	3:0:0	3:0:0	3	3
2	PC	EE503	Power System Dynamics-I	3:0:0	3:0:0	3	3
3	PC	EE511	Digital Control	3:0:0	3:0:0	3	3
4	PE		Professional Elective-I	3:0:0	3:0:0	3	3
5	PE		Professional Elective-II	3:0:0	3:0:0	3	3
6	VAC	MAT524	Research Methodology and IPR	3:0:0	3:0:0	3	3
7	VAC/ Audit**			2:0:0	0:0:0	2	0

II. Practical Subjects

S. No.	Type	Subject Code	Subject Name	Contact Hours (L:T:P)	Credits (L:T:P)	Total Contact Hours	Total Credit Hours
1	PC lab	EE505	Power System Steady State Analysis Lab	0:0:4	0:0:2	4	2
2	PE lab	EE507	Power System Dynamics lab	0:0:4	0:0:2	4	2

III. Professional Elective-I

S. No.	Type	Subject Code	Subject Name	Contact Hours (L:T:P)	Credits (L:T:P)	Total Contact Hours	Total Credit Hours
1	PE	EE509	Advanced Power Electronics Circuits	3:0:0	3:0:0	3	3
2	PE	EE513	Renewable Energy Systems	3:0:0	3:0:0	3	3
3	PE	EE515	Engineering Optimization	3:0:0	3:0:0	3	3

IV. Professional Elective-II

S. No.	Type	Subject Code	Subject Name	Contact Hours (L:T:P)	Credits (L:T:P)	Total Contact Hours	Total Credit Hours
1	PE	EE517	PWM Converter and Applications	3:0:0	3:0:0	3	3
2	PE	EE519	Electric Power Distribution System	3:0:0	3:0:0	3	3
3	PE	EE521	SCADA System & its Applications	3:0:0	3:0:0	3	3
4	PE	EE523	Optimal & Adaptive Control	3:0:0	3:0:0	3	3

Total contact hours =28

Total credit hours =22

SEMESTER II

Scheme for M. Tech. 2nd Semester

I. Theory Subjects

S. No.	Type	Subject Code	Subject Name	Contact Hours (L:T:P)	Credits (L:T:P)	Total Contact Hours	Total Credit Hours
1	PC	EE502	Power System Dynamics-II	3:0:0	3:0:0	3	3
2	PC	EE504	Digital Protection of Power System	3:0:0	3:0:0	3	3
3	PC	EE510	Advance Control System	3:0:0	3:0:0	3	3
4	PE		Professional Elective-III	3:0:0	3:0:0	3	3
5	PE		Professional Elective-IV	3:0:0	3:0:0	3	3
6	Audit**			2:0:0	0:0:0	2	0

II. Practical Subjects

S. No.	Type	Subject Code	Subject Name	Contact Hours (L:T:P)	Credits (L:T:P)	Total Contact Hours	Total Credit Hours
1	PC lab	EE506	Power System Protection Lab	0:0:4	0:0:2	4	2
2	PE lab		Professional Elective Lab-I	0:0:4	0:0:2	4	2

III. Professional Elective-III

S. No.	Type	Subject Code	Subject Name	Contact Hours (L:T:P)	Credits (L:T:P)	Total Contact Hours	Total Credit Hours
1	PE	EE512	Advanced Digital Signal Processing	3:0:0	3:0:0	3	3
2	PE	EE514	Dynamics of Electrical Machines	3:0:0	3:0:0	3	3
3	PE	EE516	Smart Grids	3:0:0	3:0:0	3	3

IV. Professional Elective-IV

S. No.	Type	Subject Code	Subject Name	Contact Hours (L:T:P)	Credits (L:T:P)	Total Contact Hours	Total Credit Hours
1	PE	EE518	Distributed Generation	3:0:0	3:0:0	3	3
2	PE	EE520	Robust Control	3:0:0	3:0:0	3	3
3	PE	EE522	AI Techniques	3:0:0	3:0:0	3	3
4	PE	EE524	Industrial Load Modeling & Control	3:0:0	3:0:0	3	3

V. Professional Elective-I Lab

S. No.	Type	Subject Code	Subject Name	Contact Hours (L:T:P)	Credits (L:T:P)	Total Contact Hours	Total Credit Hours
1	PE	EE526	Power Electronics Applications to Power Systems	0:0:4	0:0:2	4	2
2	PE	EE528	Smart Grids Lab	0:0:4	0:0:2	4	2
4	PE	EE530	Artificial Intelligence Lab	0:0:4	0:0:2	4	2

Total contact hours =25

Total credit hours =19

SEMESTER III

Scheme for M. Tech. 3rd Semester

I. Theory Subjects

S. No.	Type	Subject Code	Subject Name	Contact Hours (L:T:P)	Credits (L:T:P)	Total Contact Hours	Total Credit Hours
1	PE		Professional Elective-V	3:0:0	3:0:0	3	3
3	OE	**Open Elective-I**					
		CE611	Introduction to Rural Technology and Community Development	4:0:0	4:0:0	4	4
		ME 611	Industrial Safety Engineering	4:0:0	4:0:0	4	4
		ME 613	Concepts of Composite Materials	4:0:0	4:0:0	4	4
		ME615	Concepts of Renewable Energy Resources	4:0:0	4:0:0	4	4
		EE611	Electrical Installation and Safety	4:0:0	4:0:0	4	4
		COM223	Business Analytics	4:0:0	4:0:0	4	4
		CSE540	Introduction to Internet of things	4:0:0	4:0:0	4	4
		CSE542	Software Project Planning and Management	4:0:0	4:0:0	4	4

II. Practical Subjects

S. No.	Type	Subject Code	Subject Name	Contact Hours (L:T:P)	Credits (L:T:P)	Total Contact Hours	Total Credit Hours
1	PC lab	EE609	Dissertation-I	0:0:20	0:0:10	20	10
2	PROJ	EE613	Mini project with seminar	0:0:4	0:0:2	4	2

III. Professional Elective-V

S. No.	Type	Subject Code	Subject Name	Contact Hours (L:T:P)	Credits (L:T:P)	Total Contact Hours	Total Credit Hours
1	PE	EE601	FACTS and Custom Power Devices	3:0:0	3:0:0	3	3
2	PE	EE603	Modeling and Control of Distributed Parameter System	3:0:0	3:0:0	3	3
4	PE	EE605	Dynamics of Linear Systems	3:0:0	3:0:0	3	3
	PE	EE607	Energy Conversion Processes	3:0:0	3:0:0	3	3

Total Contact Hours = 31

Total Credits Hours = 19

SEMESTER IV

Scheme for M. Tech. 4th Semester

I. Theory Subjects

S. No.	Type	Subject Code	Subject Name	Contact Hours (L:T:P)	Credits (L:T:P)	Total Contact Hours	Total Credit Hours
1	Thesis	EE602	Dissertation-II	0:0:32	0:0:16	32	16
2	PC	EE606	Research and Publication Ethics	2:0:0	2:0:0	2	2

Total Contact Hours = 34

Total Credits Hours = 18

** Audit courses:

COURSE CODE: ENG001 English for Research Paper Writing

EVS501 Disaster Management

LAW006 Constitution of India

EDU002 Personality Development through Life Enlightenment Skills

EDU003 Pedagogy Studies

SSC008 Value Education

PED001 Stress Management by Yoga

OPEN ELECTIVE-I

S. No.	Type	Subject Code	Subject Name	Contact Hours (L:T:P)	Credits (L:T:P)	Total Contact Hours	Total Credit Hours
1	OE	ME	Supply Chain Management	3:0:0	3:0:0	3	3
2	OE	ME	Total Quality Management	4:0:0	4:0:0	4	4
3	OE	ME	Operation Research	4:0:0	4:0:0	4	4
4	OE	CSE	Computational Intelligence	4:0:0	4:0:0	4	4
5	OE	CSE	Internet of Things	4:0:0	4:0:0	4	4
6	OE	CSE	Business Analytics	4:0:0	4:0:0	4	4
7	OE	CE	Remote Sensing and Geographical Information System	4:0:0	4:0:0	4	4
8	OE	CE	Rural Technology and Community Development	4:0:0	4:0:0	4	4
9	OE	CE	Site investigation	4:0:0	4:0:0	4	4
10	OE	ECE	Analog & Digital Communications	4:0:0	4:0:0	4	4
11	OE	ECE	VLSI Design	4:0:0	4:0:0	4	4
12	OE	EE	Fundamentals of Electrical Machines	4:0:0	4:0:0	4	4
13	OE	EE	Wind and Solar energy System	4:0:0	4:0:0	4	4
14	OE	EE	Energy Auditing & Management	4:0:0	4:0:0	4	4
15	OE	MGT	Organizational Behaviour	4:0:0	4:0:0	4	4

COURSE SCHEME SUMMARY

Sem	L	T	P	Contact hrs/wk	Credits	PC	PE	OE	VAC	Add on/ Audit Courses	Project/ Trg/Seminar / Term Paper
1	20	-	8	28	22	11	8		3	1 unit	-
2	17	-	8	25	19	11	8			1 unit	
3	7	-	24	31	19	10	3	4			2(mini project with seminar)
4	2		32	34	18	2	-				16 (Dissertation-II)
Total	**46**		**72**	**118**	**78**	**34**	**19**	**4**	**3**	2 units	

First Semester

Course Code	**501**
Course Title	Power System Analysis
Type of Course	PC
L T P	3 0 0
Credits	3
Course Prerequisites	Power system.
Course Objectives (CO)	Study various methods of load flow and their advantages and disadvantages, Understand how to analyze various types of faults in power system, power system security concepts and study the methods to rank the contingencies and need of state estimation and studysimple algorithms for state estimation.

SYLLABUS

UNIT-I

Load flow: Overview of Newton-Raphson, Gauss-Siedel, fast decoupled methods, convergence properties, sparsity techniques, handling Q-max violations in constant matrix, inclusion in frequency effects.

AVR in load flow, handling of discrete variable in load flow, Fault Analysis: Simultaneous faults, open conductor faults, generalized method of fault analysis.

UNIT-II

Security Analysis: Security state diagram, contingency analysis, generator shift distribution factors. line outage distribution factor, multiple line outages, overload index ranking.

UNIT-III

Power System Equivalents: WARD REI. equivalents, State Estimation: Sources of errors in measurement Virtual and Pseudo, Measurement, Observability, Tracking state estimation, WSL method, bad data correction.

UNIT-IV

Voltage Stability: Voltage collapse, P-V curve, multiple power flow solution, continuation power flow, optimal multiplies load flow, voltage collapse proximity indices

RECOMMENDED BOOKS

Sr. no.	Name	Author(s)	Publisher
1	Power system analysis	J.J. Grainger & W.D.Stevenson	McGraw Hill ,2003
2	Advanced Power System Analysis and Dynamic	L.P. Singh	New Age International, 2006
3	Faulted power system analysis.	P.M. Anderson.	IEEE Press , 1995
4	Power generation, operation and control	A.J. Wood	John Wiley, 1994

Course Code	**503**
Course Title	Power System Dynamics-I
Type of Course	PC
L T P	3 0 0
Credits	3
Course Prerequisites	Power system, Electrical Machines
Course Objectives (CO)	1. Study of system dynamics and its physical interpretation 2. Development of mathematical models for synchronous machine 3. Modeling of induction motor.

SYLLABUS

UNIT-I

Synchronous Machines: Per unit systems, Park's Transformation (modified), Flux-linkage equation. Voltage and current equations, Formulation of State-space equations, Equivalent circuit.

UNIT-II

Sub-transient and transient inductance and Time constants, Simplified models of synchronous machines.

UNIT-III

Small signal model: Introduction to frequency model, Excitation systems and Philips-Heffron model, PSS Load modeling.

UNIT-IV

Modeling of Induction Motors, Prime mover controllers.

RECOMMENDED BOOKS			
Sr. no.	**Name**	**Author(s)**	**Publisher**
1	Power System Dynamics and Stability.	J Machowski, J Bialek & J. R W. Bumby,	John Wiley & Sons, 1997
2	Power system stability Vol. I & III.	E.W. Kimbark	John Wiley & Sons, New York 2002
3	Power System Control and Stability Galgotia.	P. M. Anderson & A. A. Fouad	New Delhi, 1981
4	Power System Stability and Control	P.Kundur	McGraw Hill Inc., 1994.

Course Code	**509**
Course Title	Advanced Power Electronic Circuits
Type of Course	PC
L T P	3 0 0
Credits	3
Course Prerequisites	Power Electronics.
Course Objectives (CO)	1. Understand the operation of advanced power electronic circuit topologies. 2. Understand the control strategies involved. 3. Learn few practical circuits, used in practice

SYLLABUS

UNIT-I

Boost type APFC and control, Three phase utility interphases and control-Buck, Boost, Buck-Boost SMPS Topologies.

UNIT-II

Modes of operation –Push-Pull and Forward Converter Topologies - Voltage Mode Control. Half and Full Bridge Converters.

UNIT-III

Flyback Converter. Introduction to Resonant Converters. Load Resonant Converter. Zero Voltage Switching Clamped Voltage Topologies.

UNIT-IV

Resonant DC Link Inverters with Zero Voltage Switching. High Frequency Link Integral Half Cycle Converter. Modelling and design of DC-DC Converters for various renewable energy conversion. Few power electronic circuits used in practice for controlling electric drives.

RECOMMENDED BOOKS

Sr. no.	Name	Author(s)	Publisher
1	Power Electronics.	Rashid	Prentice Hall India 2007.
2	Thyristorised Power Controllers.	G.K.Dubey et.al	John Wiley & Sons, New York 2002
3	Power Semiconductor Circuits.	Dewan & Straughen	John Wiley &Sons., 1975.
4	Modern Power Electronics and AC Drives.	P.Kundur	Pearson Education (Asia)., 2007

Course Code	**511**
Course Title	Digital Control
Type of Course	PC
L T P	3 0 0
Credits	3
Course Prerequisites	Digital, Control System.
Course Objectives (CO)	1. To familiarize the student with the concept of discretization 2. Introduction to discrete-time system representations and digital control 3. Learn to design controller for digital systems

SYLLABUS

UNIT-I

Introduction to discrete-time systems Frequency domain approach – Analysis and discretization Time domain approach, analysis and discretization State space formulation for discretized systems

UNIT-II

Engineering aspects of computer controlled systems. Sampled data systems Control of Sampled data systems.

UNIT-III

Concept of differential sampling, Closed loop analysis of differentially sampled systems Control design based on differential sampling.

UNIT-IV

Recent applications of Digital Control.

RECOMMENDED BOOKS			
Sr. no.	**Name**	**Author(s)**	**Publisher**
1	Discrete-time Control Systems.	K. Ogata	Ed. 2, Prentice-Hall, 1995.
2	Digital Control Systems.	Benjamin C. Kuo,	Ed. 2, Oxford Uiversity Press, 1999

Course Code	**513**
Course Title	**Renewable Energy System**
Type of Course	PC
L T P	3 0 0
Credits	3
Course Prerequisites	Non-Conventional Energy Resources.
Course Objectives (CO)	1. Study of system dynamics and its physical interpretation 2. Development of mathematical models for synchronous machine 3. Modeling of induction motor

SYLLABUS

UNIT-I

Introduction, Distributed vs Central Station Generation, Sources of Energy such as Micro-turbines, Internal Combustion Engines.

UNIT-II

Introduction to Solar Energy, Wind Energy, Combined Heat and Power, Hydro Energy, Tidal Energy, Wave Energy, Geothermal Energy, Biomass and Fuel Cells.

UNIT-III

Power Electronic Interface with the Grid Impact of Distributed Generation on the Power System, Power Quality Disturbances.

UNIT-IV

Transmission System Operation, Protection of Distributed Generators,Economics of Distributed Generation, Case Studies.

RECOMMENDED BOOKS			
Sr. no.	**Name**	**Author(s)**	**Publisher**
1	Photovoltaic System Engineering.	Roger A.	Messenger, Jerry Ventre 3rd Ed, 2010
2	Renewable Energy Sources and Emerging Technologies.	Ranjan Rakesh, Kothari D.P, Singal K.C.	2nd Ed. Prentice Hall of India, 2011
3	Integration of Distributed Generation in the Power System.	Math H. Bollen, Fainan Hassan	July 2011, Wiley-IEEE Press
4	Distributed Generation: Induction and Permanent Magnet Generators.	Loi Lei Lai, Tze Fun Chan	October 2007, Wiley-IEEE Press.

Course Code	**515**
Course Title	**Engineering Optimization**
Type of Course	PC
L T P	3 0 0
Credits	3
Course Prerequisites	
Course Objectives (CO)	1. To understand the need for optimization and different techniques involved and also constraints. 2. To know Linear/Non-linear Programming. 3. To understand the importance of optimization to solve Engineering problems 4. To know genetic algorithm for Engineering Optimization

SYLLABUS

UNIT-I

Concepts of optimization: Engineering applications Statement of optimization Problem, Classification - type and size of the problem Classical Optimization Techniques: Single and multi variable problemsTypes of Constraints Semi definite case-saddle point.

UNIT-II

Linear programming: Standard form-Geometry of LP problems-Theorem of LP Relation to convexity - formulation of LP problems - simplex method and algorithm Matrix form- two phase method. Duality dual simplex method- LU Decomposition.

UNIT-III

Sensitivity analysis. Artificial variables and complementary solutions-QP Engineering Applications: Minimum cost flow problem Network problems-transportation, assignment & allocation, scheduling Karmarkar method-unbalanced and routing problems.

UNIT-IV

Basic decent methods: Fibonacci & Golden section search – Gradient methods – Newton Method-Lagrange multiplier method - Kuhn-tucker conditions QuasiNewton method- separable convex programming- Frank and Wolfe method, Engineering applications Nonlinear programming-Constrained optimization: Characteristics of constraints -Direct methods- SLP, SQP-Indirect methods. Transformation techniques-penalty function-Langrange multiplier methods checking convergence- Engineering applications

RECOMMENDED BOOKS

Sr. no.	Name	Author(s)	Publisher
1	Linear and Non Linear Programming.	David G Luenberger,	AddisonWesley Pub. Co., Massachusetts, 2003
2	Operation Research-Applications & Algorithms.	W.L. Winston	2nd Ed., PWS-KENT Pub. Co., Boston, 2007
3	Engineering Optimization	S.S.Rao	3rd Ed., New Age International (P) Ltd, New Delhi, 2007
4	Non Linear Optimization: theory and algorithms.	L.C.W. Dixton	Birkhauser, Boston, 1980

Course Code	**517**
Course Title	**PWM Converters And Application**
Type of Course	PC
L T P	3 0 0
Credits	3
Course Prerequisites	Power Electronics.
Course Objectives (CO)	1. Understand the concepts and basic operation of PWM converters, including basic circuit operation and design. 2. Understand the steady-state and dynamic analysis of PWM converters along with the applications like solid state drives and power quality.

SYLLABUS

UNIT-I

AC/DC and DC/AC power conversion Overview of applications of voltage source converters and current source converters. Pulse width modulation techniques for bridge converters Bus clamping PWM. Space vector based PWM. Advanced PWM techniques.

UNIT-II

Practical devices in converter. Calculation of switching and conduction power losses. Compensation for dead time and DC voltage regulation. Dynamic model of PWM converter. Multilevel converters. Constant V/F induction motor drives.

UNIT-III

Estimation of current ripple and torque ripple in inverter fed drives. Line-side converters with power factor compensation.

UNIT-IV

Active power filtering. Reactive power compensation. Harmonic current compensation. Selective harmonic elimination PWM technique for high power electric drives

RECOMMENDED BOOKS			
Sr. no.	**Name**	**Author(s)**	**Publisher**
1	Power Electronics: Converters, Applications and Design.	Mohan, Undeland and Robbins.	John's Wiley and Sons.
2	Fundamentals of Power Electronics.	Erickson RW	Chapman and Hall.
3	Power Electronics: Principles and Applications.	Vithyathil. J	McGraw Hill.

Course Code	**519**
Course Title	**Electrical Power Distribution System**
Type of Course	PC
L T P	3 0 0
Credits	3
Course Prerequisites	Power System.
Course Objectives (CO)	1. Learning about power distribution system 2. Learning of SCADA System 3. Understanding Distribution Automation

SYLLABUS

UNIT-I

Distribution of Power, Management, Power Loads, Load Forecasting Short-term & Long-term, Power System Loading, Technological Forecasting.

UNIT-II

Advantages of Distribution Management System (D.M.S.), Distribution Automation: Definition, Restoration / Reconfiguration of Distribution Network, Different Methods and Constraints, Power Factor Correction.

UNIT-III

Interconnection of Distribution, Control & Communication Systems, Remote Metering, Automatic Meter Reading and its implementation, SCADA: Introduction, Block Diagram, SCADA Applied To Distribution Automation, Common Functions of SCADA, Advantages of Distribution Automation through SCADA.

UNIT-IV

Calculation of Optimum Number of Switches, Capacitors, Optimum Switching Device Placement in Radial, Distribution Systems, Sectionalizing Switches – Types, Benefits, Bellman'sOptimality Principle, Remote Terminal Units, Energy efficiency in electrical distribution & Monitoring. Maintenance of Automated Distribution Systems, Difficulties in Implementing Distribution, Automation in Actual Practice, Urban/Rural Distribution, Energy Management, AI techniques applied to Distribution Automation.

RECOMMENDED BOOKS

Sr. no.	Name	Author(s)	Publisher
1	Electric Power Distribution.	A.S. Pabla	Tata McGraw Hill Publishing Co. Ltd., Fourth Edition.
2	G.M. Dhole, "A Text Book of Electrical power Distribution Automation.	M.K. Khedkar	University Science Press, New Delhi.
3	Electrical Distribution Engineering	Anthony J Panseni	CRC Press McGraw Hill.
4.	Electric Power Distribution, automation, protection & control.	James Momoh	CRC

Course Code	**521**
Course Title	**SCADA Systems And Applications**
Type of Course	PC
L T P	3 0 0
Credits	3
Course Prerequisites	Power System.
Course Objectives (CO)	1. To understand what is meant by SCADA and its functions. 2. To know SCADA communication. 3. To get an insight into its application

SYLLABUS

UNIT-I

Introduction to SCADA: Data acquisition systems, Evolution of SCADA, Communication technologies. Monitoring and supervisory functions, SCADA applications in Utility Automation, Industries SCADA.

UNIT-II

Industries SCADA System Components: Schemes- Remote Terminal Unit (RTU), Intelligent Electronic Devices (IED), Programmable Logic Controller (PLC), Communication Network, SCADA Server, SCADA/HMI Systems.

UNIT-III

SCADA Architecture: Various SCADA architectures, advantages and disadvantages of each system - single unified standard architecture -IEC 61850.

UNIT-IV

SCADA Communication: various industrial communication technologies -wired and wireless methods and fiber optics. open standard communication protocols. SCADA Applications: Utility applications- Transmission and Distribution sector- operations, monitoring, analysis and improvement. Industries - oil, gas and water, Case studies, Implementation, Simulation Exercises

RECOMMENDED BOOKS.

Sr. no.	Name	Author(s)	Publisher
1	SCADA-Supervisory Control and Data Acquisition.	Stuart A. Boyer	Instrument Society of America Publications, USA, 2004
2	Practical Modern SCADA Protocols: DNP3, 60870.5 and Related Systems.	Gordon Clarke, Deon Reynders	Newnes Publications, Oxford, UK,2004.
3	Cybersecurity for SCADA systems.	William T. Shaw	PennWell Books, 2006
4.	Practical SCADA for industry	David Bailey, Edwin Wright	Newnes, 2003

Course Code	**523**
Course Title	**Optimal & Adaptive Control**
Type of Course	PC
L T P	3 0 0
Credits	3
Course Prerequisites	Power System.
Course Objectives (CO)	1. To know the operation of closed and open loop optimal control. 2. Understand the adaptive control strategies. 3. Learn dynamic programming method.

SYLLABUS

UNIT-I

Optimal control problem – fundamental concepts and theorems of calculus of variations–Euler - Language equation and extremal of functional. Variational approach to solving optimal control problems. Hamiltonian and different boundary conditions for optimal control problem.

UNIT-II

Linear regulator problem - Pontryagin's minimum principle Dynamic programming - Principle of optimality and its application to optimal control problem.

UNIT-III

Hamilton-Jacobi-Bellman equation - model reference adaptive systems(MRAS) - Design hypothesis.

UNIT-IV

Introduction to design method based on the use of Liapunov function. Design and simulation of variable structure adaptive model following control.

RECOMMENDED BOOKS.

Sr. no.	Name	Author(s)	Publisher
1	Optimal Control Theory An introduction.	Donald E. Kirk	Prentice Hall Inc, 2004
2	Optimum Systems Control.	A.P. Sage	Prentice Hall, 1977
3	Modern Control, Principles and Applications.	HSU and Meyer	McGraw Hill, 1968
4.	Adaptive Control (Model Reference Approach)	Yoan D. Landu	Marcel Dekker,1981

Course Code	**MAT524**
Course Title	**Research Methodology and IPR**
Type of Course	Audit
L T P	3 0 0
Credits	3
Course Prerequisites	Basic knowledge of mathematical concepts
Course Objectives (CO)	The course aims at equipping students with an understanding of the research process, tools and techniques in order to facilitate managerial decision making.

SYLLABUS

Unit –I

An Introduction to Research: Meaning, Definition, Objectives and Process; Research Problem: Selection of Problem, Understanding Problem, Necessity of Defined Problem; Review of Literature in Research. Research Design: Meaning, Types –Descriptive, Diagnostic, Exploratory and Experimental.

Unit –II

Sources Of Data: Primary And Secondary; Data Collection Methods; Questionnaire Designing: Construction, Types And Developing A Good Questionnaire. Sampling Design and Techniques, Scaling Techniques, Meaning, Types, Data Processing Operations, Editing, Coding, Classification, Tabulation. Research Proposal/Synopsis Writing.

Unit –III

Statistics - Descriptive Statistics: Central Tendency and Dispersion, Correlation: Linear, Partial and Multiple, Simple and Multiple Regression, Discriminant Analysis, Conjoint Analysis, Time Series and Business Forecasting. Applications of Index Numbers; Sampling Distribution; Tests Of Significance: Z-Test, T-Test, Chi-Square Test, F -Test, And ANOVA; Use Of SPSS For T-Test, Chi-Square Test and ANOVA.

Unit –IV

Multi Dimensional Scaling: Factor Analysis, Cluster Analysis, Interpretation of Data, Report Preparation and Presentation. Each Student has to prepare Mini Research Project on Topic / Area of their Choice and Make Presentation. The report should consist of application of tests and techniques mentioned in above units. Relevant Case Studies should be discussed in class.
Note: Practical-Use of SPSS / Systat and Excel.

RECOMMENDED BOOKS			
Sr. no.	**Name**	**Sr. no.**	**Name**
1	Business Research Methods	1	Business Research Methods
2	An Applied Orientation	2	An Applied Orientation
4	Research Methodology: Methods & Techniques	4	Research Methodology: Methods & Techniques
4	SPSS Explained	4	SPSS Explained

Course Code	**EE505**
Course Title	Power System Steady State Analysis Lab
Type of Course	PC
L T P	0 0 2
Credits	1
Course Prerequisites	Power Electronics.
Course Objectives (CO)	1. To understand power system problems 2. To understand how to analyze the power system load flow studies, forecasting & unit Commitment. 3. To understand the role of power electronic devices.

SYLLABUS

1. Power Systems & Power Electronics Lab
2. Computer Simulation Lab
3. Simulation of IGBT Inverters.
4. Simulation of Thyristor Converters.
5. Transient Stability Studies.
6. Short Circuit Studies.
7. Load Flow Studies
8. Load Forecasting and Unit Commitment.

Course Code	**EE507**
Course Title	Power System Dynamics Lab.
Type of Course	PC
L T P	0 0 2
Credits	1
Course Prerequisites	Electrical machines Lab.
Course Objectives (CO)	1. To understand the stability analysis for single machine system 2. To understand the stability analysis for single machine system using models. 3. Development of simulink model for excitation system using MATLAB.

SYLLABUS

1. To develop a MATLAB program to study small signal stability analysis of single machine infinite bus system using classical machine model.

2. To develop a MATLAB program to study small signal stability analysis of single machine infinite bus system using Type B1 model.

3. To develop a simulink model of IEEE type 1(1968) excitation system using MATLAB.

4. To develop a MATLAB program to study small signal stability analysis of single machine infinite bus system using Type B1 –effect of excitation system.

5. To develop a MATLAB program to study small signal stability analysis of single machine infinite bus system using Type B1 machine model with simple excitation system- effect of PSS.

Course Code	**502**
Course Title	**Power System Dynamics-II**
Type of Course	PC
L T P	3 0 0
Credits	3
Course Prerequisites	Power System.
Course Objectives (CO)	1. Study of power system dynamics 2. Interpretation of power system dynamic phenomena 3. Study of various forms of stability

SYLLABUS

UNIT-I

Basic Concepts of Dynamic Systems and Stability Definition, Small Signal Stability (Low Frequency Oscillations) of Unregulated and Regulated System Effect of Damper, Flux Linkage Variation and AVR.

UNIT-II

Large Signal Rotor Angle Stability, Dynamic Equivalents And Coherency, Direct Method of Stability Assessment, Stability Enhancing Techniques, Mitigation Using Power System Stabilizer.

UNIT-III

Asynchronous Operation and Resynchronization, Multi-Machine Stability Dynamic Analysis of Voltage Stability, Voltage Collapse.

UNIT-IV

Frequency Stability, Automatic Generation Control, Primary and Secondary Control, Sub-Synchronous Resonance and Counter Measures.

RECOMMENDED BOOKS.			
Sr. no.	**Name**	**Author(s)**	**Publisher**
1	Power System Stability and Control.	P. Kundur	McGraw Hill Inc, 1994
2	Power System Dynamics and Stability.	J. Machowski, Bialek, Bumby	John Wiley & Sons, 1997
3	Power System Stability and Control	L. Leonard Grigsby (Ed.);	CRC Press, 2007
4.	Computational Techniques for voltage stability assessment & control.	V. Ajjarapu	Springer, 2006

Course Code	**504**
Course Title	**Digital Protection Of Power System**
Type of Course	PC
L T P	3 0 0
Credits	3
Course Prerequisites	Power system Protection
Course Objectives (CO)	1. Study of numerical relays 2. Developing mathematical approach towards protection 3. Study of algorithms for numerical protection.

SYLLABUS

UNIT-I

Evolution of digital relays from electromechanical relays, Performance and operational characteristics of digital protection Mathematical background to protection algorithms, Finite difference techniques.

UNIT-II

Interpolation formulae, Forward, backward and central difference interpolation, Numerical differentiation, Curve fitting and smoothing, Least squares method, Fourier analysis, Fourier series and Fourier transform, Walsh function analysis.

UNIT-III

Basic elements of digital protection, Signal conditioning: transducers, surge protection, analog filtering, analog multiplexers, Conversion subsystem: the sampling theorem, signal aliasing, Error, sample and hold circuits, multiplexers, analog to digital conversion, Digital filtering concepts, The digital relay as a unit consisting of hardware and software.

UNIT-IV

Sinusoidal wave based algorithms, Sample and first derivative (Mann and Morrison) algorithm, Fourier and Walsh based algorithms Fourier Algorithm: Full cycle window algorithm, fractional cycle window algorithm, Walsh function based algorithm, Least Squares based algorithms, Differential equation based algorithms, Traveling Wave based Techniques, Digital Differential Protection of Transformers, Digital Line Differential Protection, Recent Advances in Digital Protection of Power Systems

RECOMMENDED BOOKS.

Sr. no.	**Name**	**Author(s)**	**Publisher**
1	Computer Relaying for Power Systems.	A.G. Phadke and J. S. Thorp	Wiley/Research studies Press, 2009.
2	Digital Protection of Power Systems.	A.T. Johns and S. K. Salman	IEEE Press,1999
3	Numerical Distance Protection.	Gerhard Zeigler	Siemens Publicis Corporate Publishing, 2006
4.	"Digital Power System Protection"	S.R. Bhide	PHI Learning Pvt.Ltd.2014.

Course Code	510

Course Title	Advance Control System.
Type of Course	PC
L T P	3 0 0
Credits	3
Course Prerequisites	Control System.
Course Objectives (CO)	1. The course provides glimpses into the advanced methods of modeling and analysis of the dynamical systems. 2. The course is a strong step in inculcating the research aptitude in the students

SYLLABUS

UNIT-I

Math Modelling of Dynamical Systems: Newtonian and Lagrangian approaches, Concept of dynamical state of a system, Concept of equilibrium point, linearization of non-linear model. Review of Linear Algebra concepts: Field, Vector space, linear combination, linear independence, bases of a vector space, representation of any vector on different basis, matrix representation of a linear operator, change of basis, rank, nullity, range space and null space of a matrix. Eigen value and Eigen vector of a matrix, similarity transform, Diagonalisation.

UNIT-II

Modern Control Analysis: Concept and computation of systems modes, controllability theorem and its proof, Observability theorem and its proof, Controllable and observable subspaces. Stability Analysis: Stability of linear systems, stability types and their definitions for any general system, Stability of an equilibrium point, Lyapunov stability theory for LTI systems, Quadratic forms and Lyapunov functions.

UNIT-III

Modern Control Design: Converting the math model to controllable canonical form and its use for pole placement, Concept of linear observer and its design, Design of reduced order observer, Compensator design using separation principle, Poles of compensator, Open loop and close-loop systems.

UNIT-IV

Optimal Control Theory: Introduction to the philosophy of optimal control, formulation of optimal control problem, different performance criterion, Linear quadratic regulator (LQR) and optimum gain matrix, Riccati equations, conceptual models and statistical models for random processes, Kalman filter.

RECOMMENDED BOOKS.

Sr. no.	Name	Author(s)	Publisher
1	Control System Design: An Introduction to State-Space Methods.	Bernard Friedland	Dover Publications, Inc. Mineola, New York, 2012
2	Linear Systems	Thomas Kailath	Prentice-Hall Inc., New Jersey, 1986
3	Modern Control System Theory.	M. Gopal	New Age International (P) Limited, New Delhi,2000

Course Code	**512**
Course Title	Advanced Digital Signal Processing
Type of Course	PC
L T P	3 0 0
Credits	3
Course Prerequisites	Digital Signal Processing.
Course Objectives (CO)	1. To understand the difference between discrete-time and continuous-time signals 2. To understand and apply Discrete Fourier Transforms (DFT)

SYLLABUS

UNIT-I

Discrete time signals, Linear shift invariant systems- Stability and causality, Sampling of continuous time signals- Discrete time Fourier transformDiscrete Fourier series- Discrete Fourier transform, Z transform-Properties of different transforms.

UNIT-II

Linear convolution using DFT, Computation of DFT Design of IIR digital filters from analog filters, Impulse invariance method, Bilinear transformation method. FIR filter design usingwindow functions, Comparison of IIR and FIR digital filters, Basic IIR and FIR filter realization structures, Signal flow graph representations Quantization process and errors, Coefficient quantisation effects in IIR and FIR filters.

UNIT-III

A/D conversion noise- Arithmetic round-off errors, Dynamic range scaling, Overflowoscillations and zero Input limit cycles in IIR filters, Linear Signal Models. All pole, All zero and Pole-zero models, Power spectrum estimation Spectral analysis of deterministic signals, Estimation of power spectrum of stationary random signals.

UNIT-IV

Optimum linear filters, Optimum signal estimation, Mean square error estimation, Optimum FIR and IIR Filters.

RECOMMENDED BOOKS.

Sr. no.	Name	Author(s)	Publisher
1	Digital Signal Processing: A computer-based approach.	Sanjit K Mitra	Tata Mc-Graw-Hill Edition1998
2	Statistical and Adaptive Signal Processing.	Dimitris G. Manolakis, Vinay K. Ingle and Stephen M. Kogon,	Mc Grow Hill international editions. - 200

Course Code	**514**
Course Title	**Dynamics Of Electrical Machines**
Type of Course	PC
L T P	3 0 0
Credits	3
Course Prerequisites	Electrical Machines.
Course Objectives (CO)	1. Learn Performance characteristics of machine 2. To understand the dynamics of the machine 3. To understand how to determine stability of machine 4. Learn the synchronous machine

SYLLABUS

UNIT-I

Stability, Primitive 4 Winding Commutator Machine, Commutator Primitive Machine, Complete Voltage Equation of Primitive 4 Winding, Commutator Machine.

UNIT-II

Torque Equation Analysis of Simple DC Machines using the Primitive Machine Equations, The Three Phase Induction Motor, Transformed Equations, Different Reference Frames for Induction Motor Analysis Transfer, Function Formulation.

UNIT-III

Three Phase Salient Pole Synchronous Machine, Parks Transformation, Steady State Analysis. Large Signal Transient, Small Oscillation Equations in State Variable form, Dynamical Analysis of Interconnected Machines.

UNIT-IV

Large Signal Transient Analysis using Transformed Equations, DC Generator /DC Motor System. Alternator /Synchronous Motor System.

RECOMMENDED BOOKS.

Sr. no.	Name	Author(s)	Publisher
1	Electrical Machine Dynamics.	D.P. Sengupta& J.B. Lynn	The Macmillan Press Ltd. 1980
2	Electric Motor Drives, Modeling, Analysis, and Control.	R Krishnan	Pearson Education., 2001
3	Analysis of Electrical Machines.	P.C. Kraus	McGraw Hill Book Company,1987
4	Electrical Machine Dynamics	I. Boldia& S.A. Nasar	The Macmillan Press Ltd. 1992
5	The Unified Theory of Electrical Machines.	C.V. Jones	Butterworth, London. 1967.

Course Code	**516**
Course Title	**Smart Grid.**
Type of Course	PC
L T P	3 0 0
Credits	3
Course Prerequisites	Power System.
Course Objectives (CO)	1. Understand concept of smart grid and its advantages over conventional grid. 2. Know smart metering techniques. 3. Learn wide area measurement techniques. 4. Understanding the problems associated with integration of distributed generation & its solution through smart grid.

SYLLABUS

UNIT-I

Introduction to Smart Grid, Evolution of Electric Grid. Concept of Smart Grid, Definitions, Need of Smart Grid. Concept of Robust &Self-Healing Grid, Present development & International policies in Smart Grid. Introduction to Smart Meters, Real Time Prizing, Smart Appliances. Automatic Meter Reading (AMR). Outage Management System (OMS). Plug in Hybrid Electric Vehicles(PHEV). Vehicle to Grid, Smart Sensors. Home & Building Automation, Smart Substations, Substation Automation, Feeder Automation.

UNIT-II

Geographic Information System (GIS). Intelligent Electronic Devices (IED) & their application for monitoring &protection, Smart storage like Battery, SMES, Pumped Hydro. Compressed Air Energy Storage. Wide Area Measurement System (WAMS), Phase Measurement Unit (PMU).

UNIT-III

Concept of micro-grid, need & applications of micro-grid. Formation of microgrid, Issues of interconnection. Protection & control of micro-grid. Plastic & Organic solar cells, Thin film solar cells. Variable speed wind generators, fuelcells, micro-turbines. Captive power plants,Integration of renewable energy sources.

UNIT-IV

Advanced Metering Infrastructure (AMI), Home Area Network (HAN). Neighbourhood Area Network (NAN), Wide Area Network (WAN). Bluetooth, ZigBee, GPS, Wi-Fi, Wi-Max based communication. Wireless Mesh Network. Basics of CLOUD Computing &Cyber Security for Smart Grid. Broadband over Power line (BPL). IP based protocols.

RECOMMENDED BOOKS.

Sr. no.	**Name**	**Author(s)**	**Publisher**
1	Electrical Machine Dynamics.	D.P. Sengupta& J.B. Lynn	The Macmillan Press Ltd. 1980
2	Electric Motor Drives, Modeling, Analysis, and Control.	R Krishnan	Pearson Education., 2001
3	Analysis of Electrical Machines.	P.C. Kraus	McGraw Hill Book Company,1987
4	Electrical Machine Dynamics	I. Boldia& S.A. Nasar	The Macmillan Press Ltd. 1992
5	The Unified Theory of Electrical Machines.	C.V. Jones	Butterworth, London. 1967.

Course Code	**518**
Course Title	**Distribution Generation.**
Type of Course	PC
L T P	3 0 0
Credits	3
Course Prerequisites	Power System.
Course Objectives (CO)	1. To understand renewable energy sources. 2. To gain understanding of the working of off-grid and grid-connected renewable energy generation schemes.

SYLLABUS

UNIT-I

Need for Distributed generation. Renewable sources in distributed generation and current scenario in Distributed Generation. Planning of DGs. Sitting and sizing of DGs optimal placement of DG sources in distribution systems. Grid integration of DGs Different types of interfaces, Inverter based DGs and rotating machine based interfaces. Aggregation of multiple DG units.

UNIT-II

Technical impacts of DGs. Transmission systems Distribution Systems Deregulation Impact of DGs upon protective relaying. Impact of DGs upon transient and dynamic stability of existing distribution systems, Steady-state and Dynamic analysis.

UNIT-III

Economic and control aspects of DGs Market facts. Issues and challenges Limitations of DGs, Voltage control techniques. Reactive power control, Harmonics Power quality issues, Reliability of DG based systems.

UNIT-IV

Introduction to micro-grids. Types of micro-grids: autonomous and nonautonomous grids Sizing of micro-grids. Modeling & analysis of Micro-grids with multiple DGs. Microgrids with power electronic interfacing units. Transients in micro-grids, Protection of micro-grids, Case studies, Advanced topics.

RECOMMENDED BOOKS.

Sr. no.	Name	Author(s)	Publisher
1	Distributed Power Generation – Planning and Evaluation.	H. Lee Willis, Walter G. Scott	Marcel Decker Press
2	Renewable Energy Systems – Design and Analysis with Induction Generators.	M.Godoy Simoes, Felix A.Farret	CRC press.
3	Smart Grid: Infrastructure Technology Solutions.	Stuart Borlase	CRC Press

Course Code	**520**
Course Title	**Robust Control.**
Type of Course	PC
L T P	3 0 0
Credits	3
Course Prerequisites	Control System.
Course Objectives (CO)	1. Introduction to control techniques with greater emphasis on robustness to modeling uncertainty 2. Introduction to parameter variations, and presence of disturbances and noise.

SYLLABUS

UNIT-I

Modeling of uncertain systems, Signals and Norms Lyapunov theory for LTI systems.

UNIT-II

Passive systems – frequency domain Passive systems – time domain Robust Stability and performance, Stabilizing controllers – Coprime factorization.

UNIT-III

LQR, LQG problems, Ricatti equations and solutions, Ricatti equation solution through LMI.

UNIT-IV

H-infinity control and mu-synthesis, Linear matrix inequalities for robust control.

RECOMMENDED BOOKS.			
Sr. no.	**Name**	**Author(s)**	**Publisher**
1	Optimal and Robust Control.	L. Fortuna, M. Frasca (Eds.).	CRC Press, 2012
2	Robust and Optimal Control.	K. Zhou, J. C. Doyle and K. Glover	Prentice Hall, 1996
3	Francis and A. R. Tannenbaum, "Feedback Control Theory".	J. C. Doyle, B. A.	Macmillan, 1992

Course Code	**522**
Course Title	Artificial Intelligence Techniques
Type of Course	PC
L T P	3 0 0
Credits	3
Course Prerequisites	
Course Objectives (CO)	1.Understanding fuzzy logic, ANN 2.Understanding GA & EP

SYLLABUS

UNIT-I

Biological foundations to intelligent Systems, Artificial Neural Networks, Single layer and Multilayer Feed Forward NN LMS and Back Propagation Algorithm, Feedback networks and Radial Basis Function Networks.

UNIT-II

Fuzzy Logic, Knowledge Representation and Inference Mechanism Defuzzification Methods.

UNIT-III

Fuzzy Neural Networks, some algorithms to learn the parameters of the network like GA.System Identification using Fuzzy and Neural Network.

UNIT-IV

Genetic algorithm, Reproduction cross over, mutation, Introduction to evolutionary program. 8 6 Applications of above mentioned techniques to practical problems.

RECOMMENDED BOOKS.			
Sr. no.	**Name**	**Author(s)**	**Publisher**
1	An Introduction to ANN.	J M Zurada	Jaico Publishing House
2	Neural Networks	Simon Haykins	Prentice Hall
3	Fuzzy Logic with Engg. Applications.	Timothy Ross	McGraw. Hill
4	An Introduction to Fuzzy Control.	Driankov, Dimitra	Narosa Publication
5	Genetic Algorithms.	Golding	Addison-Wesley Publishing Com

Course Code	**524**
Course Title	Industrial Load Modeling And Control
Type of Course	PC
L T P	3 0 0
Credits	3
Course Prerequisites	Generation of Electrical Power.
Course Objectives (CO)	1. Understand the energy demand scenario 2. Understand the modeling of load and its ease to study load demand industrially 3. Know Electricity pricing models 4. Study Reactive power management in Industries

SYLLABUS

UNIT-I

Electric Energy Scenario-Demand Side Management-Industrial Load Management, Load Curves-Load Shaping Objectives-MethodologiesBarriers, Classification of Industrial Loads- Continuous and Batch processes -Load Modelling.

UNIT-II

Electricity pricing – Dynamic and spot pricing –Models, Direct load control- Interruptible load control, Bottom up approach- schedulingFormulation of load models, Optimization and control algorithms, Case studies.

UNIT-III

Reactive power management in industries-controls, Power quality impacts-application of filters Energy saving in Industries. Cooling and heating loads, Load profiling- Modeling, Cool storageTypes-Control strategies, Optimal operation, Problem formulation, Case studies.

UNIT-IV

Captive power units- Operating and control strategies, Power PoolingOperation models, Energy banking, Industrial Cogeneration. Selection of Schemes Optimal Operating Strategies-Peak load Saving, Constraints, Problem formulation- Case study, Integrated Load management for Industries.

RECOMMENDED BOOKS.

Sr. no.	Name	Author(s)	Publisher
1	Industrial Load Management - Theory, Practice and Simulations.	C.O. Bjork	Elsevier, the Netherlands,1989
2	Load management concepts. IEEE Press.	C.W. Gellings and S.N. Talukdar	New York, 1986, pp. 3-28
3	Physically based Industrial load.	Y. Manichaikul and F.C. Schweppe	IEEE Trans. on PAS, April 1981.
4	Least cost Electricity Utility Planning.	H. G. Stoll	Wiley Interscience Publication, USA, 1989.
5	Modern Power System Engineering.,	I.J.Nagarath and D.P.Kothari	Tata McGraw Hill publishers, NewDelhi, 1995

Course Code	**506**
Course Title	**Power System Protection Lab.**
Type of Course	PC
L T P	0 0 4
Credits	2
Course Prerequisites	Power System.
Course Objectives (CO)	1. To understand power system protection through feeders. 2. To understand the transformer protection, reverse power and induction relay.

SYLLABUS

1. Introduction to Power System Protection
2. Impact of Induction Motor Starting on Power System
3. Modelling of Differential Relay using MATLAB
4. Radial Feeder Protection
5. Parallel Feeder Protection
6. Principle of Reverse Power Protection
7. Differential Protection of Transformer
8. To the study time Vs. voltage characteristics of over voltage induction relay

Course Code	**526**
Course Title	**Power Electronics Applications To Power Systems Lab**
Type of Course	PC
L T P	0 0 4
Credits	2
Course Prerequisites	Power System and Power Electronics.
Course Objectives (CO)	1. To understand and analyze the performance of thyristor, converters and inverters 2. Applications of power electronics in operation of power system.

SYLLABUS

1. Study of three phase line commutated thyristor converter circuit
2. To study the performance of three phase variable frequency drive
3. Switching characteristics of MOSFET and IGBT
4. Performance analysis of Buck and Boost converter
5. Study of three phase PWM and non PWM inverter

Course Code	**528**
Course Title	**Smart Grid**
Type of Course	PC
L T P	0 0 4
Credits	2
Course Prerequisites	Power System.
Course Objectives (CO)	1. To understand smart grid structure 2. Understand the microgrid 3. Understand power quality issues in smart grid.

SYLLABUS

1. To study the components of smart grid.
2. To analyze the geographic information system for smart grid.
3. Formation of microgrid and protection and control of grid.
4. Understand power quality issues in grid connected renewable energy sources
5. Performance analysis of smart meters.

Course Code	**530**
Course Title	**Artificial Intelligence Lab**
Type of Course	PC
L T P	0 0 4
Credits	2
Course Prerequisites	MATLAB
Course Objectives (CO)	1. To understand applications of artificial intelligence technqiues 2. Designing of control system using these techniques. 3. Customization of controlling variables.

SYLLABUS

1. Write A Program For Best First Search.
2. Write A Program to Generate the output for A* Algorithm.
3. Write a Program To Show the Tic Tac Toe Game for 0 and X.
4. Write A Program For Expert System By Using Forward Chaining.
5. Comparing the Search Methods.
6. Implement the Greedy Search Algorithm.
7. Implement the min-max Algorithm.
8. Adding a Heuristic.

Course Code	**601**
Course Title	**FACTS and Custom Power Devices**
Type of Course	PC
L T P	3 0 0
Credits	3
Course Prerequisites	Power System Analysis & Generation of Electrical Power.
Course Objectives (CO)	1. To learn the active and reactive power flow control in power system 2. To understand the need for static compensators 3. To develop the different control strategies used for compensation

SYLLABUS

UNIT-I

Reactive power flow control in Power Systems – Control of dynamic power unbalances in Power System, Power flow control -Constraints of maximum transmission line loading –Benefits of FACTS Transmission line compensation, Uncompensated line -Shunt compensation - Series compensation –Phase angle control. Reactive power compensation, Shunt and Series compensation principles – Reactive compensation at transmission and distribution level.

UNIT-II

Static versus passive VAR compensator, Static shunt compensators: SVC and STATCOM - Operation and control of TSC, TCR and STATCOM - Compensator control, Comparison between SVC and STATCOM.

UNIT-III

Static series compensation: TSSC, SSSC -Static voltage and phase angle regulators – TCVR and TCPAR Operation and Control –Applications, Static series compensation – GCSC, TSSC, TCSC and Static synchronous series compensators and their Control. SSR and its damping Unified Power Flow Controller: Circuit Arrangement, Operation and control of UPF, Basic Principle of Pand Q control- Independent real and reactive power flow control- Applications.

UNIT-IV

Introduction to interline power flow controller. Modeling and analysis of FACTS Controllers – Simulation of FACTS controllers Power quality problems in distribution systems, harmonics, Loads that create harmonics, modeling, harmonic propagation, series and parallel resonances, mitigation of harmonics, passive filters, active filtering – shunt , series and hybrid and their control. Voltage swells, sags, flicker, unbalance and mitigation of these problems by power line conditioners- IEEE standards on power quality.

RECOMMENDED BOOKS.			
Sr. no.	**Name**	**Author(s)**	**Publisher**
1	FACTS Controllers in Power Transmission and Distribution.	K R Padiyar	New Age International Publishers, 2007
2	Flexible AC Transmission Systems-Modelling and Control.	X P Zhang, C Rehtanz.	B Pal
3	Understanding FACTS: Concepts and Technology of Flexible AC Transmission Systems.	N.G. Hingorani, L. Gyugyi	IEEE Press Book, Standard Publishers and Distributors, Delhi, 2001.

Course Code	**603**
Course Title	Modeling And Control Of Distributed Parameter System
Type of Course	PC
L T P	3 0 0
Credits	3
Course Prerequisites	
Course Objectives (CO)	1. Introduction to modeling, analysis and control of distributed parameter systems 2. Introduction to finite discretization

SYLLABUS

UNIT-I

Overview: Motivation and examples (wave propagation, fluid flow, network traffic, electromagnetism) 6Modeling of Distributed Parameter Systems: Parabolic and Hyperbolic.PDEs, Analytic and Numerical Solution of PDEs

UNIT-II

Lyapunov stability of DPS, Boundary control and Observer Design of DPS.

UNIT-III

Finite Difference discretization of DPS, Finite Element discretization of DPS, Boundary Elements discretization of DPS.

UNIT-IV

Reduction of discretized models. Applications: Control of systems with time delays, control of fluid flow, network control.

RECOMMENDED BOOKS.			
Sr. no.	**Name**	**Author(s)**	**Publisher**
1	Boundary Control of PDEs: A Course on Backstepping Designs.	Miroslav Krstic and Andrey Smyshlyaev	SIAM, 2008
2	Nonlinear and Robust Control of PDE Systems.	Panagiotis D. Christofides, Birkhauser	2001
3	Nonlinear Systems.	Hassan K. Khalil	Third Edition, Prentice Hall 2002

Course Code	**605**
Course Title	Dynamics of Linear Systems
Type of Course	PC
L T P	3 0 0
Credits	3
Course Prerequisites	Linear control System.
Course Objectives (CO)	1. To understand the linear system and its functions 2. To understand the stability analysis of linear systems and implement the same in MATLAB

SYLLABUS

UNIT-I

State variable representations of systems, transfer function and transfer function matrix, solutions of state equations.

UNIT-II

Observability and controllability, minimal realization of MIMO systems, analysis of linear time varying systems, the concepts of stability. Lyapunov stability analysis, Lyapunov function and its properties, controllability by state variable feedback.

UNIT-III

Ackerman's Formula - stabilisation by output feedback, asymptotic observers for state measurement, observer design. State space representation of discrete systems, solution of state equations, controllability and observabilty stability analysis using Lyapunov method.

UNIT-IV

State feedback of linear discrete time systems, design of observers - MATLAB Exercises.

RECOMMENDED BOOKS.			
Sr. no.	**Name**	**Author(s)**	**Publisher**
1	Linear Systems.	Thomas Kailath	Prentice Hall Inc., Englewood Cliffs, N.J. 1980
2	State Space Analysis of Control Systems.	K. Ogata	Prentice Hall Inc., Englewood Cliffs, N.J., 1965.
3	Modern Control Engineering, (second edition).	K. Ogata	Prentice Hall Inc., Englewood Cliffs, N.J., 1990
4	Digital Control and State Variable Methods.	M.Gopal	Tata McGraw Hill Publishing Company Ltd., New Delhi, 1997
5	Linear System Theory and Design.	C.T. Chen	New York: Holt Rinehart and Winston ,1984

Course Code	**607**
Course Title	Energy Conversion Processes
Type of Course	PC
L T P	3 0 0
Credits	3
Course Prerequisites	Electrical Machines.
Course Objectives (CO)	1. Analysis of different energy system like solar 2. Understand design aspects of MHD generators 3. Understand Fuel cell & their applications

SYLLABUS

UNIT-I

Basic science of energy conversion. Indirect verses direct conversion. Physics of semiconductor junctions for photovoltaic and photoElectro chemical conversion of solar energy. Fabrication and evaluation of varioussolar cells in photovoltaic power generation systems.

UNIT-II

Technology and physics of thermo-electric generations. Thermal-electric materials and optimization studies.

UNIT-III

Basic concepts and design considerations of MHD generators Cycle analysis of MHD systems . Thermonic power conversion and plasma diodes. Thermo dynamics and Performance of fuel cells and their applications.

UNIT-IV

Advanced topics in Energy Conversion Process.

RECOMMENDED BOOKS.			
Sr. no.	**Name**	**Author(s)**	**Publisher**
1	Energy Conversion.	S. S. L. Chang	Prentice Hall, 1963. 16
2	Direct Energy Conversion.	S. W. Angrist	Pearson, 1982
3	Magneto hydrodynamic Energy Conversion.	R. J. Rosa	Springer, 1987
4	Fuel Cell Problems and Solutions.	V. S. Bagotsky	John Wiley & Sons, 2009