KAMLA NEHRU INSTITUTE OF TECHNOLOGY, SULTANPUR

(An Autonomous Institute under Dr. A. P. J. Abdul Kalam Technical University, Lucknow)

ELECTRICAL ENGINEERING

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

(With effective from: Session 2016-17)

SEMESTER – III

Sr. No.	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 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								Subject Total
						Sessional Exam							End Semester Exam	
			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								Subject Total
						Sessional Exam							End Semester Exam	
			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 : Non-Conventional Energy Sources and Energy Converters

KMPEE 012 / KMPEE 022 / KMPEE 032 : Power Electronics for Renewable Energy Systems

KMPEE 013 / KMPEE 023 / KMPEE 033 : Artificial Neural Networks & Fuzzy Systems

KMPEE 014 / KMPEE 024 / KMPEE 034 : Power Electronics Applications in Power System

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

KMPEE 016 / KMPEE 026 / KMPEE 036 : EHV AC & DC Transmission

KMPEE 017 / KMPEE 027 / KMPEE 037 : Advanced Power Semiconductor Devices

KMPEE 018 / KMPEE 028 / KMPEE 038 : Modeling and Simulation of Electrical Machines

KMPEE 019 / KMPEE 029 / KMPEE 039 : Power Semiconductor Controlled Electric Drives

KMPEE 0110 / KMPEE 0210 / KMPEE 0310 : Power Converter Applications

KMPEE 0111 / KMPEE 0211 / KMPEE 0311 : Power System Dynamics

KMPEE 0112 / KMPEE 0212 / KMPEE 0312 : Deregulations of Power Systems

KMPEE 0113 / KMPEE 0213 / KMPEE 0313 : Power System Security

KMPEE 0114 / KMPEE 0214 / KMPEE 0314 : Distributed generation and Micro grid

KMPEE 0115 / KMPEE 0215/ KMPEE 0315 : Economic operation of Power Systems

KMPEE 0116 / KMPEE 0216 / KMPEE 0316 : Electrical transient in Power System,

KMPEE 0117 / KMPEE 0217 / KMPEE 0317 : Smart Grid Design and Analysis

KMPEE 0118 / KMPEE 0218/ KMPEE 0318 : Optimization Techniques

KMPEE 0119 / KMPEE 0219 / KMPEE 0319 : Power System Planning and Reliability

KMPEE 0120 / KMPEE 0220 / KMPEE 0320 : Energy Management and Auditing

KMPEE 0121 / KMPEE 0221 / KMPEE 0321 : Power System Reliability

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
	NON-CONVENTIONAL ENERGY SOURCES AND ENERGY CONVERTERS	3	1	0

UNIT-1:
Introduction:
Various non-conventional and renewable energy resources – introduction, importance, classification, main features, relative merits & demerits; Energy System, Energy Conservation, Prospects and potential, Indian energy scenario.

UNIT-2:
Solar Power Conversion Systems and Solar Thermal Energy:
Solar radiation, Flat plate collectors, their applications and performance, Focusing collectors, their applications and performance, Theory of solar cells, Solar cell materials, Photo-voltaic energy conversion, Solar cell power plant, Limitations, Solar thermal power plants, Thermal energy storage for solar heating & cooling and their limitations.

UNIT-3:
Magneto-hydrodynamics (MHD):
Working principle, MHD configurations, Open-cycle fossil fuelled and closed cycle nuclear fuelled MHD power plant, Practical problems associated with MHD power generation, Performance limitations and applications.
Fuel Cells:
Working principle, Various types of fuel cells, Hydrogen-oxygen fuel cell, Gibbs-Helmholtz theory, Performance, limitations and applications. Thermo-electrical and Thermionic Conversions Working principle, Performance and limitations.

UNIT-4:
Wind Energy and Wind Power Conversion Systems:
Wind power and its sources; Wind characteristics, Wind power generator, Performance and limitations. Stand-alone operation of fixed and variable-speed wind energy conversion systems.
Geothermal Energy:
Sources of geothermal energy, Thermodynamics of Geo-thermal energy – electrical conversion & non-electrical conversion, Total flow system, Environmental considerations & applications.

UNIT-5:
Bio-mass:
Availability, Bio-mass and its conversion theory, Bio-gas power generator.
Ocean Thermal Energy Conversion (OTEC):
Availability, Working principle, Performance and limitations.

Tidal Energy:
Principle of energy conversion, Single-basin and Double-basin systems of power generation, Performance and limitations.
Power Generation from Refuse:
Typical dustbin composition, Potential, Power generation from refuse, Limitations, Waste recycling.

References:

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

CODE	KMPEE 012 / KMPEE 022 / KMPEE 032	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, and 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 013 / KMPEE 023 / KMPEE 033	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 014 / KMPEE 024 / KMPEE 034	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 015 / KMPEE 025/ KMPEE 035	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 016 / KMPEE 026 / KMPEE 036	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 017 / KMPEE 027 / KMPEE 037	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 018 / KMPEE 028/ KMPEE 038	L	T	P
	MODELING AND SIMULATION OF ELECTRICAL	3	1	0

MACHINES

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 019 / KMPEE 029/ KMPEE 039	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 0110/ KMPEE 0210/ KMPEE 0310	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 0111/ KMPEE 0211/ KMPEE 0311	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 0112/ KMPEE 0212/ KMPEE 0312	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 0113/ KMPEE 0213/ KMPEE 0313	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 0114/ KMPEE 0214/ KMPEE 0314	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 0115/ KMPEE 0215/ KMPEE 0315	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 0116/ KMPEE 0216/ KMPEE 0316	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 0117/ KMPEE 0217/ KMPEE 0317	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 0118/ KMPEE 0218/ KMPEE 0318	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 0119/ KMPEE 0219/ KMPEE 0319	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 0120/ KMPEE 0220/ KMPEE 0320	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 0121/ KMPEE 0221/ KMPEE 0321	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.