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

(An Autonomous Institute under U.P.T.U. Lucknow)

STUDY AND EVALUATION SCHEME

(With Effective from: Session 2015-16)

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 U.P.T.U. Lucknow)

ELECTRICAL ENGINEERING

MASTER OF TECHNOLOGY (REGULAR)
(Power Electronics & Drives)

(With effective from: Session 2015-16)

SEMESTER – I

Sr.	Subject Code	Subject	Periods			EVALUATION SCHEME							
						Sessional Exam						End Semester Exam	Subject Total
						Theory			Practical		Total		
			L	T	P	CT	AT	TA	AT	TA			
1.	KMREE 111	Fundamentals of Electric Drives	3	1	0	30	10	10	---	---	50	100	150
2.	KMREE 112	Advanced Control Systems	3	1	0	30	10	10	---	---	50	100	150
3.	KMREE 113	Power Converters	3	0	2	15	10	05	10	10	50	100	150
4.	KMREE 114	Numerical Techniques & Simulation	3	0	2	15	10	05	10	10	50	100	150
5.	KMREE 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							
						Sessional Exam						End Semester Exam	Subject Total
						Theory			Practical		Total		
			L	T	P	CT	AT	TA	AT	TA			
1.	KMREE 211	Power Semiconductor Controlled Electric Drives	3	0	3	15	10	05	10	10	50	100	150
2.	KMREE 212	Power Converter Applications	3	1	0	30	10	10	---	---	50	100	150
3.	KMREE 213	Advanced Microprocessor & Applications	3	1	0	30	10	10	---	---	50	100	150
4.	KMREE 02	Elective – II	3	1	0	30	10	10	---	---	50	100	150
5.	KMREE 03	Elective – III	3	1	0	30	10	10	---	---	50	100	150
		TOTAL	**15**	**4**	**3**						**250**	**500**	**750**

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.	KMREE 311	State-of-the-Art Seminar	---	---	04	---	---	---	---	---	100	---	100
2.	KMREE 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	
						Theory			Practical		Total		
			L	T	P	CT	AT	TA	AT	TA			
1.	KMREE 411	Dissertation (Phase – II)	---	---	22	---	---	---	---	---	100	200	300
		TOTAL	**---**	**---**	**22**						**100**	**200**	**300**

LIST OF ELECTIVES

KMREE 01 / KMREE 02 / KMREE 03: ELECTIVE -I / ELECTIVE – II / ELECTIVE – III

KMREE 011 / KMREE 021 / KMREE 031 : Power Electronics for Renewable Energy Systems

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

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

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

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

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

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

KMREE 018 / KMREE 028 / KMREE 038 : Advanced power Electronics & ASIC Design

KMREE 019 / KMREE 029 / KMREE 039 : Modern Rectifiers and Resonant Converters

KMREE 0110 / KMREE 0210 / KMREE 0310 : Control Techniques in power Electronics

CODE	KMREE 111	L	T	P
	FUNDAMENTALS OF ELECTRIC DRIVES	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 system 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 ratings, 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 Drives:

Servo motor drive, step 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 Subramanian, "Electric Drive: Concepts and Applications", Tata McGraw Hill, 1994.

CODE	KMREE 112	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. K. Ogata, "Modern Control Engineering", John Wiley & Sons, 2001.
2. Norman S. Nise, "Control System Engineering", John Wiley & Sons, 2001.
3. Kuo B. C., "Digital Control Systems", Saunders College Publishing, 1992.
4. M. Gopal, "Digital Control and State Variable Methods", Tata McGraw Hill, 1997.
5. I. J. Nagrath & M. Gopal, "Modern Control Engineering", New Age International, 2005.
6. S. M. Tripathi, "Modern Control Systems: An Introduction", Jones & Bartellet Publishers, USA, 2009.

7. M. Gopal, “Modern Control System Theory”, Wiley Eastern, 1993.
8. K. Ogata, “Discrete Time Control System”, Prentice Hall International, 1987.

CODE	KMREE 113	L	T	P
	POWER CONVERTERS	3	0	2

UNIT-1:
DC-DC Switched Mode Converters:
Review of Buck Converter, Boost Converter, Buck-Boost, Duty cycle derivation, Different conduction modes (CCM & DCM), Voltage and Current waveforms, Calculation of output voltage ripple.

UNIT-2:
Voltage Source Converters:
3-phase full wave bridge converter, operation and harmonics, Transformer connection for 12 pulse operation, 24 and 48 pulse operation. Operation of 12-pulse converter. 3-level voltage source converter. PWM converter. Generalised technique of harmonic elimination and voltage control. Advanced modulation techniques (SPWM, space vector modulation, 3rd harmonic PWM) Comparison of PWM techniques, Converter rating.

UNIT-3:
Self and Line Commutated Current Source Converter:
Basic concepts and principle of operation of CSC, converters with self commutating devices. Comparison with voltage source converter

UNIT-4:
Resonant Converters:
Switch-mode inductive current switching, Zero Voltage & Zero Current switching , Resonant switch converters, Basic resonant circuit concepts, Resonant switch converters, ZCS and ZVS resonant switch converters , Comparison of ZCS and ZVS topologies. Load resonant converters, resonant switch converters, resonant dc-link Converters, high-frequency-link integral half cycle converters.

UNIT-5:
Multilevel Converters:
Multilevel concept, Types of multilevel converters, diode clamped multilevel converters, flying-capacitors multilevel converters, cascaded multilevel converters, Vienna Converter, applications switching device currents, d. c. link capacitor voltage balancing, features of multilevel converters, comparison of multilevel converters.

References:

1. K. Kit Sum, "Switch-Mode Power Conversion: Basic theory and design", Marcel Decker.
2. G. Chryssis, "High Frequency Switching Power supplies: Theory and Design", Mc Graw Hill.
3. M. H. Rashid, "Power Electronics: Circuits, Devices and Applications", Prentice Hall of India, 1996.
4. N. Mohan, T. M. Undeland and W. P. Robbins, "Power Converters, Applications and Design", John Wiley & Sons, 1995.
5. G. K. Dubey et al, "Thyristorized Power Controllers", Wiley Eastern, 1987.
6. B. R. Pelly, "Thyristor Phase Controlled Converters and Cyclo-converters", Wiley Intersicence, 1971.
7. M. D. Singh and K. B. Khanchandani, "Power Electronics", Tata McGraw Hill, 2001.
8. V. Subrahmanyam, "Power Electronics", New Age International Publishers, 1997.
9. D. Grahame Holmes, Thomas A. Lipo, T. A. Lipo "Pulse width modulation for power converters: principles and practice", Wiley-IEEE press, 2003.

CODE	KMREE 114	L	T	P
	NUMERICAL TECHNIQUES & SIMULATION	3	0	2

UNIT-1:

Calculus of Finite Differences & Interpolation:

$\Delta, \nabla, E\ E^{-1}$ 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:

Programming 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:

Programming Applications:

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

Modeling & Simulation of Electrical Systems:

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; Sim Power Systems 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., "Sim Power Systems: 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	KMREE 211	L	T	P
	POWER SEMICONDUCTOR CONTROLLED ELECTRIC DRIVES	3	0	3

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 D.C. 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 A.C. 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's 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 A.C. Motors", Pergamon Press, 1988.
3. S. B. Dewan & G. R. Slemon & 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. Krishan, "Electric Motor Drives Modeling, Analysis and Control", Prentice Hall International, 2002.

CODE	KMREE 212	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	KMREE 213	L	T	P
	ADVANCED MICROPROCESSORS AND APPLICATIONS	3	1	0

UNIT-1:

Introduction:

Review of basic microprocessor, Architecture and instruction set of a typical 8 bit microprocessor, Concepts of micro controller and micro computer, Micro controllers (8051/8751) based design, Applications of micro computer in on line real time control.

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 multiprocessing, Multi-user, Multitasking operating system concepts, Pentium I, II, III and IV processors, Motorola 68000 processor.

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 Rs. 232.

Programmable Support Chips:

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

UNIT-4:

Control of Power Converters:

Control strategies and microprocessor based control schemes for line converters, AC voltage controllers, Cyclo-converters, Choppers and Bridge inverters.

UNIT-5:

Sensing and Processing of Feedback Signals:

Sensing of position, speed, current, torque for feedback purposes and signal conditioning, Synchronizing signals, Quantization, Digitalization, Filtering and implementation, Microprocessor in electric drive control, Selection criteria

References:

1. R. S. Gaonker, "Microprocessor Architecture, Programming and Application", Wiley Eastern Limited.
2. M. D. Singh and K. B. Khanchandani, "Power Electronics", Tata Mc Graw Hill, 2001.
3. B. K. Bose, "Power Electronics and Variable Frequency Drive", Standard Publishers Distributions, 2000.
4. D. V. Hall, "Microprocessors and Interfacing Programming and Software," Mc Graw Hill.

ELECTIVES

CODE	KMREE 011 / KMREE 021 / KMREE 031	L	T	P
	POWER ELECTRONICS FOR RENEWABLE ENERGY SYSTEMS	3	1	0

UNIT-1:

Introduction to Renewable Energy Sources:

Introduction, importance, classification and qualitative study of different renewable energy resources: Solar, Wind, Ocean, Biomass, Fuel cell, Hydrogen energy systems and Hybrid renewable energy systems.

UNIT-2:

Renewable Energy Converters:

Three-phase AC-DC-AC converters: uncontrolled rectifiers, PWM Inverters, Grid Interactive Inverters, matrix converters, Principle of operation: line commutated converters (inversion-mode), Boost and buck-boost converters

Electrical Machines:

Review of reference theory fundamentals, Principle of operation and analysis: SCIG, PMSG, and DFIG.

UNIT-3:

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, Grid integrated PMSG and SCIG Based WECSs, Machine side & Grid side controllers, Grid connection Issues related to Wind Systems.

UNIT-4:

Solar Power Conversion Systems:

Theory of solar cells, solar materials, solar cell power plant, limitations, Block diagram of solar photo-voltaic system, selection of inverter, battery sizing, array sizing, Grid Integrated solar system, Grid connection Issues related to solar systems.

UNIT-5:

Hybrid Renewable Energy Systems:

Need for Hybrid Systems, Range and types of Hybrid systems, Wind-Diesel Hybrid System, Wind-Photovoltaic Hybrid Systems, Photovoltaic-Diesel Hybrid System, Case studies of Wind-PV Maximum Power Point Tracking (MPPT), Grid connection Issues related to hybrid systems.

References:

1. S. N. Bhadra, D. Kastha, S. Banerjee, Wind Electrical Systems, Oxford Press.
2. Rai. G. D, "Non conventional energy sources", Khanna publishes, 1993.
3. Rai. G. D," Solar energy utilization", Khanna publishes, 1993.
4. Gray, L. Johnson, "Wind energy system", prentice hall, 1995.
5. B. H. Khan, Non-conventional Energy sources, Tata Mc Graw-hill, New Delhi.
6. L. L. Freris "Wind Energy conversion Systems", Prentice Hall, 1990
7. Ion Boldea, "Variable speed generators", Taylor & Francis group, 2006.
8. E. W. Golding "The generation of Electricity by wind power", Redwood burn Ltd., Trowbridge, 1976.
9. S. Heir "Grid Integration of WECS", Wiley 1998.

CODE	KMREE 012 / KMREE 022 / KMREE 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 & Multilayer 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. Bose & 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 Lalakshim 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	KMREE 013 / KMREE 023 / KMREE 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	KMREE 014 / KMREE 024 / KMREE 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	KMREE 015 / KMREE 025 / KMREE 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, 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. Dugan, 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	KMREE 016 / KMREE 026 / KMREE 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 Junction 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 (IGBT):
Physical structure and device operation, static V-I and switching characteristics, safe operating area, drive and snubber, circuit.

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. Khanchandani, "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	KMREE 017 / KMREE 027 / KMREE 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	KMREE 018 / KMREE 028 / KMREE 038	L	T	P
	ADVANCED POWER ELECTRONICS & ASIC DESIGN	3	1	0

UNIT-1:

Analysis and design of switch-mode dc-dc converters. Basic converter topologies: buck, boost and buck/boost and transformer-couples derivatives.

UNIT-2:

Closed loop converter control pulse width modulation. Limitation of semiconductor components as characterized by their behavior under clamped inductive switching, properties of magnetic materials and their influence on design of high-frequency inductors and transformers.

UNIT-3:
Advanced control and modulation techniques for inverters and rectifiers; simulation of transients, simulation tools: SABER, PSPICE and MATLAB-SIMULINK: Simulation of converters, inverters and Cycloconverter.

UNIT-4:
Design of digital application specific integrated circuits (ASICs) based on hardware description languages (Verilog, VHDL) and CAD Tools. Emphasis on design practices and underlying algorithms.

UNIT-5:
Introduction to deep sub-micron design issues like interconnections and low power and to modern applications including multi-media, wireless. Telecommunications and computing controller.

References:

1. M. H. Rashid, "Power Electronics: Circuits, Devices & Applications", Prentice Hall of India Ltd. 3rd Edition, 2004.
2. V. R. Moorthy, "Power Electronics: Devices, Circuits and Industrial Applications", Oxford University Press, 2007.
3. Ned Mohan, T. M. Undeland and W. P. Robbins, "Power Electronics: Converters, Applications and Design", Wiley India Ltd, 2008.

CODE	KMREE 019 / KMREE 029 / KMREE 039	L	T	P
	MODERN RECTIFIERS AND RESONANT CONVERTERS	3	1	0

UNIT-1:
Power System Harmonics & Line Commutated Rectifiers:
Average power-RMS value of a waveform-Power factor-AC line current harmonic standards IEC 1000-IEEE 519- The Single phase full wave rectifier-Continuous Conduction Mode-Discontinuous Conduction Mode-Behaviour when C is large-Minimizing THD when C is small-Three phase rectifiers-Continuous Conduction Mode-Discontinuous Conduction Mode-Harmonic trap filters.

UNIT-2:
Pulse Width Modulated Rectifiers:
Properties of Ideal rectifiers-Realization of non ideal rectifier-Control of current waveform-Average current control-Current programmed Control- Hysteresis control- Nonlinear carrier control-Single phase converter system incorporating ideal rectifiers- Modeling losses and efficiency in CCM high quality rectifiers-Boost rectifier Example-expression for controller duty cycle-expression for DC load current-solution for converter Efficiency η.

UNIT-3:

Resonant Converters:

Review on Parallel and Series Resonant Switches-Soft Switching- Zero Current Switching - Zero Voltage Switching -Classification of Quasi resonant switches-Zero Current Switching of Quasi Resonant Buck converter, Zero Current Switching of Quasi Resonant Boost converter, Zero Voltage Switching of Quasi Resonant Buck converter, Zero Voltage Switching of Quasi Resonant Boost converter: Steady State analysis.

UNIT-4:

Dynamic Analysis of Switching Converters:

Review of linear system analysis-State Space Averaging-Basic State Space Average Model-State Space Averaged model for an ideal Buck Converter, ideal Boost Converter, ideal Buck Boost Converter, for an ideal Cuk Converter.

UNIT-5:

Control of Resonant Converters:

Pulse Width Modulation-Voltage Mode PWM Scheme-Current Mode PWM Scheme-Design of Controllers: PI Controller, Variable Structure Controller, Optimal Controller for the source current shaping of PWM rectifiers.

References:

1. Robert W. Erickson & Dragon Maksimovic, "Fundamentals of Power Electronics", Second Edition, 2001 Springer science and Business media.
2. William Shepherd and Li Zhang, "Power Converters Circuits", Marceld Ekkerin, C.
3. Simon Ang and Alejandro Oliva, "Power- Switching Converters", Taylor & Francis Group.

CODE	KMREE 0110 / KMREE 0210 / KMREE 0310	L	T	P
	CONTROL TECHNIQUES IN POWER ELECTRONICS	3	1	0

UNIT-1:

State space modeling and simulation of linear system, discrete time models, conventional controllers using small signal models.

UNIT-2:

Variable structure and sliding mode control, hysteresis controllers, output and state feedback switching controllers.

UNIT-3:

Linear Quadratic Controller (LQR), Deadbeat controller, pole shift controller.

UNIT-4:

Structure and control of Power converters: single-phase H-bridge and three-phase inverter, multilevel inverters, PWM for inverters;

UNIT-5:

Introduction of fuzzy and neural network control of power converters.

References:

1. Arindum Ghosh & Gerard Ledwich, "Power Quality Enhancement Using Custom Power Devices", Kluwer Academic Publishers
2. M. Gopal, "Digital Control and State variable Methods", Tata Mc Graw Hill
3. Ajit K. Madal, "Introduction to Control Engineering: Modeling, Analysis and Design", New Age International.
4. S. Rajasekaran & G.A.Vjayalakshmi Pai, "Neural Networks, Fuzzy Logic and Genetic Algorithms: Synthesis and Applications", Prentice Hall of India.
5. Donald E. Kiv, "Optimal Control Theory: An Introduction", Prentice Hall
6. B. C. Kuo, "Digital Control Systems", Sounders College Publishing
7. C. H. Houpisand G. B. Lamont, "Digital Control Systems: Theory, Hardware, Software", Mc Graw Hill.

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

ELECTRICAL ENGINEERING

MASTER OF TECHNOLOGY (Part-Time)
(Power System)

(With effective from: Session 2015-16)

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.	KMPEE 111	Power System Operation & Control	3	1	0	30	10	10	---	---	50	100	150
2.	KMPEE 112	Numerical Techniques & Simulation	3	0	2	15	10	05	10	10	50	100	150
3.	KMPEE 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.	KMPEE 211	Advanced Protective Relaying	3	1	0	30	10	10	---	---	50	100	150
2.	KMPEE 212	Computer Aided Power System Analysis	3	0	3	15	10	05	10	10	50	100	150
3.	KMPEE 213	Advanced Control Systems	3	1	0	30	10	10	---	---	50	100	150
		TOTAL	**9**	**2**	**3**						**150**	**300**	**450**

SEMESTER – III

Sr. No.	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.	KMPEE 311	High Voltage Engineering	3	1	---	30	10	10	---	---	50	100	150
2.	KMPEE 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							
						Sessional Exam						End Semester Exam	Subject Total
			L	T	P	Theory			Practical		Total		
						CT	AT	TA	AT	TA			
1.	KMPEE 02	Elective – II	3	1	---	30	10	10	---	---	50	100	150
2.	KMPEE 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							
						Sessional Exam						End Semester Exam	Subject Total
			L	T	P	Theory			Practical		Total		
						CT	AT	TA	AT	TA			
1.	KMPEE 511	State-of-the-Art Seminar	---	---	04	---	---	---	---	---	100	---	100
2.	KMPEE 512	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.	KMPEE 611	Dissertation (Phase – II)	---	---	12	---	---	---	---	---	100	200	300
		TOTAL	**---**	**---**	**12**						**100**	**200**	**300**

LIST OF ELECTIVES

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

KMPEE 011 / KMPEE 021 / KMPEE 031 : Power Electronics for Renewable Energy Systems

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

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

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

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

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

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

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

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

KMPEE 0110 / KMPEE 0210 / KMPEE 0310 : Power System Dynamics

KMPEE 0111 / KMPEE 0211 / KMPEE 0311 : Deregulations of Power Systems

KMPEE 0112 / KMPEE 0212 / KMPEE 0312 : Power System Security

KMPEE 0113 / KMPEE 0213 / KMPEE 0313 : Distributed generation and Micro grid

KMPEE 0114 / KMPEE 0214 / KMPEE 0314 : Economic operation of Power Systems

KMPEE 0115 / KMPEE 0215 / KMPEE 0315 : Electrical transient in Power System,

KMPEE 0116 / KMPEE 0216 / KMPEE 0316 : Smart Grid Design and Analysis

KMPEE 0117 / KMPEE 0217 / KMPEE 0317 : Optimization Techniques

KMPEE 0118 / KMPEE 0218 / KMPEE 0318 : Power System Planning and Reliability

KMPEE 0119 / KMPEE 0219 / KMPEE 0319 : Energy Management and Auditing

KMPEE 0120 / KMPEE 0220 / KMPEE 0320 : Power System Reliability

CODE	KMPEE 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 security.

UNIT-2:
Economic Operation:
Problem of unit commitment, system constraints, incremental fuel cost, economic load scheduling with and without transmission losses, penalty 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:
State Estimation:
State estimation detection and identification linear and nonlinear models.

Flexible AC Transmission System:
Concept and objectives, basic FACTS controllers TCR, FC-TSC, SVC, STATCOM. TCSC, SSSC, PAR and UPFC

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	KMPEE 112	L	T	P
	NUMERICAL TECHNIQUES & SIMULATION	3	0	2

UNIT-1:

Calculus of Finite Differences & Interpolation:

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:

Programming 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:

Programming Applications:

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:

Modeling & Simulation of Electrical Systems:

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; Sim Power Systems 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., "Sim Power Systems: 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	KMPEE 113	L	T	P
	POWER CONVERTERS	3	0	2

UNIT-1:
DC-DC Switched Mode Converters:
Review of Buck Converter, Boost Converter, Buck-Boost, Duty cycle derivation, Different conduction modes (CCM & DCM), Voltage and Current waveforms, Calculation of output voltage ripple.

UNIT-2:
Voltage Source Converters:
3-phase full wave bridge converter, operation and harmonics, Transformer connection for 12 pulse operation, 24 and 48 pulse operation. Operation of 12-pulse converter. 3-level voltage source converter. PWM converter. Generalised technique of harmonic elimination and voltage control. Advanced modulation techniques (SPWM, space vector modulation, 3rd harmonic PWM) Comparison of PWM techniques, Converter rating.

UNIT-3:
Self and Line Commutated Current Source Converter:
Basic concepts and principle of operation of CSC, converters with self commutating devices. Comparison with voltage source converter

UNIT-4:
Resonant Converters:
Switch-mode inductive current switching, Zero Voltage & Zero Current switching , Resonant switch converters, Basic resonant circuit concepts, Resonant switch converters, ZCS and ZVS

resonant switch converters , Comparison of ZCS and ZVS topologies. Load resonant converters, resonant switch converters, resonant dc-link Converters, high-frequency-link integral half cycle converters.

UNIT-5:

Multilevel Converters:

Multilevel concept, Types of multilevel converters, diode clamped multilevel converters, flying-capacitors multilevel converters, cascaded multilevel converters, Vienna Converter, applications switching device currents, d. c. link capacitor voltage balancing, features of multilevel converters, comparison of multilevel converters.

References:

1. K. Kit Sum, "Switch-Mode Power Conversion: Basic theory and design", Marcel Decker.
2. G. Chryssis, "High Frequency Switching Power supplies: Theory and Design", Mc Graw Hill.
3. M. H. Rashid, "Power Electronics: Circuits, Devices and Applications", Prentice Hall of India, 1996.
4. N. Mohan, T. M. Underland and W. P. Robbins, "Power Converters, Applications and Design", John Wiley & Sons, 1995.
5. G. K. Dubey et al, "Thyristorized Power Controllers", Wiley Eastern, 1987.
6. B. R. Pelly, "Thyristor Phase Controlled Converters and Cyclo-converters", Wiley Intersicence, 1971.
7. M. D. Singh and K. B. Khanchandani, "Power Electronics", Tata McGraw Hill, 2001.
8. V. Subrahmanyam, "Power Electronics", New Age International Publishers, 1997.
9. D. Grahame Holmes, Thomas A. Lipo, T. A. Lipo "Pulse width modulation for power converters: principles and practice", Wiley-IEEE press, 2003.

CODE	KMPEE 211	L	T	P
		3	1	0

ADVANCED PROTECTIVE RELAYING

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 Mac Graw Hill".
3. A. R. Van C. Warringtaon, "Protective Relays-Their Theory and Practice, Vol. I & II", John 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	KMPEE 212	L	T	P
	COMPUTER AIDED POWER SYSTEM ANALYSIS	3	1	0

UNIT-1:

Network Matrices:

Evaluation of bus admittance matrix (Y_{BUS}), Bus impedance matrix (Z_{BUS}), Branch impedance matrix (ZBT) and loop Impedance matrix (Z_{LOOP}) by singular and non singular transformations.

UNIT-2:
Short Circuit Studies:
Formulation of Z_{BUS} for single phase and three phase networks, Transformation of network matrices using symmetrical components; Short circuit studies using Z_{BUS}, Y_{BUS} and Z_{LOOP}.

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:
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.

UNIT-5:
Voltage Stability and Small-Signal Stability:
Voltage Stability Transmission system characteristics, Generator characteristics, Load characteristics. Introduction of reactive compensating devices. Classification of voltage Stability, voltage stability Analysis, voltage collapse and its Prevention.

Small-Signal Stability-Concept of stability of Dynamic System, Eigen-properties of the State Matrix, Single-machine Infinite Bus System, Power System Stabilizer.

References:

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

CODE	KMPEE 213	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. K. Ogata, "Modern Control Engineering", John Wiley & Sons, 2001.
2. Norman S. Nise, "Control System Engineering", John Wiley & Sons, 2001.
3. Kuo B. C., "Digital Control Systems", Saunders College Publishing, 1992.
4. M. Gopal, "Digital Control and State Variable Methods", Tata McGraw Hill, 1997.
5. I. J. Nagrath & M. Gopal, "Modern Control Engineering", New Age International, 2005.
6. S. M. Tripathi, "Modern Control Systems: An Introduction", Jones & Bartellet Publishers, USA, 2009.
7. M. Gopal, "Modern Control System Theory", Wiley Eastern, 1993.
8. K. Ogata, "Discrete Time Control System", Prentice Hall International, 1987.

CODE	KMPEE 311	L	T	P
	HIGH VOLTAGE ENGINEERING	3	1	0

UNIT-1:

Breakdown Phenomena:

Basic processes of breakdown, Breakdown phenomena in gaseous, liquid, solid & composite dielectrics, Breakdown in vacuum insulation

UNIT-2:

Generation of Test High Voltages:

Generation of High D. C. voltage by voltage multiplier circuit and electrostatic generators, generation of high A. C. voltage by cascaded transformers and resonant transformers, 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 R-C potential dividers, sphere gap, electrostatic voltmeter, generating voltmeter, impulse voltage measurement, measurement of high D. C., A. C. and impulse currents.

UNIT-4:

High Voltage Testing:

Requirement 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 overvoltages, protection of transmission line and substation against overvoltage insulation coordination.

References:

1. E Kuffel & W.S.Zaongol, "High Voltage Engineering", Pergaman Press.
2. N. S. Naidoo & 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	KMPEE 011 / KMPEE 021 / KMPEE 031	L	T	P
	POWER ELECTRONICS FOR RENEWABLE ENERGY SYSTEMS	3	1	0

UNIT -1:

Introduction to Renewable Energy Sources:

Introduction, importance, classification and qualitative study of different renewable energy resources: Solar, Wind, Ocean, Biomass, Fuel cell, Hydrogen energy systems and Hybrid renewable energy systems,

UNIT-2:

Renewable Energy Converters:

Three-phase AC-DC-AC converters: uncontrolled rectifiers, PWM Inverters, Grid Interactive Inverters, matrix converters, Principle of operation: line commutated converters (inversion-mode), Boost and buck-boost converters

Electrical Machines:

Review of reference theory fundamentals, Principle of operation and analysis: SCIG, PMSG, and DFIG.

UNIT-3:

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, Grid integrated PMSG and SCIG Based WECSs, Machine side & Grid side controllers, Grid connection Issues related to Wind Systems.

UNIT-4:

Solar Power Conversion Systems:

Theory of solar cells, solar materials, solar cell power plant, limitations, Block diagram of solar photo-voltaic system, selection of inverter, battery sizing, array sizing, Grid Integrated solar system, Grid connection Issues related to solar systems.

UNIT-5:

Hybrid Renewable Energy Systems:

Need for Hybrid Systems, Range and types of Hybrid systems, Wind-Diesel Hybrid System, Wind-Photovoltaic Hybrid Systems, Photovoltaic-Diesel Hybrid System, Case studies of Wind-PV Maximum Power Point Tracking (MPPT), Grid connection Issues related to hybrid systems.

References:

1. S. N. Bhadra, D. Kastha, S. Banerjee, “Wind Electrical Systems”, Oxford Press.
2. Rai. G. D, “Non conventional energy sources”, Khanna publishes, 1993.
3. Rai. G. D, “Solar energy utilization”, Khanna publishes, 1993.
4. Gray, L. Johnson, “Wind energy system”, Prentice Hall, 1995.
5. B. H. Khan, “Non-conventional Energy sources”, Tata Mc Graw Hill, New Delhi.
6. L. L. Freris, “Wind Energy conversion Systems”, Prentice Hall, 1990
7. Ion Boldea, “Variable speed generators”, Taylor & Francis group, 2006.
8. E. W. Golding, “The generation of Electricity by wind power”, Redwood burn Ltd., Trowbridge, 1976.
9. S. Heir, “Grid Integration of WECS”, Wiley 1998.

CODE	KMPEE 012 / KMPEE 022 / KMPEE 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 & Multilayer 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. Bose & 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	KMPEE 013 / KMPEE 023 / KMPEE 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	KMPEE 014 / KMPEE 024/ KMPEE 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	KMPEE 015 / KMPEE 025 / KMPEE 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, 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. Dugan, 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	KMPEE 016 / KMPEE 026 / KMPEE 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 Junction 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, circuit.

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	KMPEE 017 / KMPEE 027/ KMPEE 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	KMPEE 018 / KMPEE 028/ KMPEE 038	L	T	P
	POWER SEMICONDUCTOR CONTROLLED ELECTRIC DRIVES	3	0	3

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 D.C. 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 A.C. 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 A. C. Motors", Pergamon Press, 1988.
3. S. B. Dewan & G. R. Slemon & 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 D C Drives", Wiley Interscience, 1987.
7. R. Krishan, "Electric Motor Drives Modeling, Analysis and Control", Prentice Hall International, 2002.

CODE	KMPEE 019/ KMPEE 029/ KMPEE 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.

CODE	KMPEE 0110/ KMPEE 0210/ KMPEE 0310	L	T	P
	POWER SYSTEM DYNAMICS	**3**	**1**	**0**

UNIT-1:

Synchronous Machine Modelling:

Schematic Diagram, Physical Description: armature and field structure, machines with multiple pole pairs, MMF waveforms, direct and quadrature axes, Mathematical Description of a Synchronous Machine: Basic equations of a synchronous machine: stator circuit equations, self and mutual inductances of stator and stator to rotor mutual inductances, dq0 Transformation: flux linkage and voltage equations for stator and rotor in dq0 coordinates, electrical power and torque, physical interpretation of dq0 transformation, Per Unit Representations: Lad-reciprocal per unit system and that from power-invariant form of Park's transformation; Equivalent circuit and steady state analysis, Equations of Motion: Swing Equation, calculation of inertia constant, Representation in system studies, Synchronous Machine Representation in Stability Studies: Simplifications for large-scale studies : by Neglecting of stator $p\Psi$ terms and speed variations, Simplified model with amortisseurs neglected: two-axis model with amortisseur windings neglected, classical model.

UNIT-2:

Modelling of Excitation and Speed Governing Systems:

Excitation System Types, Control and protective functions; IEEE (1992) block diagram for simulation of excitation systems. Turbine and Governing System

Modelling: Functional Block Diagram of Power Generation and Control, Schematic of a hydroelectric plant, classical transfer function of a hydraulic turbine (no derivation), special characteristic of hydraulic turbine, electrical analogue of hydraulic turbine, Governor for Hydraulic Turbine: Requirement for a transient droop, Block diagram of governor with transient droop compensation, Steam turbine modelling: Single reheat tandem compounded type only and IEEE block diagram for dynamic simulation; generic speed-governing system model for normal speed/load control function.

UNIT-3:

Small-signal Stability Analysis without Controllers:

Classification of Stability, Basic Concepts and Definitions: Rotor angle stability, The Stability Phenomena. Fundamental Concepts of Stability of Dynamic Systems: State-space representation, stability of dynamic system, Linearization. Eigen properties of the state matrix: Eigen values and eigenvectors, modal matrices, eigen value and stability, mode shape and participation factor. Single-Machine Infinite Bus (SMIB) Configuration: Classical Machine Model stability analysis with numerical example, Effects of Field Circuit Dynamics: synchronous machine, network and linearised system equations, block diagram representation with K-constants; expression for K-constants (no derivation), effect of field flux variation on system stability.

UNIT-4:

Small-signal Stability Analysis with Controllers:

Effects Of Excitation System: Equations with definitions of appropriate K-constants and simple thyristor excitation system and AVR, block diagram with the excitation system, analysis of effect of AVR on synchronizing and damping components using a numerical example, Power System **Stabiliser:** Block diagram with AVR and PSS, Illustration of principle of PSS application with numerical example, Block diagram of PSS with description, system state matrix including PSS, analysis of stability with numerical example. Multi-Machine Configuration: Equations in a common reference frame, equations in individual machine rotor coordinates, illustration of formation of system state matrix for a two-machine system with classical models for synchronous machines, illustration of stability analysis using a numerical example.

UNIT-5:

Enhancement of Small Signal Stability:

Principle behind small-signal stability improvement methods: delta-omega and delta P-omega stabilizers. Power System Stabilizer – Stabilizer based on shaft speed signal (delta omega) – Delta – P-Omega stabilizer-Frequency-based stabilizers – Digital Stabilizer – Excitation control design – Exciter gain-Phase lead compensation – Stabilizing signal washout stabilizer gain – Stabilizer limits.

References:

1. P. Kundur, "Power System Stability and Control", McGraw-Hill, 1993.
2. IEEE Committee Report, "Dynamic Models for Steam and Hydro Turbines in Power System Studies", IEEE Trans., Vol. PAS-92, pp 1904-1915, November/December, on Turbine-Governor Model, 1973.
3. P. M. Anderson and A. A. Fouad, "Power System Control and Stability", Iowa State University Press, Ames, Iowa, 1978.
4. R. Ramanujam, "Power System Dynamics, Analysis and Simulation", PHI Learning, New Delhi, January 2010.

CODE	KMPEE 0111/ KMPEE 0211/ KMPEE 0311	L	T	P
	DEREGULATION OF POWER SYSTEM	3	1	0

UNIT-1:

Introduction to restructuring of power Sector:

Introduction: Deregulation of power Sector, Restructuring process, Issues involved in deregulation, Deregulation of various power systems – Fundamentals of Economics: Consumer behavior, Supplier behavior, Power trading model, open access, Market equilibrium, Short and long run costs, Various costs of production-Market models: Market models based on Contractual arrangements, Comparison of various market models, Electricity vis-a-vis other commodities, Market architecture, Case study.

UNIT-2:

Transmission Congestion Management:

Introduction: Definition of Congestion, reasons for transfer capability limitation, Importance of congestion management, Features of congestion management – Classification of congestion management methods – Calculation of ATC - Non – market methods – Market methods – Nodal pricing-Inter zonal and Intra zonal congestion management – Price area congestion management – Capacity alleviation method.

UNIT-3:

Locational Marginal Prices and Financial Transmission Rights:

Mathematical preliminaries: Locational marginal pricing– Lossless DCOPF model for LMP calculation – Loss compensated DCOPF model for LMP calculation – ACOPF model for LMP calculation – Financial Transmission rights – Risk hedging functionality - Simultaneous feasibility test and revenue adequency – FTR issuance process: FTR auction, FTR allocation – Treatment of revenue shortfall – Secondary trading of FTRs – Flow gate rights – FTR and market power - FTR and merchant transmission investment.

UNIT-4:

Ancillary Service Management and Pricing of Transmission Network:

Introduction of ancillary services – Types of Ancillary services – Classification of Ancillary services – Load generation balancing related services – Voltage control and reactive power support devices – Black start capability service - ancillary service –Co-optimization of energy and reserve services - International comparison - Transmission pricing – Principles – Classification – Role in transmission pricing methods – Marginal transmission pricing paradigm – Composite pricing paradigm – Merits and demerits of different paradigm.

UNIT-5:

Reforms in Indian Power Sector:

Introduction – Framework of Indian power sector – Reform initiatives - Availability based tariff – Electricity act 2003 – Open access issues – Power exchange – Reforms in the near future.

References:

1. Mohammad Shahidehpour, Muwaffaq Alomoush, Marcel Dekker, “Restructured electrical power systems: operation, trading and volatility”, Pub., 2001.
2. Kankar Bhattacharya, Jaap E. Daadler, Math H. J. Boolen, “Operation of restructured power systems”, Kluwer Academic Publishers, USA, 2001.
3. Sally Hunt, “Making competition work in electricity”, John Willey and Sons Inc. 2002.
4. Steven Stoft, “Power system economics: designing markets for electricity”, John Wiley & Sons, 2002.
5. Lei Lee Lai, “Power System restructuring and deregulation”, John Wiley and Sons, UK. 2001.

CODE	KMPEE 0112/ KMPEE 0212/ KMPEE 0312	L	T	P
	POWER SYSTEM SECURITY	3	1	0

UNIT-1:

Introduction:

Basic concepts and definitions of Rotor angle stability, Voltage stability or voltage collapse and Mid-term and long-term stability, Classification of stability.

UNIT-2:

Basic Concepts:

Power system-security-observability and reliability, factors affecting power system security, decomposition and multilevel approach, system monitoring, security assessment, static and dynamic – online and offline, security enhancement.

UNIT-3:

Power System State Estimation: DC and AC network, orthogonal decomposition algorithm, detection identification of bad measurements, network observability and pseudo measurements, application of power system state estimation, introduction to supervisory control and data acquisition.

UNIT-4:

Power System Security Assessment: contingency analysis, network sensitivity factors, contingency selection, performance indices, security constrained optimization, SCOPF, basis of evolutionary optimization techniques, preventive, emergency and restorative controls though non-linear programming (NLP) and linear programming (LP) methods.

UNIT-5:

Security in Deregulated Environment: Need and conditions for deregulation, electricity sector structure model, power wheeling transactions, congestion management methods, available transfer capability (ATC), system security in deregulation.

References:

1. Wood and Wollenberg, “Power generation, operation and control”, John Wiley & Sons, 2000.
2. K. Bhattacharya, M. H. J Bollen and J. E. Daaider, “Operation of restructured power system”, Kluwer Power Electronics and Power System series (2001)
3. N. S. Rau, “Optimization Principles: Practical Applications to the operation and Markets of the Electric Power Industry”.
4. Sally Hunt, “Making competition work in Electricity”, John Wiley, 2002

CODE	KMPEE 0113/ KMPEE 0213/ KMPEE 0313	L	T	P
	DISTRIBUTED GENERATION AND MICROGRID	3	1	0

UNIT-1:
Introduction:
Conventional power generation: advantages and disadvantages, Energy crises, Non-conventional energy (NCE) resources: review of Solar PV, Wind Energy systems, Fuel Cells, micro-turbines, biomass and tidal sources.

UNIT-2:
Distributed Generations (DG):
Concept of distributed generations, topologies, selection of sources, regulatory standards/ framework, Standards for interconnecting Distributed resources to electric power systems: IEEE 1547. DG installation classes, security issues in DG implementations. Energy storage elements: Batteries, ultra-capacitors, flywheels. Captive power plants.

UNIT-3:
Impact of Grid Integration:
Requirements for grid interconnection, limits on operational parameters,: voltage, frequency, THD, response to grid abnormal operating conditions, islanding issues. Impact of grid integration with NCE sources on existing power system: reliability, stability and power quality issues.

UNIT-4:
Microgrids:
Concept and definition of microgrid, microgrid drivers and benefits, review of sources of microgrids, typical structure and configuration of a microgrid, AC and DC microgrids, Power Electronics interfaces in DC and AC microgrids, communication infrastructure, modes of operation and control of microgrid: grid connected and islanded mode, Active and reactive power control, protection issues, anti-islanding schemes: passive, active and communication based techniques.

UNIT-5:
Power Quality Issues in Microgrids:
Power quality issues in microgrids-Modelling and Stability analysis of Microgrid, regulatory standards, Microgrid economics, Introduction to smart microgrids.

References:

1. Amirnaser Yezdani, and Reza Iravani, "Voltage Source Converters in Power Systems: Modeling, Control and Applications", IEEE John Wiley Publications, 2009.
2. Dorin Neacsu, "Power Switching Converters: Medium and High Power", CRC Press, Taylor & Francis, 2006.

3. Chetan Singh Solanki, “Solar Photo Voltaics”, PHI learning Pvt. Ltd., New Delhi, 2009.
4. J. F. Manwell, “Wind Energy Explained, theory design and applications,” J. G. McGowan Wiley publication, 2002.
5. D. D. Hall and R. P. Grover, “Biomass Regenerable Energy”, John Wiley, New York, 1987.
6. John Twidell and Tony Weir, “Renewable Energy Resources”, Taylor and Francis Publications, 2005.

CODE	KMPEE 0114/ KMPEE 0214/ KMPEE 0314	L	T	P
	ECONOMIC OPERATION OF POWER SYSTEM	3	1	0

UNIT-1:

Power system restructuring:

Introduction, Market Structure and operation:- Objective of market operation, Electricity market models, Power market types, Market power, Key components in market operation. Demand and supply, Demand analysis - theory of demand, Elasticity of demand, Demand forecasting types-techniques of forecasting.

UNIT-2:

Economics of Power Generation:

Introduction, cost of electrical energy, expression for cost of electrical energy, depreciation, power plant cost analysis, economics in plant selection, selection of types of generation and types of equipments, factors effecting economic generations and distributions, generating cost.

UNIT-3:

Economical Operations of Thermal Power Plants:

Generator operating cost, input and output curves, heat rate and incremental rate curves of generating units, system constraints, economic dispatch problem, economic dispatch using Newton Raphson method, classical method, Calculation of loss coefficient using Ybus, using Sensitivity Factors: Generation Shift Distribution (GSD) factors, Generalised Generation shift Distribution (GGSD) Factors. Effects of transmission losses, transmission loss coefficients, formula, function of generation and loads, economic dispatch using exact loss formula which is function of real and reactive power, evaluation of incremental transmission loss, economic dispatch based on penalty factors.

UNIT-4:

Economical Operations of Hydrothermal Power Plants:

Classification of hydro plants, long-range and short-range problem. Hydro Plant performance Model, Glimn- Kirchmayer Model, Hamilton-Lamonts Model, thermal and hydro model for short range fixed head hydrothermal scheduling, equality and inequality constraints, transmission losses, advantages of combined operation, base load, peak load operation requirement, Newton Raphson method for short range fixed head hydrothermal scheduling, reservoir dynamics, equality and inequality constraints, idea of multi-objective generation scheduling.

UNIT-5:

Interconnected System:

Merits and demerits, parallel operation of alternators, synchronizing current, power & toque, effect of change of excitation, driving torque & speed of one of the alternators, load sharing and power limit of interconnected stations, voltage, frequency & load control of interconnected stations.

References:

1. Maket Operations in Electric Power Systems (IEEE)- Mohammad Shahidehpour, Hatim Yamin, Zuyi Li ,A John Wiley & Sons, Inc., Publications
2. Understanding electric utilities and de-regulation, Lorrin Philipson, H. Lee Willis, Marcel Dekker Pub., 1998.
3. Power system economics: designing markets for electricity Steven Stoft, John Wiley & Sons, 2002.
4. Operation of restructured power systems. Kankar Bhattacharya, Jaap E. Daadler, Math H. J. Boolen, Kluwer Academic Pub., 2001.
5. Restructured electrical power systems: operation, trading and volatility Mohammad Shahidehpour, Muwaffaq Alomoush, Marcel Dekker Pub., 2001
6. W. H. J. R. Dunn, M. A. Rossi, B. Avaramovic: Impact of market restructuring on power systems operation, IEEE computer Applications on Power Engineering, vol. 8, January 1995, pp 42–47.
7. M. A. Olson, S. J. Rassenti, V. L. Smith: Market design and motivated human trading behaviors in electricity markets, in Proceedings of 34th Hawaii International Conference Systems Science, Hawaii, January 5–8, 1999
8. X. Guan, P. B. Luh: Integrated resource scheduling and bidding in the deregulated electric power market: New challenges, Special Issue J. Discrete Event Dynamical Systems, Vol. 9, No. 4, 1999, pp 331–350.
9. Turner, Wayne. C., Energy Management Hand Book.,2nd Edition
10. Industrial Economics-an introductory text book. R R Barathwal- Professor IIT Kanpur
11. Micro Economics-Theory and Application by Aninydya Senpplied economics for Engineers and Managers by S. K. Jain – Vikas Publishing House.
12. Series on Electrical Power capacitors Reactive power Management, D. M. Tagare, Madhav Electricals, Pune, Tata McGraw Hill Publishing Company Ltd
13. K. Kirchmayr, “Economic Control of interconnected systems”, J. Wiley Publications.
14. Robert H Miller & James H. Malinowski, “Power System Operation”, TMH Publications

CODE	KMPEE 0115/ KMPEE 0215/ KMPEE 0315	L	T	P
	ELECTRICAL TRANSIENTS IN POWER SYSTEMS	3	1	0

UNIT-1:

Review of Travelling Wave Phenomena:

Lumped and Distributed Parameters-Wave Equation-Reflection, Refraction, Behaviour of Travelling waves at the line terminations-Lattice Diagrams-Attenuation and Distortion.

UNIT-2:

Lightning, Switching and Temporary Overvoltages:

Lightning overvoltages: interaction between lightning and power system- ground wire voltage and voltage across insulator; switching overvoltage: Short line or kilometric fault, energizing transients - closing and re-closing of lines, methods of control; temporary overvoltages: line dropping, load rejection; voltage induced by fault; very fast transient overvoltage (VFTO).

UNIT-3:

Parameters and Modelling of Overhead Lines:

Review of line parameters for simple configurations: series resistance, inductance and shunt capacitance; bundle conductors: equivalent GMR and equivalent radius; modal propagation in transmission lines: modes of multi-phase transposed transmission lines, α-β-0 transformation and symmetrical components transformation, modal impedances; analysis of modes on untransposed lines; effect of ground return and skin effect; transposition schemes.

UNIT-4:

Parameters of Underground Cables:

Distinguishing features of underground cables: technical features, electrical parameters, cable types; series impedance and shunt admittance of single-core self-contained cables, impedance and admittance matrices for three phase system formed by three single-core self-contained cables; approximate formulas for cable parameters.

UNIT-5:

COMPUTATION OF POWER SYSTEM TRANSIENTS-EMTP:

Digital computation of line parameters: line parameter evaluation programs, salient features of multi-terminal line; constructional features that affect transmission line parameters; elimination of ground wires bundling of conductors; principle of digital computation of transients: features and capabilities of EMTP; steady state and time step solution modules: basic solution methods.

References:

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

2. Rakosh Das Begamudre, "Extra High Voltage AC Transmission Engineering", (Second edition) New age International (P) Ltd., New Delhi, 1990.
3. Naidu M S and Kamaraju V, "High Voltage Engineering", Tata McGraw-Hill Publishing Company Ltd., New Delhi, 2004.
4. Hermann W. Dommel, EMTP Theory Book, second Edition, Microtran Power System Analysis Corporation, Vancouver, British Columbia, Canada, May 1992, Last Update: April 1999.
5. EMTP Literature from www.microtran.com.
6. IV Begley, "Traveling waves in Transmission Systems", John Wiley (1933,51).
7. R. Rudenberg. "Electric Stroke waves in Power Systems", Harvard University Press, Cambridge, Massachusetts.
8. Allan Greenwood, "Electric Transients in Power Systems", Wiley Interscience.
9. CS Indulkar and DP Kothari, "Power System Transients, A Statistical Approach", Prentice-Hall of India Pvt Ltd., New Delhi. 110 001.
10. VA Venikov, "Transient phenomena in Electrical Power Systems", Pergamon Press, London.

CODE	KMPEE 0116/ KMPEE 0216/ KMPEE 0316	L	T	P
	SMART GRID DESIGN AND ANALYSIS	3	1	0

UNIT-1:
Smart Grid Architectural Designs:
Introduction, Comparison of Power grid with Smart grid, power system-communication and standards, General View of the Smart Grid Market Drivers, Stakeholder Roles and Function, Measures, Representative Architecture, Functions of Smart Grid Components, Wholesale energy market in smart grid, smart vehicles in smart grid.

UNIT-2:
Smart Grid Communications and Measurement Technology:
Communication and Measurement-Monitoring, Phasor Measurement Unit (PMU), Smart Meters, Wide area monitoring systems (WAMS), Advanced metering infrastructure, GIS and Google Mapping Tools.

UNIT-3:
Performance Analysis Tools for Smart Grid Design:
Introduction to Load Flow Studies, Challenges to Load Flow in Smart Grid and Weaknesses of the Present Load Flow Methods, Load Flow State of the Art: Classical, Extended Formulations, and Algorithms, Load flow for smart grid design, Contingencies studies for smart grid.

UNIT-4:
Stability Analysis Tools for Smart Grid:
Voltage Stability Analysis Tools, Voltage Stability Assessment Techniques, Voltage Stability Indexing-Application and Implementation Plan of Voltage Stability in smart grid-Angle stability

assessment in smart grid-Approach of smart grid to State Estimation-Energy management in smart grid.

UNIT-5:

Renewable Energy and Storage:

Renewable Energy Resources-Sustainable Energy Options for the Smart Grid-Penetration and Variability Issues Associated with Sustainable Energy Technology-Demand Response Issues-Electric Vehicles and Plug-in Hybrids-PHEV Technology-Environmental Implications-Storage Technologies-Grid integration issues of renewable energy sources.

References:

1. James Momoh, "Smart Grid: Fundamentals of design and analysis", John Wiley & sons Inc, IEEE press 2012.
2. Janaka Ekanayake, Nick Jenkins, Kithsiri Liyanage, Jianzhong Wu, Akihiko Yokoyama, "Smart Grid: Technology and Applications", John Wiley & sons Inc, 2012.
3. Fereidoon P. Sioshansi, "Smart Grid: Integrating Renewable, Distributed & Efficient Energy", Academic Press, 2012.
4. Clark W. Gellings, "The smart grid: Enabling energy efficiency and demand response", Fairmont Press Inc, 2009.

CODE	KMPEE 0117/ KMPEE 0217/ KMPEE 0317	L	T	P
	OPTIMIZATION TECHNIQUES	3	1	0

UNIT-1:

Fundamentals of Optimization:

Definition-Classification of optimization problems-Unconstrained and Constrained optimization-Optimality conditions-Classical Optimization techniques (Linear and non linear programming, Quadratic programming, Mixed integer programming).

UNIT-2:

Evolutionary Computation Techniques:

Evolution in nature, Fundamentals of Evolutionary algorithms, Working Principles of Genetic Algorithm, Evolutionary Strategy and Evolutionary Programming, Genetic Operators-Selection, Crossover and Mutation-Issues in GA implementation, GA based Economic Dispatch solution, Fuzzy Economic Dispatch including losses, Tabu search algorithm for unit commitment problem, GA for unit commitment, GA based Optimal power flow, GA based state estimation.

UNIT-3:

Particle Swarm Optimization:

Fundamental principle, Velocity Updating-Advanced operators, Parameter selection, Hybrid approaches (Hybrid of GA and PSO, Hybrid of EP and PSO), Binary, discrete and combinatorial

PSO-Implementation issues-Convergence issues, PSO based OPF problem and unit commitment-PSO for reactive power and voltage control-PSO for power system reliability and security.

UNIT-4:
Advanced Optimization Methods:
Simulated annealing algorithm-Tabu search algorithm-SA and TS for unit commitment-Ant colony optimization- Bacteria Foraging optimization.

UNIT-5:
Multi Objective Optimization:
Concept of Pareto optimality-Conventional approaches for MOOP-Multi objective GA-Fitness assignment-Sharing function-Economic Emission dispatch using MOGA-Multiobjective PSO (Dynamic neighbourhood PSO, Vector evaluated PSO)-Multiobjective OPF problem.

References:

1. D. P. Kothari and J. S. Dhillon, "Power System Optimization", 2nd Edition, PHI learning private limited, 2010.
2. Kalyanmoy Deb, "Multi objective optimization using Evolutionary Algorithms", John Wiley and Sons, 2008.
3. Kalyanmoy Deb, "Optimization for Engineering Design", Prentice hall of India first edition, 1988.
4. Carlos A. Coello Coello, Gary B. Lamont, David A. Van Veldhuizen, "Evolutionary Algorithms for solving Multi Objective Problems", 2nd Edition, Springer, 2007.
5. Soliman Abdel Hady, Abdel Aal Hassan Mantawy, "Modern optimization techniques with applications in Electric Power Systems", Springer, 2012.
6. Jizhong Zhu, "Optimization of power system operation", John Wiley and sons Inc publication, 2009.
7. Kwang Y. Lee, Mohammed A. El Sharkawi, "Modern heuristic optimization techniques", John Wiley and Sons, 2008.

CODE	KMPEE 0118/ KMPEE 0218/ KMPEE 0318	L	T	P
	POWER SYSTEM PLANNING AND RELIABILITY	3	1	0

UNIT-1:
Load Forecasting:
Objectives of forecasting-Load growth patterns and their importance in planning-Load forecasting Based on discounted multiple regression technique-Weather sensitive load forecasting, Determination of annual forecasting-Use of AI in load forecasting.

UNIT-2:

Generation System Reliability Analysis:

Probabilistic generation and load models- Determination of LOLP and expected value of demand not served –Determination of reliability of ISO and interconnected generation systems.

UNIT-3:

Transmission System Reliability Analysis:

Deterministic contingency analysis-probabilistic load flow-Fuzzy load flow probabilistic transmission system reliability analysis-Determination of reliability indices like LOLP and expected value of demand not served.

UNIT-4:

Expansion Planning:

Basic concepts on expansion planning-procedure followed for integrate transmission system planning, current practice in India-Capacitor placer problem in transmission system and radial distributions system.

UNIT-5:

Distribution System Planning Overview:

Introduction, sub transmission lines and distribution substations, Design of primary and secondary systems-distribution system protection and coordination of protective devices.

References:

1. Roy Billinton & Ronald N. Allan, "Reliability Evaluation of Power System", Springer Publication, 1986.
2. R.L. Sullivan, "Power System Planning", Tata McGraw Hill Publishing Company Ltd, 2012.
3. X. Wang & J.R. McDonald, "Modern Power System Planning", McGraw Hill Book Company, 1994.
4. T. Gonen, "Electrical Power Distribution Engineering", McGraw Hill Book Company, 1986.

CODE	KMPEE 0119/ KMPEE 0219/ KMPEE 0319	L	T	P
	ENERGY MANAGEMENT AND AUDITING	3	1	0

UNIT-1:

Introduction:

Need for energy management-energy basics-designing and starting an energy management program-energy accounting-energy monitoring, targeting and reporting- energy audit process.

UNIT-2:

Energy Cost and Load Management:

Important concepts in an economic analysis, economic models-time value of money-utility rate structures, cost of electricity-loss evaluation.

Load management: demand control techniques, utility monitoring and control system, energy management, economic justification.

UNIT-3:
Energy Management for Machines and Electrical Equipments:
Systems and equipment-electric motors-transformers and reactors-capacitors and synchronous machines.

UNIT-4:
Metering for Energy Management:
Relationships between parameters-Units of measure-typical cost factors-utility meters-timing of meter disc for kilowatt measurement-demand meters-paralleling of current transformers-instrument transformer burdens – multitasking solid-state meters-metering location vs. requirements metering techniques and practical examples.

UNIT-5:
Lighting Systems and Cogeneration:
Concept of lighting systems-the task and the working space-light sources-ballasts-luminaries-lighting controls-optimizing lighting energy-power factor and effect of harmonics on power quality-cost analysis techniques-lighting and energy standards.
Cogeneration: forms of cogeneration-feasibility of cogeneration.

References:

1. Eastop T. D. and Croft D. R., "Energy Efficiency for Engineers and Technologists", Logman Scientific & Technical, 1990.
2. Reay D. A., "Industrial Energy Conservation", first edition, Pergamon Press, 1977.
3. IEEE Recommended Practice for Energy Management in Industrial and Commercial Facilities, IEEE, 1996.
4. Amit K. Tyagi, "Handbook on Energy Audits and Management", TERI, 2003.
5. Barney L. Capehart, Wayne C. Turner, and William J. Kennedy, "Guide to Energy Management", Fifth Edition, The Fairmont Press, Inc., 2006.

CODE	KMPEE 0120/ KMPEE 0220/ KMPEE 0320	L	T	P
	POWER SYSTEMS RELIABILITY	3	1	0

UNIT-1:
Review of probability theory, probability laws, binomial, Poisson's, Normal Exponential, Gamma and Weibull distributions.
Markov processes (discrete state and continuous time), State transition matrix and state transition diagram.

UNIT-2:

Reliability definition, Hazard rate, General reliability function, Mean time to failure, mortality curve, reliability evaluation using state enumeration, tie set and cut set methods, reliability indices from state transition matrix and state transition diagram.

UNIT-3:

Models for generation system reliability evaluation, capacity outage probability, recursive algorithm, loss of load indices, load forecast uncertainty, loss of energy indices, frequency and duration methods, system risk indices.

UNIT-4:

Spinning capacity evaluation, load forecast uncertainty, derated capacity levels. Reliability evaluation of two area interconnected system. Conditional probability approach for evaluation reliability of a generation- transmission system.

UNIT-5:

Transmission system reliability evaluation using average interruption rate method and frequency and duration methods, Stormy and normal weather effects, Markov processes approach. Interruption indices for distribution systems and their evaluation for radial distribution systems. Introduction to protective system reliability evaluation.

References:

1. M. L. Shooman, "Probabilistic Reliability-An engineering approach", RK Pub. Co., Florida.
2. C. O. Smith, "Introduction to reliability in design", McGraw Hill, Tokyo.
3. R. Billinton, R. J Ringlee and A. J Wood, "Power System Reliability Calculations", MIT Press, Cambridge.
4. J. Eudrenyl, "Reliability modeling in electric power systems", John Wiley, NY.
5. C. Singh & R. Billinton, "System Reliability modeling and evaluation", Hutchisn London.
6. R. L Sullivan, "Power System Planning", McGraw Hill New York.

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

ELECTRICAL ENGINEERING

MASTER OF TECHNOLOGY (Part-Time)
(Solid State Control)

(With effective from: Session 2015-16)

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.	KMPEE 121	Fundamentals of Electric Drives	3	1	0	30	10	10	---	---	50	100	150
2.	KMPEE 122	Numerical Techniques & Simulation	3	0	2	15	10	05	10	10	50	100	150
3.	KMPEE 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.	KMPEE 221	Advanced Control System	3	1	0	30	10	10	---	---	50	100	150
2.	KMPEE 222	Power Semiconductor Controlled Electric Drives	3	0	3	15	10	05	10	10	50	100	150
3.	KMPEE 223	Advanced Microprocessor & Applications	3	1	0	30	10	10	---	---	50	100	150
		TOTAL	**9**	**2**	**3**						**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.	KMPEE 321	Power Converter Applications	3	1	---	30	10	10	---	---	50	100	150
2.	KMPEE 012	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.	KMPEE 022	Elective – II	3	1	---	30	10	10	---	---	50	100	150
2.	KMPEE 032	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.	KMPEE 521	State-of-Art Seminar	---	---	04	---	---	---	---	---	100	---	100
2.	KMPEE 522	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.	KMPEE 621	Dissertation (Phase – II)	---	---	12	---	---	---	---	---	100		200	300
		TOTAL	**---**	**---**	**12**						**100**		**200**	**300**

LIST OF ELECTIVES

MPEE 012 / KMPEE 022 / KMPEE 032 : ELECTIVE – I / ELECTIVE – II / ELECTIVE – III

KMPEE 0121 / KMPEE 0221 / KMPEE 0321 : Power Electronics for Renewable Energy Systems

KMPEE 0122 / KMPEE 0222 / KMPEE 0322 : Artificial Neural Networks & Fuzzy Systems

KMPEE 0123 / KMPEE 0223 / KMPEE 0323 : Power Electronics Applications in Power System

KMPEE 0124 / KMPEE 0224 / KMPEE 0324 : EHV AC & DC Transmission

KMPEE 0125 / KMPEE 0225 / KMPEE 0325 : Electrical Power Quality

KMPEE 0126 / KMPEE 0226 / KMPEE 0326 : Advanced Power Semiconductor Devices

KMPEE 0127 / KMPEE 0227 / KMPEE 0327 : Modeling and Simulation of Electrical Machines

CODE	KMPEE 121	L	T	P
	FUNDAMENTALS OF ELECTRIC DRIVES	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 system 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 ratings, 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, step 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 Subramanian, "Electric Drive: Concepts and Applications" Tata McGraw Hill, 1994.

CODE	KMPEE 122	L	T	P
	NUMERICAL TECHNIQUES & SIMULATION	3	0	2

UNIT-1:

Calculus of Finite Differences & Interpolation:

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:

Programming 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:

Programming Applications:

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:

Modeling & Simulation of Electrical Systems:

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; Sim Power Systems 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., "Sim Power Systems: 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	KMPEE 123	L	T	P
	POWER CONVERTERS	3	0	2

UNIT-1:

DC-DC Switched Mode Converters:

Review of Buck Converter, Boost Converter, Buck-Boost, Duty cycle derivation, Different conduction modes (CCM & DCM), Voltage and Current waveforms, Calculation of output voltage ripple.

UNIT-2:

Voltage Source Converters:

3-phase full wave bridge converter, operation and harmonics, Transformer connection for 12 pulse operation, 24 and 48 pulse operation. Operation of 12-pulse converter. 3-level voltage source converter. PWM converter. Generalised technique of harmonic elimination and voltage control. Advanced modulation techniques (SPWM, space vector modulation, 3rd harmonic PWM) Comparison of PWM techniques, Converter rating.

UNIT-3:

Self and Line Commutated Current Source Converter:

Basic concepts and principle of operation of CSC, converters with self commutating devices. Comparison with voltage source converter

UNIT-4:

Resonant Converters:

Switch-mode inductive current switching, Zero Voltage & Zero Current switching , Resonant switch converters, Basic resonant circuit concepts, Resonant switch converters, ZCS and ZVS resonant switch converters , Comparison of ZCS and ZVS topologies. Load resonant converters, resonant switch converters, resonant dc-link Converters, high-frequency-link integral half cycle converters.

UNIT-5:

Multilevel Converters:

Multilevel concept, Types of multilevel converters, diode clamped multilevel converters, flying-capacitors multilevel converters, cascaded multilevel converters, Vienna Converter, applications switching device currents, d. c. link capacitor voltage balancing, features of multilevel converters, comparison of multilevel converters.

References:

1. K. Kit Sum, "Switch-Mode Power Conversion: Basic theory and design", Marcel Decker.
2. G. Chryssis, "High Frequency Switching Power supplies: Theory and Design", Mc Graw Hill.
3. M. H. Rashid, "Power Electronics: Circuits, Devices and Applications", Prentice Hall of India, 1996.
4. N. Mohan, T. M. Underland and W. P. Robbins, "Power Converters, Applications and Design", John Wiley & Sons, 1995.
5. G. K. Dubey et al, "Thyristorized Power Controllers", Wiley Eastern, 1987.
6. B. R. Pelly, "Thyristor Phase Controlled Converters and Cyclo-converters", Wiley Intersicence, 1971.
7. M. D. Singh and K. B. Khanchandani, "Power Electronics", Tata McGraw Hill, 2001.
8. V. Subrahmanyam, "Power Electronics", New Age International Publishers, 1997.
9. D. Grahame Holmes, Thomas A. Lipo, T. A. Lipo "Pulse width modulation for power converters: principles and practice", Wiley-IEEE press, 2003.

CODE	KMPEE 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. K. Ogata, "Modern Control Engineering", John Wiley & Sons, 2001.
2. Norman S. Nise, "Control System Engineering", John Wiley & Sons, 2001.
3. Kuo B.C., "Digital Control Systems, "Saunders College Publishing, 1992.
4. M. Gopal, "Digital Control and State Variable Methods", Tata McGraw Hill, 1997.
5. I. J. Nagrath & M. Gopal, "Modern Control Engineering", New Age International, 2005.
6. S. M. Tripathi, "Modern Control Systems: An Introduction", Jones & Bartellet Publishers, USA, 2009.
7. M. Gopal, "Modern Control System Theory", Wiley Eastern, 1993.
8. K. Ogata, "Discrete Time Control System", Prentice Hall International, 1987.

CODE	KMPEE 222	L	T	P
	POWER SEMICONDUCTOR CONTROLLED ELECTRIC DRIVES	3	0	3

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 D. C. 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 A. C. 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 A.C. Motors", Pergamon Press, 1988.
3. S. B. Dewan & G.R. Slemon & 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. Krishan, "Electric Motor Drives Modeling, Analysis and Control", Prentice Hall International, 2002.

CODE	KMPEE 223	L	T	P
	ADVANCED MICROPROCESSORS AND APPLICATIONS	3	1	0

UNIT-1:

Introduction:

Review of basic microprocessor, Architecture and instruction set of a typical 8 bit microprocessor, Concepts of micro controller and micro computer, Micro controllers (8051/8751) based design, Applications of micro computer in on line real time control.

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 multiprocessing, Multi-user, Multitasking operating system concepts, Pentium I, II, III and IV processors, Motorola 68000 processor.

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 Rs. 232.

Programmable Support Chips:

Functional schematic, Operating modes, Programming and interfacing of 8255, 8251, 8259 and 253 with microprocessor

UNIT-4:

Control of Power Converters:

Control strategies and microprocessor based control schemes for line converters, AC voltage controllers, Cyclo-converters, Choppers and Bridge inverters.

UNIT-5:

Sensing and Processing of Feedback Signals:

Sensing of position, speed, current, torque for feedback purposes and signal conditioning, Synchronizing signals, Quantization, Digitalization, Filtering and implementation, Microprocessor in electric drive control, Selection criteria

References:

1. R.S. Gaonker, "Microprocessor Architecture, Programming and Application", Wiley Eastern Limited.
2. M.D. Singh and K.B. Khanchandani, "Power Electronics", Tata McGraw Hill, 2001.
3. B.K. Bose, "Power Electronics and Variable Frequency Drive", Standard Publishers Distributions, 2000.
4. D.V. Hall, "Microprocessors and Interfacing Programming and Software," McGraw Hill.

CODE	KMPEE 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-4:

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.

ELECTIVES

CODE	KMPEE 0121 / KMPEE 0221 / KMPEE 0321	L	T	P
	POWER ELECTRONICS FOR RENEWABLE ENERGY SYSTEMS	3	1	0

UNIT-1:

Introduction to Renewable Energy Sources:

Introduction, importance, classification and qualitative study of different renewable energy resources: Solar, Wind, Ocean, Biomass, Fuel cell, Hydrogen energy systems and Hybrid renewable energy systems,

UNIT-2:

Renewable Energy Converters:

Three-phase AC-DC-AC converters: uncontrolled rectifiers, PWM Inverters, Grid Interactive Inverters, matrix converters, Principle of operation: line commutated converters (inversion-mode), Boost and buck-boost converters

Electrical Machines

Review of reference theory fundamentals, Principle of operation and analysis: SCIG, PMSG, and DFIG.

UNIT-3:

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, Grid integrated PMSG and SCIG Based WECSs, Machine side & Grid side controllers, Grid connection Issues related to Wind Systems.

UNIT-4:

Solar Power Conversion Systems

Theory of solar cells, solar materials, solar cell power plant, limitations, Block diagram of solar photo-voltaic system, selection of inverter, battery sizing, array sizing, Grid Integrated solar system, Grid connection Issues related to solar systems.

UNIT-5:

Hybrid Renewable Energy Systems

Need for Hybrid Systems, Range and types of Hybrid systems, Wind-Diesel Hybrid System, Wind-Photovoltaic Hybrid Systems, Photovoltaic-Diesel Hybrid System, Case studies of Wind-PV Maximum Power Point Tracking (MPPT), Grid connection Issues related to hybrid systems.

References:

1. S. N. Bhadra, D. Kastha, S. Banerjee, Wind Electrical Systems, Oxford Press.

2. Rai G. D, “Non conventional energy sources”, Khanna publishes, 1993.
3. Rai G. D,” Solar energy utilization”, Khanna publishes, 1993.
4. Gray, L. Johnson, “Wind energy system”, prentice hall, 1995.
5. B. H. Khan, Non-conventional Energy sources, Tata McGraw-hill, New Delhi.
6. L. L.Freris “Wind Energy conversion Systems”, Prentice Hall, 1990
7. Ion Boldea, “Variable speed generators”, Taylor & Francis group, 2006.
8. E. W. Golding “The generation of Electricity by wind power”, Redwood burn Ltd., Trowbridge, 1976.
9. S. Heir “Grid Integration of WECS”, Wiley 1998.

CODE	KMPEE 0122 / KMPEE 0222 / KMPEE 0322	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 & Multilayer 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. Bose & 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	KMPEE 0123 / KMPEE 0223 / KMPEE 0323	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	KMPEE 0124 / KMPEE 0224 / KMPEE 0324	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	KMPEE 0125 / KMPEE 0225 / KMPEE 0325	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, 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. Dugan, 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	KMPEE 0126 / KMPEE 0226 / KMPEE 0326	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 Junction 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, circuit.

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. Khanchandani, "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	KMPEE 0127 / KMPEE 0227 / KMPEE 0327	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.

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Institute Vision

To be supplier of globally competitive professionally well qualified technical man power of world class standard for contributing need of the nation by evolving sustainable flexible and dynamic system responsive to as aspirants of the industry and to be resource centre for generation and dissemination of technology for the socio-economic development of the society.