KAMLA NEHRU INSTITUTE OF TECHNOLOGY, SULTANPUR (U.P.)

(An Autonomous Institute under G.B.T.U. Lucknow)

STUDY AND EVALUATION SCHEME

(With Effective From : Session 2013-14)

~~~~~~

ELECTRICAL ENGINEERING

~~~~~~

MASTER OF TECHNOLOGY (REGULAR)
Power Electronics & Drives

MASTER OF TECHNOLOGY (PART-TIME)
Power System

MASTER OF TECHNOLOGY (PART-TIME)
Solid-State Control

KAMLA NEHRU INSTITUTE OF TECHNOLOGY, SULTANPUR
(An Autonomous Institute under G.B.T.U. Lucknow)

ELECTRICAL ENGINEERING

MASTER OF TECHNOLOGY (REGULAR)
Power Electronics & Drives

(With effective from: Session 2013-14)

SEMESTER – I

Sr.	Subject Code	Subject	Periods			EVALUATION SCHEME							Subject Total
						Sessional Exam						End Semester Exam	
			L	T	P	Theory			Practical		Total		
						CT	AT	TA	AT	TA			
1.	REE 111	Fundamentals of Electric Drives	3	1	0	30	10	10	---	---	50	100	150
2.	REE 112	Advanced Control Systems	3	1	0	30	10	10	---	---	50	100	150
3.	REE 113	Power Converters	3	0	2	15	10	05	10	10	50	100	150
4.	REE 114	MATLAB Programming, Computational Techniques & Simulation	3	0	2	15	10	05	10	10	50	100	150
5.	OEE 01	Elective – I	3	1	0	30	10	10	---	---	50	100	150
		TOTAL	**15**	**3**	**4**						**250**	**500**	**750**

SEMESTER – II

Sr.	Subject Code	Subject	Periods			EVALUATION SCHEME							Subject Total
						Sessional Exam						End Semester Exam	
			L	T	P	Theory			Practical		Total		
						CT	AT	TA	AT	TA			
1.	REE 211	Power Semiconductor Controlled Electric Drives	3	0	2	15	10	05	10	10	50	100	150
2.	REE 212	Power Converter Applications	3	1	0	30	10	10	---	---	50	100	150
3.	REE 213	Advanced Microprocessor & Applications	3	0	2	15	10	05	10	10	50	100	150
4.	OEE 02	Elective – II	3	1	0	30	10	10	---	---	50	100	150
5.	OEE 03	Elective – III	3	1	0	30	10	10	---	---	50	100	150
		TOTAL	**15**	**3**	**4**						**250**	**500**	**750**

SEMESTER – III

Sr.	Subject Code	Subject	Periods			EVALUATION SCHEME							Subject Total
						Sessional Exam						End Semester Exam	
			L	T	P	Theory			Practical		Total		
						CT	AT	TA	AT	TA			
1.	REE 311	State-of-Art Seminar	---	---	04	---	---	---	---	---	100	---	100
2.	REE 312	Dissertation (Phase – I)	---	---	18	---	---	---	---	---	100	---	100
		TOTAL	**---**	**---**	**22**						**200**	**---**	**200**

SEMESTER – IV

Sr.	Subject Code	Subject	Periods			EVALUATION SCHEME							Subject Total
						Sessional Exam						End Semester Exam	
			L	T	P	Theory			Practical		Total		
						CT	AT	TA	AT	TA			
1.	REE 411	Dissertation (Phase – II)	---	---	22	---	---	---	---	---	100	200	300
		TOTAL	**---**	**---**	**22**						**100**	**200**	**300**

LIST OF ELECTIVES

OEE 01 / OEE 02 / OEE 03 : ELECTIVE – I / ELECTIVE – II / ELECTIVE – III

OEE 011 / OEE 021 / OEE 031 : Non-conventional Energy Sources & Energy Converters

OEE 012 / OEE 022 / OEE 032 : Artificial Neural Networks & Fuzzy Systems

OEE 013 / OEE 023 / OEE 033 : Power Electronics Applications in Power System

OEE 014 / OEE 024 / OEE 034 : EHV AC & DC Transmission

OEE 015 / OEE 025 / OEE 035 : Electrical Power Quality

OEE 016 / OEE 026 / OEE 036 : Advanced Power Semiconductor Devices

OEE 017 / OEE 027 / OEE 037 : Modeling and Simulation of Electrical Machines

KAMLA NEHRU INSTITUTE OF TECHNOLOGY, SULTANPUR
(An Autonomous Institute under G.B.T.U. Lucknow)

ELECTRICAL ENGINEERING

MASTER OF TECHNOLOGY (Part-Time)
Power System

(With effective from: Session 2013-14)

SEMESTER – I

Sr.	Subject Code	Subject	Periods			EVALUATION SCHEME							Subject Total
						Sessional Exam						End Semester Exam	
			L	T	P	Theory			Practical		Total		
						CT	AT	TA	AT	TA			
1.	PEE 111	Power System Operation & Control	3	1	0	30	10	10	---	---	50	100	150
2.	PEE 112	MATLAB Programming, Computational Techniques & Simulation	3	0	2	15	10	05	10	10	50	100	150
3.	PEE 113	Power Converters	3	0	2	15	10	05	10	10	50	100	150
		TOTAL	**9**	**1**	**4**						**150**	**300**	**450**

SEMESTER – II

Sr.	Subject Code	Subject	Periods			EVALUATION SCHEME							Subject Total
						Sessional Exam						End Semester Exam	
			L	T	P	Theory			Practical		Total		
						CT	AT	TA	AT	TA			
1.	PEE 211	Advanced Protective Relaying	3	1	0	30	10	10	---	---	50	100	150
2.	PEE 212	Computer Aided Power System Analysis	3	0	2	15	10	05	10	10	50	100	150
3.	PEE 213	Advanced Control Systems	3	1	0	30	10	10	---	---	50	100	150
		TOTAL	**9**	**2**	**2**						**150**	**300**	**450**

SEMESTER – III

Sr.	Subject Code	Subject	Periods			EVALUATION SCHEME							Subject Total
						Sessional Exam						End Semester Exam	
						Theory			Practical		Total		
			L	T	P	CT	AT	TA	AT	TA			
1.	PEE 311	High Voltage Engineering	3	1	---	30	10	10	---	---	50	100	150
2.	OEE 01	Elective – I	3	1	---	30	10	10	---	---	50	100	150
		TOTAL	**6**	**2**	---						**100**	**200**	**300**

SEMESTER – IV

Sr.	Subject Code	Subject	Periods			EVALUATION SCHEME							Subject Total
						Sessional Exam						End Semester Exam	
						Theory			Practical		Total		
			L	T	P	CT	AT	TA	AT	TA			
1.	OEE 02	Elective – II	3	1	---	30	10	10	---	---	50	100	150
2.	OEE 03	Elective – III	3	1	---	30	10	10	---	---	50	100	150
		TOTAL	**6**	**2**	---						**100**	**200**	**300**

SEMESTER – V

Sr.	Subject Code	Subject	Periods			EVALUATION SCHEME							Subject Total
						Sessional Exam						End Semester Exam	
						Theory			Practical		Total		
			L	T	P	CT	AT	TA	AT	TA			
1.	PEE 511	State-of-Art Seminar	---	---	04	---	---	---	---	---	100	---	100
2.	PEE 512	Dissertation (Phase – I)	---	---	08	---	---	---	---	---	100	---	100
		TOTAL	**---**	**---**	**12**						**200**	**---**	**200**

SEMESTER –VI

Sr.	Subject Code	Subject	Periods			EVALUATION SCHEME							Subject Total
						Sessional Exam						End Semester Exam	
			L	T	P	Theory			Practical		Total		
						CT	AT	TA	AT	TA			
1.	PEE 611	Dissertation (Phase – II)	---	---	12	---	---	---	---	---	100	200	300
		TOTAL	**---**	**---**	**12**						**100**	**200**	**300**

LIST OF ELECTIVES

OEE 01 / OEE 02 / OEE 03 : ELECTIVE – I / ELECTIVE – II / ELECTIVE – III

OEE 011 / OEE 021 / OEE 031 : Non-conventional Energy Sources & Energy Converters

OEE 012 / OEE 022 / OEE 032 : Artificial Neural Networks & Fuzzy Systems

OEE 013 / OEE 023 / OEE 033 : Power Electronics Applications in Power System

OEE 014 / OEE 024 / OEE 034 : EHV AC & DC Transmission

OEE 015 / OEE 025 / OEE 035 : Electrical Power Quality

OEE 016 / OEE 026 / OEE 036 : Advanced Power Semiconductor Devices

OEE 017 / OEE 027 / OEE 037 : Modeling and Simulation of Electrical Machines

OEE 018 / OEE 028 / OEE 038 : Power Semiconductor Controlled Electric Drives

OEE 019 / OEE 029 / OEE 039 : Power Converter Applications

KAMLA NEHRU INSTITUTE OF TECHNOLOGY, SULTANPUR
(An Autonomous Institute under G.B.T.U. Lucknow)

ELECTRICAL ENGINEERING

MASTER OF TECHNOLOGY (Part-Time)
Solid State Control

(With effective from: Session 2013-14)

SEMESTER – I

Sr.	Subject Code	Subject	Periods			EVALUATION SCHEME							Subject Total
						Sessional Exam						End Semester Exam	
			L	T	P	Theory			Practical		Total		
						CT	AT	TA	AT	TA			
1.	PEE 121	Fundamentals of Electric Drives	3	1	0	30	10	10	---	---	50	100	150
2.	PEE 122	MATLAB Programming, Computational Techniques & Simulation	3	0	2	15	10	05	10	10	50	100	150
3.	PEE 123	Power Converters	3	0	2	15	10	05	10	10	50	100	150
		TOTAL	**9**	**1**	**4**						**150**	**300**	**450**

SEMESTER – II

Sr.	Subject Code	Subject	Periods			EVALUATION SCHEME							Subject Total
						Sessional Exam						End Semester Exam	
			L	T	P	Theory			Practical		Total		
						CT	AT	TA	AT	TA			
1.	PEE 221	Advanced Control System	3	1	0	30	10	10	---	---	50	100	150
2.	PEE 222	Power Semiconductor Controlled Electric Drives	3	0	2	15	10	05	10	10	50	100	150
3.	PEE 223	Advanced Microprocessor & Applications	3	1	0	30	10	10	---	---	50	100	150
		TOTAL	**9**	**2**	**2**						**150**	**300**	**450**

SEMESTER – III

Sr.	Subject Code	Subject	Periods			EVALUATION SCHEME							Subject Total
						Sessional Exam						End Semester Exam	
			L	T	P	Theory			Practical		Total		
						CT	AT	TA	AT	TA			
1.	PEE 321	Power Converter Applications	3	1	---	30	10	10	---	---	50	100	150
2.	OEE 01	Elective – I	3	1	---	30	10	10	---	---	50	100	150
		TOTAL	**6**	**2**	**---**						**100**	**200**	**300**

SEMESTER – IV

Sr.	Subject Code	Subject	Periods			EVALUATION SCHEME							Subject Total
						Sessional Exam						End Semester Exam	
			L	T	P	Theory			Practical		Total		
						CT	AT	TA	AT	TA			
1.	OEE 02	Elective – II	3	1	---	30	10	10	---	---	50	100	150
2.	OEE 03	Elective – III	3	1	---	30	10	10	---	---	50	100	150
		TOTAL	**6**	**2**	**---**						**100**	**200**	**300**

SEMESTER – V

Sr.	Subject Code	Subject	Periods			EVALUATION SCHEME							Subject Total
						Sessional Exam						End Semester Exam	
			L	T	P	Theory			Practical		Total		
						CT	AT	TA	AT	TA			
1.	PEE 521	State-of-Art Seminar	---	---	04	---	---	---	---	---	100	---	100
2.	PEE 522	Dissertation (Phase – I)	---	---	08	---	---	---	---	---	100	---	100
		TOTAL	**---**	**---**	**12**						**200**	**---**	**200**

SEMESTER –VI

Sr.	Subject Code	Subject	Periods			EVALUATION SCHEME							
						Sessional Exam						End Semester Exam	Subject Total
			L	T	P	Theory			Practical		Total		
						CT	AT	TA	AT	TA			
1.	PEE 621	Dissertation (Phase – II)	---	---	12	---	---	---	---	---	100	200	300
		TOTAL	**---**	**---**	**12**						**100**	**200**	**300**

LIST OF ELECTIVES

OEE 01 / OEE 02 / OEE 03 : ELECTIVE – I / ELECTIVE – II / ELECTIVE – III

OEE 011 / OEE 021 / OEE 031 : Non-conventional Energy Sources & Energy Converters

OEE 012 / OEE 022 / OEE 032 : Artificial Neural Networks & Fuzzy Systems

OEE 013 / OEE 023 / OEE 033 : Power Electronics Applications in Power System

OEE 014 / OEE 024 / OEE 034 : EHV AC & DC Transmission

OEE 015 / OEE 025 / OEE 035 : Electrical Power Quality

OEE 016 / OEE 026 / OEE 036 : Advanced Power Semiconductor Devices

OEE 017 / OEE 027 / OEE 037 : Modeling and Simulation of Electrical Machines

CODE	REE 111 / PEE 121	L	T	P

FUNDAMENTALS OF ELECTRIC DRIVE **3 1 0**

UNIT – 1:

Introduction to Electric Drive:
Basic drive components, Classification and operating modes of electric drive, Nature and types of mechanical loads, Review of speed-torque Characteristics of electric motors and load, Joint speed-torque characteristics, Plugging, dynamic and regenerative braking of DC and AC motors.

UNIT – 2:

Dynamic of Electric Drives System:
Equation of motion, Equivalent model of motor-load combination, Stability considerations, Electro-mechanical transients during starting and braking, Calculation of time and energy losses, Losses in electric drive system and their minimization, Energy efficient operation of drives, Load equalization.

UNIT – 3:

Estimation of Motor Power Rating:
Heating and cooling of electric motors, Load diagrams, Classes of duty, Reference to Indian standards, Estimation of rating of electric motors for continuous, Short time and intermittent duties, Selection criteria of electric drive for industrial applications

UNIT – 4:

Traction Drive:
Electric traction services, Duty cycle of traction drives, Calculations of drive rating and energy consumption, Desirable characteristics of traction drive and suitability of electric motors, Control of traction drives.

UNIT – 5:

Special Electric Drive
Servo motor drive, Stepper motor drive, Linear induction motor drive, Permanent magnet motor drive.

References:

1. G.K. Dubey, "Fundamentals of Electric Drive" Narosa Publishing House 1995.
2. S.K. Pillai, "A first course on Electric Drive", New Age International Publishers, 1981
3. M. Chilkin, "Electric Drive", Mir Publications.
4. N.K. DE and P.K. Sen, "Electric Drives," Prentice Hall of India, 1999.
5. Vedam Subramaniam, "Electric Drive: Concepts and Applications" Tata McGraw Hill, 1994.

CODE	PEE 111	L	T	P

POWER SYSTEM OPERATION AND CONTROL **3 1 0**

UNIT – 1

Introduction:
Large scale power systems – their interconnections and operation; Load dispatch centre and control centre, Introduction to centralized and decentralized controls; Various operational stages of power system; Power system stability & security.

UNIT – 2

Economic Operation:
Problem of unit commitment, System constraints, Incremental fuel cost, Economic load scheduling with and without transmission losses, Penality factor, Loss coefficient, Incremental transmission loss; Optimal power flow problem; Optimal operation of hydro-thermal system.

UNIT – 3

Load Frequency Control:
Concept of load frequency control, Speed governing systems and its representation, Automatic generation control – modeling of single area and multi-area systems, tie line control, supervisory control; Automatic generation control including excitation system, Optimum load frequency control.

UNIT – 4

Voltage and Reactive Power Control:
Concept of voltage control, Methods of voltage control – reactive power injection, control by tap changing transformer, series compensation, static VAR compensation, Excitation system stabilizer – Rate feedback controller, PID controller.

UNIT – 5

Flexible AC Transmission System (FACTS):
Concept and objectives, Basic FACTS controllers: TCR, FC-TCR, TSC, SVC, STATCOM, TCSC, SSSC, PAR, UPFC, IPFC and HPFC.

References;

1. O.I. Elgerd, "Electric Energy System Theory", Mc Graw Hill, 1971.
2. Leon K. Kirchmayer, "Economic Operation of Power Systems". Wiley Eastern Ltd.
3. A. Chakrabarti, D. P.Kothari and A.K. Mukhopadhyay, "Performance, Operation and Control of EHV Power Transmission Systems" Wheeler Publishing Co.

CODE	REE 112 / PEE 213 / PEE 221	L	T	P

ADVANCED CONTROL SYSTEMS **3 1 0**

UNIT – 1:

State Space Analysis of Continuous-time LTI System:
Review of state space representation of continuous linear time invariant system, Conversion of state variable models to transfer functions and vice-versa, Transformation of state variables, Solution of state equations, Similarity transformation.

UNIT – 2:

Controllability and Observability:
State and output controllability and observability, Kalman's and Gilbert's Tests for controllability and Observability.

UNIT – 3:

Analysis of Discrete-time System:
Discrete time signals and systems, z-transformation, modeling of sample-hold circuit, pulse transfer function, solution of difference equation by z-transform method, stability analysis in z-plane.

UNIT – 4:

Analysis of Nonlinear System:
Common physical nonlinearities, singular points, phase plane analysis, limit cycles, describing function method and stability analysis, jump resonance, Linearization of nonlinear systems. Lyapunov stability, Methods for generating Lyapunov function, Statement of Lure problem, Circle criterion, Popov's criterion.

UNIT – 5:

Optimal and Adaptive Control:
Basic concepts of optimal control, Adaptive control, Intelligent control and Robust control systems.

References:

1. M. Gopal, "Digital Control and State Variable Methods", Tata McGraw Hill, Second edition 1997/2006.
2. I. J. Nagrath & M. Gopal, "Modern Control Engineering", New Age International, Second/Fifth edition 1997.
3. Donald E. Kirk, "Optimal Control Theory: An Introduction, Prentice-Hall Inc
4. Yoand D. Landau, "Adaptive Control: The Model Reference Approach", Marcel Dekkar,Inc.
5. Kuo B.C., "Digital Control Systems", Saunders College Publishing, 1992.
6. M. Gopal, "Modern Control System Theory", Wiley Eastern, 1993.
7. K. Ogata, "Discrete Time Control System", Prentice Hall International, 1987

CODE	REE 113 / PEE 113 / PEE 123	L	T	P

POWER CONVERTERS

3 0 2

UNIT – 1:

Power Semiconductor Devices:
Structure, Characteristics, Ratings and protection of SCR, TRIAC, Gate turn off (GTO) Thyrister, Insulated gate bipolar transistor (IGBT) and MOS controlled thyristor (MCT), Drive and snubber circuits, Triggering circuits.

UNIT – 2:

Line Commutated Converters:
Single-phase and three-phase fully controlled and half controlled converters, Performance characteristics, Effect of load & source inductances, Discontinuous current operation, Inverter operation, Power factor improvement techniques, Sequence control, 12-pulse converters, Dual converter.

UNIT – 3:

AC Voltage Controllers:
Single-phase and three-phase AC voltage controllers feeding resistive and resistive-inductive loads, Sequence control.

Cyclo-converters:
Single-phase and three-phase cyclo-converters, Circulating and non-circulating current operations, Performance characteristics, Control of harmonics, Voltage and frequency control, Control circuit.

UNIT – 4:

DC-DC Converters:
Review of chopper fundamentals, Step-down chopper with resistive and resistive-inductive loads with continuous and discontinuous current operations, Step-up chopper, Commutation techniques, Impulse commutated and resonant pulse choppers, Multi-quadrant and multi-phase choppers.

UNIT – 5:

DC-AC Inverters:
Single phase and three phase voltage source and current source inverters, Commutation methods, Voltage and frequency control, Harmonic reductions.

Resonant Inverters:
Classification, Series and parallel resonant inverters, Load resonant inverters, Zero voltage switching and zero current switching resonant inverters, Resonant DC link inverters.

References:

1. M.H Rashid, “Power Electronics: Circuits, Devices and Applications”, Prentice Hall of India, 1996.
2. N. Mohan, T.M. Underland and W.P. Robbins, “ power Converters, Applications and Design”, John Wiley & Sons, 1995.
3. G.K. Dubey et al, “Thyristorized Power Controllers”, Wiley Eastern, 1987.
4. B.R. Pelly, “Thyristor Phase Controlled Converters and Cyclo-converters”, Wiley Intersicence, 1971.
5. M.D. Singh and K.B. Khanchandani, “Power Electronics”, Tata McGraw Hill, 2001.
6. V. Subrahmanyam, “Power Electronics”, New Age International Publishers, 1997.

CODE	REE 114 / PEE 112 / PEE 122	L	T	P
	MATLAB PROGRAMMING, COMPUTATIONAL TECHNIQUES & SIMULATION	**3**	**0**	**2**

UNIT – 1

Calculus of Finite Differences & Interpolation

Operators Δ, ∇, E, E^{-1} and their relations, Interpolation with equal intervals – Newton-Gregory formula for forward and backward interpolations, Interpolation with unequal intervals – Lagrange's interpolation formula, inverse interpolation.

UNIT - 2

Curve Fitting & Numerical Analysis

Method of least square, Curve fitting procedures for linear, power and exponential curves, Numerical integration – trapezoidal, Simpson's one-third & three-eighth rule, Numerical computations & solutions – Gauss-Seidal, Newton-Raphson & Runge-Kutta methods.

UNIT – 3

MATLAB Basics

General overview & understanding of MATLAB and its interface – command window, workspace, data types, dimensions, case sensitivity, variables and assignments, vector and matrices, arithmetic / relational / logical operators; Basic matrix operations, Concatenation of Matrices, Eigen values and eigen vectors, Polynomial roots, Differentiation and integration, Complex arithmetic, Solution of linear equations, Solution of ordinary differential equations (ODE), Plotting of 2D and 3D curves, Subplot, Figure Editor, Data analysis and statistics.

UNIT – 4

MATLAB Programming

Flow control structures (if-else, for, while, switch and case, continue, break, return), Built-in and user-defined functions, Programming in M-files, Script & Function files, MATLAB programming applications in – interpolation, numerical computations & solutions, fitting a polynomial curve, signal analysis, electrical circuits analysis (RC, RL, RLC type) and frequency responses analysis of transfer functions.

UNIT – 5

MATLAB Toolboxes & Simulation

Simulink – Simulink model editor, Simulink blocks library, concepts of blocksets, block diagram construction, subsystem, simulation parameters & solvers, S-function, passing parameters to S-function, running a simulation; SimPowerSystems blockset, Simulink based modeling & simulation of electrical circuits, Linear state-space modeling & simulation, MATLAB toolboxes – symbolic math toolbox, control system toolbox, signal processing toolbox and fuzzy logic toolbox.

References:

1. H.C. Saxena, "Finite Differences and Numerical Analysis", S.Chand & Co., New Delhi, 1993.
2. S. C. Gupta & V. K. Kapoor, "Fundamentals of Mathematical Statistics", Sultan Chand & Sons, New Delhi
3. Rudra Pratap, "Getting Started with MATLAB 7".
4. The MathWorks Inc., "MATLAB: The Language of Technical Computing".
5. The MathWorks Inc, "SIMULINK: Dynamic System Simulation".
6. The MathWorks Inc., "SimPowerSystems : User's Guide".
7. B.R. Hunt, R. L. Lipsman & J. M. Rosenberg, "A Guide to MATLAB", Cambridge University Press, 2003.
8. O. Beucher and M. Weeks, "Introduction to MATLAB & SIMULINK – A Project Approach", Infinity Science Press LLC, Hingham, MA, Third Edition.

CODE	PEE 211	L	T	P

ADVANCED PROTECTIVE RELAYING **3 1 0**

UNIT – 1:

Introduction to Protection System:
Introduction to protection system and its elements, Functions of protective relaying, Essential qualities of protection, Zones of protection, Primary & backup protection, Classification of relays, Basic protective schemes.

UNIT – 2:

Relay Application and Characteristics:
Transfer impedance, Mixing circuits, Amplitude and phase comparators and their duality, Static realization of amplitude and phase comparators, Multi-input comparators, Over-current relays, Directional relays, Distance relays, Differential relay, Advanced schemes for protection of transmission lines, alternators, transformers, motors and bus-bars.

UNIT – 3:

Static Relays:
Comparison with electromagnetic relay, Classification and their description, Basic construction, Input-output devices, Merits and demerits of static relays, Application of solid state devices.

UNIT – 4:

Static Protection:
Over current relaying schemes, Differential relaying schemes, Distance relaying schemes, Power swing and protection of long lines, Protection of multi-terminal lines, New type of relaying criteria, Quadrilateral relay, Elliptical relay, Restricted distance relays.

UNIT – 5:

Digital Protection:
Concept of digital protection, Microprocessor based over-current and distance relay schemes, Generalized interface for distance relays.

References:

1. Y. G. Paithankar and S R Bhide, “Fundamentals of Power System Protection”, Prentice Hall of India.
2. T.S.M Rao,“Power System Protection: Static Relays with Microprocessor Applications” Tata Macgraw Hill”.
3. A.R. Van C. Warringtaon, “Protective Relays- Their Theory and Practice, Vol. I & II” Jhon Willey & Sons.
4. B.D.Russel and M.I. Council, “Power System Control and Protection”, Academic Press,1982.
5. B.Ravindranath and M.Chander,”Power System Protection and Switchgear Wiley Eastern,1977.
6. S.S.Rao,”Switchgear and Protection”Khanna Publishers, 1986.
7. B.Ram and D.N.Viswakarma, “Power System Protection and Switchgear” Tata Mc.Graw Hill, 1995.

CODE	REE 211 / PEE 222	L	T	P

POWER SEMICONDUCTOR CONTROLLED ELECTRIC DRIVES **3 0 2**

UNIT - 1

Introduction:
Solid state controlled electric drives – concept, elements and salient features, Power converter motor system, Closed-loop control of electric drives, Sensing of speed and current, Performance parameters.

UNIT - 2

Control of DC Drives:
Control of DC separately and series excited motor drives using controlled converters (single-phase and three-phase) and choppers, Static Ward-Leonard control scheme, Solid-state electric braking schemes, Current and speed control loops for closed-loop control of solid-state DC drives; (P, PI and PID) controllers – response comparison, Simulation of converter and chopper fed DC drive.

UNIT - 3

Control of AC Motor Drives:
Operation of induction and synchronous motor drives from voltage source and current source inverters, Static rotor resistance control, Injection of voltage in the rotor circuit, Slip power recovery – static Kramer's and Scherbius' drives, Pump drives using AC line controllers, Self controlled synchronous motor derives, Brushless DC motor drive, Switched reluctance motor drive.

UNIT - 4

Scalar and Field Oriented Control:
Constant and variable frequency operation, Constant V/Hz operation, Field-oriented control of induction and synchronous machines – theory, DC drive analogy, direct and indirect methods, flux vector estimation, Direct torque control of induction and synchronous machines – torque expression with stator and rotor fluxes, DTC control strategy.

UNIT - 5

Microprocessor Control of Electric Drive:
Function of microprocessor in electric drive control, Salient features of microprocessor control, Microprocessor based control scheme for DC, induction and synchronous motor drives, Applications.

References:

1. G. K. Dubey, "Power Semiconductor Controlled Drives", Prentice Hall International, 1989.
2. J.M.D. Murphy & I.G. Turnbull, "Power Electronic Control of AC Motors", Pergamon Press, 1988.
3. S.B. Dewan, G.R. Slemon and A. Straughen, "Power Semiconductor Drives". Wiley Interscience, 1984.
4. V. Subrahmanyam, "Thyristor Control of Electric Motors", Tata Mc Graw Hill.
5. B. K. Bose, "Power Electronics and AC Drives", Prentice Hall International, 1986.
6. P.C. Sen, "Thyristor DC Drives", Wiley Interscience, 1987.
7. R. Krishnan, "Electric Motor Drives Modeling, Analysis and Control", Prentice Hall International, 2002.

CODE	PEE 212	L	T	P

COMPUTER AIDED POWER SYSTEM ANALYSIS 3 0 2

UNIT – 1:

Network Matrices
Evaluation of bus admittance matrix (YBUS), Bus impedance matrix (ZBUS), Branch impedance matrix (ZBT) and loop Impedance matrix (ZLOOP) by singular and non singular transformations.

UNIT – 2:

Short Circuit Studies
Formulation of ZBUS for single phase and three phase networks, Transformation of network matrices using symmetrical components; Short circuit studies using ZBUS, YBUS and ZLOOP.

UNIT – 3:

Load Flow Studies
Representation of off-load, on-load tap changing and phase shifting transformers, DC link, Decoupled and fast decoupled methods, Sparsity technique; Introduction to load flow of integrated AC/DC system.

UNIT – 4 & 5:

Stability Studies
Network formulation for stability studies for different types of loads (constant impedance, constant current and constant power loads), Digital computer solution of swing equation for single and multi-machine cases using Runge-Kutta and predictor corrector methods, Effects of exciter and governor on transient stability.

References:

1. G.W.Stagg and A.H.EI-Abiad,"Computer Methods in Power System Analysis", McGraw Hill, 1971.
2. G.I. Kusic,"Computer Sided Power System Analysis" Prentice Hall International,1986.
3. I.P. Singh,"Advanced Power System Analysis and Dynamics,"Wiley Eastern.

CODE	REE 212 / PEE 321	L	T	P

POWER CONVERTER APPLICATIONS **3 1 0**

UNIT – 1

Industrial Applications:
Electric heating, Advantages & disadvantages, Concept of resistance and induction heating, AC voltage controllers for resistance heating, High frequency inverters for induction heating, Illumination control, High frequency fluorescent lighting system, Switch-mode welders with high frequency transformers.

UNIT – 2

Application in High Voltage DC Transmission
Introduction to HVDC transmission, Basic layout for HVDC transmission system, Types of HVDC links, Twelve pulse converters, Control of HVDC converters, Control characteristics, Converter faults and protection, Harmonic filters and power factor correction capacitors.

UNIT – 3

Applications in Static VAR Control:
Concept of static VAR control, Thyristor controlled VAR compensation techniques, Series compensation, Synchronous link converter based VAR compensation, Unified power flow controller (UPFC).

UNIT – 4

Applications in Power Supplies
Classification and sources of power line disturbances, Need of uninterruptible power supply (UPS) system, Static UPS systems – short break & no break UPS systems, Components of UPS systems, Introduction to SMPS, Configurations – flyback converter, two transistor / MOSFET flyback converter, paralleling flyback converter, forward converter, push-pull converter, half-bridge converter, full-bridge SMPS, Advantages & disadvantages, Aircraft power supplies.

UNIT – 5

Applications in Grid Interconnected Renewable Energy Systems
Single-phase and three-phase photovoltaic array interconnection, Maximum power point tracking (MPPT), Wind / fuel cell and small hydro interconnections with utility grid.

Other Applications
DC circuit breaker, single-phase and three-phase AC switches, Static excitation control of synchronous generators.

References:

1. N. Mohan, T.M. Undeland and W.P. Robbins, "Power Electronics Converters, Applications and Design', John Wiley & Sons, 1995.
2. H. Rashid, "Power Elecrtonics: Circuits, Devices and Applications", Prentice Hall of India, 1996.
3. E. W. Kimbark, "Direct Current Transmission, Vol-I", Wiley Interscience, 1971.
4. T.J. Miller, "Reactive Power Control in Electric System", Wiley Interscience, 1982.

CODE	REE 213	L	T	P

ADVANCED MICROPROCESSORS AND APPLICATIONS 3 0 2

UNIT - 1

Basic 8 bit Processor:

Review of basic microprocessor, Architecture, Operations, Addressing modes, Interrupts and instruction set of a typical 8 bit microprocessor, Concept of memory interfacing, Assembly language programming (8085 based).

UNIT - 2

Advanced Microprocessor:

Overview of 16 bit and 32 bit microprocessors, Arithmetic and I/O coprocessors, Architecture, Register details, Operation, Addressing modes and instruction set of a 16 bit 8086 microprocessor, Assembly language programming, Introduction to Pentium processors.

Analog Input & Output:

Microprocessor compatible ADC and DAC chips, Interfacing of ADC and DAC with microprocessor, User of sample and hold circuit and multiplexer with ADC.

UNIT – 3

Input-Output Interfacing:

Parallel and series I/O, programmed I/O, Interrupt driven I/O, single and multi interrupt levels, Use of software polling and interrupt controlling for multiplying interrupt levels, Programmable interrupt controller, DMA controller, Programmable timer / counter, Programmable communication and peripheral interface, Synchronous and asynchronous data transfer, Standard serial interfaces like RS232.

UNIT – 4

Programmable Support Chips:

Functional schematic, Operating modes, Programming and interfacing of 8255, 8251, 8259 and 8253 with microprocessor.

Memory Interfacing:

Types of Memory: RAM and ROM, Interfacing of static RAM and dynamic RAM.

UNIT – 5

Microcontroller and Microcomputer:

Concepts of micro-controller and micro-computer, Micro-controllers (8051/8751) Architecture and operational features, Applications of micro-computer in electrical engineering like motor control etc.

References:

1. R.S. Gaonker, "Microprocessor Architecture, Programming and Application", Wiley Eastern Limited.
2. A.K. Ray, K.M. Bhurchandi, "Advanced Microprocessor and Peripherals, Architecture, Programming & Interfacing, McGraw Hill 2006.
3. D.V. Hall, "Microprocessors and Interfacing Programming and Software," McGraw Hill.
4. Yu-cheng Liu and Glenn A. Gibson, "Microcomputer systems: The 8086/8088 Family" PHI, 2nd edition.
5. Badri Ram, "Advanced Microprocessor & Interfacing", McGraw Hill 2001.

CODE	PEE 223	L	T	P

ADVANCED MICROPROCESSORS AND APPLICATIONS 3 1 0

UNIT - 1

Basic 8 bit Processor:

Review of basic microprocessor, Architecture, Operations, Addressing modes, Interrupts and instruction set of a typical 8 bit microprocessor, Concept of memory interfacing, Assembly language programming (8085 based).

UNIT - 2

Advanced Microprocessor:

Overview of 16 bit and 32 bit microprocessors, Arithmetic and I/O coprocessors, Architecture, Register details, Operation, Addressing modes and instruction set of a 16 bit 8086 microprocessor, Assembly language programming, Introduction to Pentium processors.

Analog Input & Output:

Microprocessor compatible ADC and DAC chips, Interfacing of ADC and DAC with microprocessor, User of sample and hold circuit and multiplexer with ADC.

UNIT – 3

Input-Output Interfacing:

Parallel and series I/O, programmed I/O, Interrupt driven I/O, single and multi interrupt levels, Use of software polling and interrupt controlling for multiplying interrupt levels, Programmable interrupt controller, DMA controller, Programmable timer / counter, Programmable communication and peripheral interface, Synchronous and asynchronous data transfer, Standard serial interfaces like RS232.

UNIT – 4

Programmable Support Chips:

Functional schematic, Operating modes, Programming and interfacing of 8255, 8251, 8259 and 8253 with microprocessor.

Memory Interfacing:

Types of Memory: RAM and ROM, Interfacing of static RAM and dynamic RAM.

UNIT – 5

Microcontroller and Microcomputer:

Concepts of micro-controller and micro-computer, Micro-controllers (8051/8751) Architecture and operational features, Applications of micro-computer in electrical engineering like motor control etc.

References:

1. R.S. Gaonker, "Microprocessor Architecture, Programming and Application", Wiley Eastern Limited.
2. A.K. Ray, K.M. Bhurchandi, "Advanced Microprocessor and Peripherals, Architecture, Programming & Interfacing, McGraw Hill 2006.
3. D.V. Hall, "Microprocessors and Interfacing Programming and Software," McGraw Hill.
4. Yu-cheng Liu and Glenn A. Gibson, "Microcomputer systems: The 8086/8088 Family" PHI, 2nd edition.
5. Badri Ram, "Advanced Microprocessor & Interfacing", McGraw Hill 2001.

CODE	PEE 311	L	T	P

HIGH VOLTAGE ENGINEERING **3 1 0**

UNIT – 1:

Breakdown Phenomena
Basic processes of breakdown, Breakdown phenomena in gaseous, liquid, solid and composite dielectrics, Breakdown in vacuum insulation.

UNIT – 2:

Generation of Test High Voltages
Generation of High DC voltage, Generation of high AC voltage, Generation of impulse voltage, Triggering and synchronization of impulse generator, Generation of high impulse current.

UNIT – 3:

Measurement of High Voltage and Current
Resistance, capacitance and RC potential dividers, Sphere gap, Electrostatic voltmeter, Generating voltmeter, Impulse voltage measurement, Measurement of high DC, AC and impulse currents.

UNIT – 4:

High Voltage Testing
Requirements of high voltage test circuit, I.S. specifications, Impulse and power frequency test of transformers, Lighting arresters, Bushings, Power cables, Circuit breakers and isolators, Measurement of resistivity, Dielectric constant and loss factor, Partial discharge measurement.

UNIT – 5:

Over Voltage Phenomenon and Insulation Coordination
Lightning and switching phenomena as causes of over-voltages, Long transmission line, Protection of transmission line and substation against overvoltage, Insulation coordination.

References:

1. E Kuffel & W.S. Zaongol, “High Voltage Engineering” Pergaman Press.
2. M. S. Naidu & V.Kamaraju, “High Voltage Engineering” Tata Mc Graw Hill.
3. H. P. Chaurasia, “High Voltage Egineering,”Pergaman Press.
4. R. S. Jha, “High Voltage Engineering”
5. C. L. Wadhawa, “High Voltage Engineering” Wiley Eastern Limited.

ELECTIVES

CODE	OEE 011 / OEE 021 / OEE 031	L	T	P
	NON-CONVENTIONAL ENERGY SOURCES AND ENERGY CONVERTERS	**3**	**1**	**0**

UNIT - 1

Introduction

Various non-conventional and renewable energy resources – introduction, importance, classification, main features, relative merits & demerits; Energy System, Energy Conservation, Prospects and potential, Indian energy scenario.

UNIT – 2

Solar Power Conversion Systems and Solar Thermal Energy

Solar radiation, Flat plate collectors, their applications and performance, Focusing collectors, their applications and performance, Theory of solar cells, Solar cell materials, Photo-voltaic energy conversion, Solar cell power plant, Limitations, Solar thermal power plants, Thermal energy storage for solar heating & cooling and their limitations.

UNIT - 3

Magneto-hydrodynamics (MHD)

Working principle, MHD configurations, Open-cycle fossil fuelled and closed cycle nuclear fuelled MHD power plant, Practical problems associated with MHD power generation, Performance limitations and applications.

Fuel Cells

Working principle, Various types of fuel cells, Hydrogen-oxygen fuel cell, Gibbs-Helmholtz theory, Performance, limitations and applications.

Thermo-electrical and Thermionic Conversions

Working principle, Performance and limitations.

UNIT - 4

Wind Energy and Wind Power Conversion Systems

Wind power and its sources; Wind characteristics, Wind power generator, Performance and limitations. Stand-alone operation of fixed and variable-speed wind energy conversion systems.

Geothermal Energy

Sources of geothermal energy, Thermodynamics of Geo-thermal energy – electrical conversion & non-electrical conversion, Total flow system, Environmental considerations & applications.

UNIT – 5

Bio-mass

Availability, Bio-mass and its conversion theory, Bio-gas power generator.

Occan Thermal Energy Conversion (OTEC)

Availability, Working principle, Performance and limitations.

Tidal Energy

Principle of energy conversion, Single-basin and Double-basin systems of power generation, Performance and limitations.

Power Generation from Refuse

Typical dustbin composition, Potential, Power generation from refuse, Limitations, Waste recycling.

References:

1. Andra Gabdel, “A Handbook for Engineers and Economists”.
2. Frank Kreith, “Solar Energy Hand Book”.
3. L. L. Freris, “Wind Energy Conversion Systems”, Prentice Hall, 1990.
4. Gray, L. Johnson, “Wind Energy System”, Prentice Hall, 1995.
5. Harry L. Sorrenson, “Direct Energy Conversion”
6. W. Palz., P. Chartier and D.O. Hall, “Energy from Biomass”.
7. Rai. G.D, “Non-conventional Energy Sources”, Khanna Publishers, 1993.
8. B.H. Khan, Non-conventional Energy Sources, Tata McGraw-hill, New Delhi.

CODE	OEE 012 / OEE 022 / OEE 032	L	T	P

ARTIFICIAL NEURAL NETWORKS AND FUZZY SYSTEM 3 1 0

[A] Artificial Neural Networks

UNIT - 1

Basics of Neural Networks: Introduction and Architecture

Simple neuron, Nerve structure and synapse, Concept of multilayer nets, Auto-associative and hetero-associative nets, Artificial neural networks, Neural network tools (NNTs), Neuron signal functions, Neuron models, Neuron activation, Artificial neural network (ANN) *vs*. Traditional computers.

UNIT – 2

Learning Techniques

Learning in neural nets, Unsupervised and supervised learning, Hebbian learning, Competitive learning, Perception learning and convergence theorem, Single-layer & Multi-layer perceptron models, Back-propagation algorithm.

UNIT -3

Applications of Neural Networks

Applications in load flow study, load forecasting, detection of faults in distribution system, steady-state stability and electric drives control; Neural network simulator.

[B] Fuzzy System

UNIT – 4

Basics of Fuzzy System

Fuzzy sets and systems, Basic concepts of fuzzy logic , Fuzzy sets and crisp sets, Properties of fuzzy sets, Fuzzy set theory and operations, Fuzzy and crisp relations, Fuzzy to crisp conversions, Fuzzy entropy theorem.

UNIT – 5

Fuzzy Membership, Rules and Applications

Fuzzy numbers and Fuzzy vectors, Membership functions, Basic principle of interface in fuzzy logic, Fuzzy IF-THEN rules, Fuzzy algorithms, Approximate reasoning, Interference in fuzzy logic, Fuzzy inference engines, Fuzzy implications, Fuzzification, Defuzzification. Fuzzy control system and its elements, Fuzzy logic controller, Neuro-fuzzy control, Fuzzy control in industrial applications.

References:

1. Bart Kosko, "Neural Networks & Fuzzy Systems, "Prentice Hall International.
2. George J. Klin & Tina A. Polger, "Fuzzy Sets, Uncertainty and information", Press Inc.
3. Timothy. J. Ross,"Fuzzy Logic with Engineering Applicatioons".
4. Russel C. Ebehart & Roy W. Dobbins, "Neural Network PC tools", Academic Press Inc.
5. Kumar Satish, "Neural Networks" Tata Mc Graw Hill.
6. S. Rajsekaran & G.A. Vijayalakshmi Pai, "Neural Networks,Fuzzy Logic and Genetic Algorithm: Synthesis and Applications" Prentice Hall of India.
7. N. K. Bos & P. Liang ,"Neural Network Fundamentals with Graphs Algorithms and Applications",Tata Mc Graw hill
8. Simon Haykin, "Neural Networks,"Prentice Hall of India,"
9. S. Rajasekaran & G. A. Vijay alakshim Pai, "Neural Networks, Fuzzy Logic and Genetic Algorithms, Synthesis and Applications,"Prentice hall of India
10. N. P. Padhy,"Artificial intelligence and Intelligent Systems," oxford university press.
11. S.N.Sivanandam, S.Sumathi, S.N.Deepa, "Introduction to Neural Networks using MATLAB 6.0" Tata Mc Graw Hill.

CODE	OEE 013 / OEE 023 / OEE 033	L	T	P
	POWER ELECTRONICS APPLICATIONS IN POWER SYSTEMS	**3**	**1**	**0**

UNIT – 1:

Introduction
Concept of reactive power control in electrical power transmission lines, Uncompensated transmission line, Series & shunt compensation, Concept and merits of on line tap changing transformer (OLTC), Phase modifier circuit, Capacitor banks, Inductor banks etc.

UNIT – 2:

Static VAR Compensator (SVC) and its Applications
Voltage control by SVC, Advantages of slope in dynamic characteristics, Influence of SVC on system voltage, Design of SVC voltage regulator, Modeling of SVC for power flow and transient stability, Applications: Enhancement of transient stability, Steady-state power transfer, Enhancement of power system damping, Prevention of voltage instability.

UNIT – 3:

Thyristor Controlled Series Capacitor (TCSC) and its Applications
Operation of TCSC, Different modes of operation, Modeling of TCSC, Variable reactance model, Modeling for power flow and stability studies, Applications: Improvement of the system stability limit, Enhancement of system damping, SSR Mitigation.

UNIT – 4:

Voltage Source Converter Based FACTS Controllers
Static Synchronous Compensator (STATCOM), Principle of operation, V-I Characteristics, Applications: Steady state power transfer, Enhancement of transient stability, Prevention of voltage instability, SSSC, Operation of SSSC, Control of power flow, Modeling of SSSC in load flow and transient stability studies, Applications: SSR Mitigation, UPFC and IPFC.

UNIT – 5:

Placement & Co-ordination of FACTS Controllers
Controller interactions, SVC, SVC interaction, Co-ordination of multiple controllers using linear control techniques, Control coordination using AI techniques (fuzzy / neuro / genetic algorithm).

References:

1. N.G. Hingorani and I.Gyugyi, "Understanding FACTS", IEEE Press, 1999
2. Y.H.Songh and A.T.Johns.ed.,"Flexible AC Transmission Systems (FACTS)", IEEE 1999.
3. R.Mohan Mathur, Rajiv K.Varma, "Thyristor – Based Facts Controllers for Electrical Transmission Systems", IEEE press and John Wiley & Sons, Inc.
4. K.R.Padiyar," FACTS Controllers in Power Transmission and Distribution", New Age International(P) Limited, Publishers, New Delhi, 2008
5. V.K.Sood, HVDC and FACTS controllers – Applications of Static Converters in Power System, April 2004 , Kluwer Academic Publishers

CODE	OEE 014 / OEE 024 / OEE 034	L	T	P

EHV AC & DC TRANSMISSION **3 1 0**

UNIT – 1

Introduction

Need of EHV transmission, Standard transmission voltage, Comparison of EHV AC & DC transmission systems and their applications & limitations, Need of conductor& their applications, Mechanical considerations of transmission lines, Modern trends in EHV AC and DC transmission.

UNIT – 2

EHV AC Transmission

Parameters of EHV line, Over-voltages due to switching, Ferro-resonance, Line insulator & clearance, Corona, Audible noise – generation and characteristics, Corona pulses their generation & properties, Radio interference (RI) effects, Long distance transmission with series & shunt compensations, Principle of half wave transmission, Flexible AC transmission.

UNIT – 3

Extra High Voltage Testing:

Characteristics and generation of impulse voltage, Generation of high AC and DC voltages, Measurement of high voltage by sphere gaps and potential dividers

Consideration for Design of EHV Lines:

Design factors under steady state limits, EHV line insulation design based upon transient over-voltages, Performance parameters of EHV lines.

UNIT – 4

Multi-terminal DC Systems

Introduction to Multi-terminal DC (MTDC) system, Potential applications of MTDC systems, Types of MTDC systems, Control and protection of MTDC systems, Study of MTDC systems, Protection of terminal equipments.

HVDC Transmission

Description of DC transmission system, Planning for HVDC transmission, Modern trends in DC transmission, Types of DC links, Terminal equipments & their operations, HVDC system control, Reactive power control, Harmonics and filters.

UNIT – 5

Power Flow Analysis in AC/DC Systems

Per unit system, Modeling of AC/DC links, Solution of AC-DC power flow.

Simulation of EHV AC & DC Transmission Systems

System simulation: Philosophy and tools, HVDC systems simulation, Modeling of HVDC systems for digital dynamic simulation, Dynamic interaction between DC and AC systems.

References:

1. R.D. Begmudre, “Extra High Voltage AC Transmission Engineering”, Wiley Eastern.
2. E.W. Kimbark, “Direct Current Transmission” Vol. I. John Wiley & Sons, 1971.
3. S.Rao, “EHV AC and HVDC Transmission Engineering & Practice” Khanna Publishers.
4. K.R. Padiyar, “HVDC Power Transmission Systems”, New Age International, New Delhi, 2002.
5. P. Kundur, “Power System Stability and Control”, McGraw-Hill, 1993.
6. Erich Uhlmann, “Power Transmission by Direct Current”, BS Publications, 2004.
7. V.K. Sood, “HVDC and FACTS controllers – Applications of Static Converters in Power System”, Kluwer Academic Publishers, 2004.

CODE	OEE 015 / OEE 025 / OEE 035	L	T	P

ELECTRICAL POWER QUALITY **3 1 0**

UNIT - 1

Introduction to Power Quality:
Terms and definitions of transients, Long duration voltage variations – overvoltage, undervoltage and sustained interruptions, Short duration voltage variations – Interruption, Sag, Swell, Voltage and phase angle imbalances, Notching, Outage, Surges, DC offset, Waveform distortion, Voltage fluctuation, Power frequency variations, Electrical noise, Harmonics, Frequency deviation monitoring.

UNIT - 2

Voltage Sag & Electrical Transients:
Sources of voltage sag – motor starting, arc furnace, fault clearing etc; Estimating voltage sag performance and principle of its protection; Solutions at end user level – isolation transformer, voltage regulator, static UPS, rotary UPS, emergency & standby power systems, applications of power conditioners, active series compensator; Sources of transient overvoltage – atmospheric and switching transients, motor starting transients, pf correction capacitor switching transients, UPS switching transients, neutral voltage swing etc; Devices for over voltage protection.

UNIT - 3

Harmonics:
Causes of harmonics; Current and voltage harmonics – measurement of harmonics; Effects of harmonics on – transformers, AC motors, capacitor banks, cables, and protection devices, energy metering, communication lines etc., Harmonic mitigation techniques.

UNIT - 4

Monitoring and Measurement of Power Quality:
Power quality measurement devices – harmonic analyzer, transient disturbance analyzer, wiring and grounding tester, flicker meter, oscilloscope, multimeter etc.

Minimization of Disturbances at Customer Site
Power quality related standards, Standard test waveforms, Power distribution system design, Measures to minimize voltage disturbances.

UNIT - 5

Introduction to Custom Power Devices:
Network reconfiguration devices; Load compensation and voltage regulation using DSTATCOM; Protecting sensitive loads using DVR; Unified power quality conditioner (UPQC).

References:

1. G.W. Heydt, "Electric Power Quality", Stars in a Circle Publications, 1991.
2. R.C. Duagan, M.F. Megranaghan and H.W. Beaty, "Electric Power System Quality", Mc-Graw Hill International.
3. G.J. Parter and J.A.V. Sciver, "Power Quality Salutations: Case Study for Troubleshooters", Fairmont Press.
4. Arindum Ghosh & Gerard Ledwich, "Power Quality Enhancement Using Custom Power Devices", Kluwer Academic Publishers
5. C. Sankaran, "Power Quality" CRC Press.

CODE	OEE 016 / OEE 026 / OEE 036	L	T	P

ADVANCED POWER SEMICONDUCTOR DEVICES 3 1 0

UNIT - 1

Introduction:
General overview of power semiconductor devices and their desirable characteristics, Comparison of power semiconductor devices.

Power Diodes:
General purpose diode, Fast recovery diode, Schottky diode, Diode snubbers.

UNIT - 2

Power Bipolar Juction Transistors:
Physical structure and device operation, Static V-I and switching characteristics, Secondary breakdown and safe operating area, Snubber circuits, Base drive control.

Power MOSFETS:
Physical structure and device operation, Static V-I and switching characteristics, Operating limitations and safe operating area, Gate drive and snubber circuits.

UNIT - 3

Thyristors:
Physical structure and device operation, Two-transistor analogy, Static V-I and switching characteristics, Gate characteristics, Firing circuits, Snubber circuits, Series and parallel operation.

Triacs:
Physical structure and device operation, Static V-I characteristics and applications.

UNIT – 4

GTO (Gate Turn Off) Thyristors:
Physical structure and device operation, Static V-I and switching characteristics, Drive and snubber circuits.

Insulated Gated Bipolar Transistors:
Physical structure and device operation, Static V-I and switching characteristics, Safe operating area, Drive and snubber circuits.

UNIT - 5

Special Power Devices:
Physical structure, Device operation and static V-I characteristics of reverse conducting thyristor, Field controlled thyristor, MOS controlled thyristor.

References:

1 B. Jayant Baliga, “Modern Power Devices”, John Wiley & Sons, 1987.
2 N. Mohan, T.M. Undeland and W.P. Robbins, “ Power Electronics Converters, Applications and Design”, Johan Wiley & Sons, 1995.
3 M.H. Rashid, “Power Electronics: Circuit, Devices and Applications”, Prentice Hall of India, 1996.
4 Dubey G.K. et al, “Thyristorised Power Controllers”, Wiley Eastern Limited 1987.
5 M.D. Singh and K.B. Khanchandanu, “Power Electroncs”, Tata McGraw Hill, 2001.
6 John G. K. Kassakian, Martin F. Schlecht and G.C. Verghese, “Principles of Power Electronics”, Addison-Wesley Publishing Co., 1991.

CODE	OEE 017 / OEE 027 / OEE 037	L	T	P
	MODELING AND SIMULATION OF ELECTRICAL MACHINES	**3**	**1**	**0**

UNIT - 1

Principles of Electromagnetic Energy Conversion
General expression of stored magnetic energy, Co-energy and force / torque – example using single and doubly excited system – Calculation of air gap m.m.f. and per phase machine inductance using physical machine data.

UNIT – 2

Reference Frame Theory
Static and rotating reference frames – Transformation of variables – Reference frames – Transformation between reference frames – Transformation of a balanced set – Balanced steady-state phasor and voltage equations – Variables observed from several frames of reference.

UNIT – 3

Modeling of D.C. Machines
Analysis under motoring and generating, Simulation for transient and dynamic conditions, Voltage build-up in generators, Effects of load change, Run-up and dynamic operations of motors under different excitations, Response under load change, Reversal and braking.

UNIT – 4

Modeling of synchronous Machines
d-q transformations fixed to field structure – Steady state and dynamic equations, Electromagnetic and reluctance torques, Response under short circuit conditions, Computer simulation using mathematical softwares.

UNIT – 5

Modeling of Induction Machines
Equations under stationary and rotating reference frames, Derivation of equivalent circuits, Correlation of inductances, Run-up transient transients, Dynamics under load change, Speed reversal and braking, Computer simulation to predict dynamic response, Unbalanced and asymmetrical operations, Operations, modeling and simulation of single phase motors.

Modeling of Special Machines
Modeling and analysis of permanent magnet, switched reluctance and stepper motors.

References:

1. B. Adkins and R.G. Hartley, "The General theory of Electrical Machines". Chapman & Hall Ltd., 1975.
2. R.Krishnan, "Electric Motor Drives, Modeling, Analysis and Control" , Prentice Hall of India, 2002.
3. Paul C. Krause, "Analysis of Electric Machinery", MC Graw Hill, 1987.
4. C. V. Jones, "Unified Theory of Electrical Machines", Butterworths Publishers.
5. D. C. White and H.H. Woodson, "Electromechanical Energy Conversion", John Wiley & Sons, 1959.
6. G. Kron, "Equivalent Circuits of Electric Machinery", John Wiley & Sons, 1951.
7. A. W. Fitzgerald and C. Kingsley, "Electric Machinery", Mc Graw Hill, 1961.

CODE	OEE 018 / OEE 028 / OEE 038	L	T	P
	POWER SEMICONDUCTOR CONTROLLED ELECTRIC DRIVES	**3**	**1**	**0**

UNIT - 1

Introduction:
Solid state controlled electric drives – concept, elements and salient features, Power converter motor system, Closed-loop control of electric drives, Sensing of speed and current, Performance parameters.

UNIT - 2

Control of DC Drives:
Control of DC separately and series excited motor drives using controlled converters (single-phase and three-phase) and choppers, Static Ward-Leonard control scheme, Solid-state electric braking schemes, Current and speed control loops for closed-loop control of solid-state DC drives; (P, PI and PID) controllers – response comparison, Simulation of converter and chopper fed DC drive.

UNIT - 3

Control of AC Motor Drives:
Operation of induction and synchronous motor drives from voltage source and current source inverters, Static rotor resistance control, Injection of voltage in the rotor circuit, Slip power recovery – static Kramer's and Scherbius' drives, Pump drives using AC line controllers, Self controlled synchronous motor derives, Brushless DC motor drive, Switched reluctance motor drive.

UNIT - 4

Scalar and Field Oriented Control:
Constant and variable frequency operation, Constant V/Hz operation, Field-oriented control of induction and synchronous machines – theory, DC drive analogy, direct and indirect methods, flux vector estimation, Direct torque control of induction and synchronous machines – torque expression with stator and rotor fluxes, DTC control strategy.

UNIT - 5

Microprocessor Control of Electric Drive:
Function of microprocessor in electric drive control, Salient features of microprocessor control, Microprocessor based control scheme for DC, induction and synchronous motor drives, Applications.

References:

1. G. K. Dubey, "Power Semiconductor Controlled Drives", Prentice Hall International, 1989.
2. J.M.D. Murphy & I.G. Turnbull, "Power Electronic Control of AC Motors", Pergamon Press, 1988.
3. S.B. Dewan, G.R. Slemon and A. Straughen, "Power Semiconductor Drives". Wiley Interscience, 1984.
4. V. Subrahmanyam, "Thyristor Control of Electric Motors", Tata Mc Graw Hill.
5. B. K. Bose, "Power Electronics and AC Drives", Prentice Hall International, 1986.
6. P.C. Sen, "Thyristor DC Drives", Wiley Interscience, 1987.
7. R. Krishnan, "Electric Motor Drives Modeling, Analysis and Control", Prentice Hall International, 2002.

CODE	OEE 019 / OEE 029 / OEE 039	L	T	P

POWER CONVERTER APPLICATIONS **3 1 0**

UNIT – 1

Industrial Applications:
Electric heating, Advantages & disadvantages, Concept of resistance and induction heating, AC voltage controllers for resistance heating, High frequency inverters for induction heating, Illumination control, High frequency fluorescent lighting system, Switch-mode welders with high frequency transformers.

UNIT – 2

Application in High Voltage DC Transmission
Introduction to HVDC transmission, Basic layout for HVDC transmission system, Types of HVDC links, Twelve pulse converters, Control of HVDC converters, Control characteristics, Converter faults and protection, Harmonic filters and power factor correction capacitors.

UNIT – 3

Applications in Static VAR Control:
Concept of static VAR control, Thyristor controlled VAR compensation techniques, Series compensation, Synchronous link converter based VAR compensation, Unified power flow controller (UPFC).

UNIT – 4

Applications in Power Supplies
Classification and sources of power line disturbances, Need of uninterruptible power supply (UPS) system, Static UPS systems – short break & no break UPS systems, Components of UPS systems, Introduction to SMPS, Configurations – flyback converter, two transistor / MOSFET flyback converter, paralleling flyback converter, forward converter, push-pull converter, half-bridge converter, full-bridge SMPS, Advantages & disadvantages, Aircraft power supplies.

UNIT – 5

Applications in Grid Interconnected Renewable Energy Systems
Single-phase and three-phase photovoltaic array interconnection, Maximum power point tracking (MPPT), Wind / fuel cell and small hydro interconnections with utility grid.

Other Applications
DC circuit breaker, single-phase and three-phase AC switches, Static excitation control of synchronous generators.

References:

1. N. Mohan, T.M. Undeland and W.P. Robbins, "Power Electronics Converters, Applications and Design', John Wiley & Sons, 1995.
2. H. Rashid, "Power Elecrtonics: Circuits, Devices and Applications", Prentice Hall of India, 1996.
3. E. W. Kimbark, "Direct Current Transmission, Vol-I", Wiley Interscience, 1971.
4. T.J. Miller, "Reactive Power Control in Electric System", Wiley Interscience, 1982.