

DEPARTMENT OF ELECTRICAL ENGINEERING
ZHCET, AMU, Aligarh

Syllabi of M. Tech. (Electrical)
(PS & Drives and Inst. & Control)

AM-621N MATHEMATICS

Probability – Set Operations, Definition and Axioms, Joint and Conditional Probability, Independent Events; Random Variables – Distribution and Density functions, Operations; Random Processes – Stationarity and independence, Correlation Functions; Time frequency analysis; Short-time Fourier transform, Wigner-Ville transform; Wavelet transform – Continuous and Discrete; Multi-resolution analysis. Application of wavelets; Finite Difference, Steady State and Boundary Value Problems, Iterative methods for sparse linear systems

Books:

- 1 Peyton Z. Peebles Jr. Probability, Random Variables and random Signal Principles, 4th edition, Tata McGraw Hill, New Delhi, 2010
- 2 George R. Cooper and Clare D. McGillem Probabilistic Methods of Signal and System Analysis, Oxford University Press, 2007.
- 3 Y.T. Chan Wavelet Basics, Kluwer Publishers, 1993
- 4 K. P. Soman, K. I. Ramachandran, N. G. Resmi Insight into Wavelets: From Theory to Practice, 3rd ed. PHI, 2010
- 4 I. Daubechies Ten Lectures on Wavelets, Society for Industrial and Applied Mathematics, Philadelphia, PA, 1992.
- 5 R. J. Le Veque Finite Difference Methods for Ordinary and Partial Differential Equations: Steady-State and Time Dependent Problems, SIAM .

EE-601 MEASUREMENT & CONTROL

Measurement:

Transducers, different types of Transducers, Transducers Characteristics, Selection of an Instrumentation Transducers. Digital Transducers, Measurement using laser, Measurement using ultrasonic waves, Measurement using radiation technique, Measurement using vacuum technique, Microprocessor based Instrumentation system.

Control:

Transfer function, Transfer function for Mechanical System Control System Components, Signal flow Graph with Problems, Transient response of feedback control systems, Transient response of second order system, Steady State response and steady state Error, Problems, Stability: Routh criterion, Polar plots and bode plots, Niquist criterion, Controllers: Hydraulic and Pnematic Controllers.

Books:

1.	D. Patranabis	Principle of Industrial Instrumentation, (TMH)
2.	B.C. Kuo	Automatic Control System
3.	M.Sayer& A. Mansingh	Measurement, Instrumentation and Experiment Design in Physic and Engineering, (PHI)

EE-611 ADVANCE ELECTRIC DRIVES-I

DC Motor Drives:-

Characteristics of different dc motors: their speed control and braking operations: Converter fed dc motor drives: Analysis for motoring and braking operations; Dynamic modeling of dc motor drives; Closed-loop control; Dual converter fed dc motor drives; MATLAB simulation.

Permanent magnet dc motor drives; Solar power driven dc motor drives and their control.

Synchronous Motor Drives:-

Equivalent circuit, motoring and braking operations, Operations with non-sinusoidal power supplies; Speed control; Self-controlled synchronous motor drives.

Permanent magnet ac motor drives; LCI fed synchronous motor drives.

Switched and Synchronous reluctance motor drives.

Books:

1.	B.K. Bose	“Power Electronics and Motor Drives - Advances and Trends” IEEE Press, 2006.
2.	G.K. Dubey	“Power semiconductor controlled drives” Prentice-HALL 1989
3.	R. Krishnan	“Electric Motor Drives”, , Modeling, Analysis and Control”, Prentice Hall of India, 2002.
4.	Bin Wu	“High Power Converters and AC Drives”IEEE Press, A John Wiley and Sons, Inc., 2006.
5.	A. Buxbaum	Schierau and K. Staughen, “A design of control systems for DC drives”, Springer- Verlag, Berlin, 1990.
6.	W. Leonard	“Control of Electric Drives” Springer Verlag, NY, 1985
7.	B.K. Bose,	“Microcomputer control of power electronics and drives”, IEEE Press, 1987.
8.	B.K. Bose,	“Adjustable Speed A.C. drives”, IEEE Press, 1993.

EE-612 ADVANCE ELECTRIC DRIVES-II

Induction Motor Drives:-

Equivalent circuit; Performance under motoring and braking operations; Speed control methods and their analysis: voltage control, (V/f) control, static-rotor resistance control. FOC of IM: configurations, mathematical modeling, direct and indirect methods, VSI- and CSI- based schemes.

Slip-power recovery schemes: static Scherbius and Kramer drives.

Doubly-fed IM drives.

Books :

1.	B.K. Bose	“Power Electronics and Motor Drives - Advances and Trends” IEEE Press, 2006.
2.	G.K. Dubey	“Power semiconductor controlled drives” Prentice-HALL 1989
3.	R. Krishnan	“Electric Motor Drives”, , Modeling, Analysis and Control”, Prentice Hall of India, 2002.
4.	Bin Wu	“High Power Converters and AC Drives”IEEE Press, A John Wiley and Sons, Inc., 2006.
5.	A. Buxbaum	Schierau and K. Staughen, “A design of control systems for DC drives”, Springer- Verlag, Berlin, 1990.
6.	W. Leonard	“Control of Electric Drives” Springer Verlag, NY, 1985
7.	B.K. Bose,	“Microcomputer control of power electronics and drives”, IEEE Press, 1987.
8.	B.K. Bose,	“Adjustable Speed A.C. drives”, IEEE Press, 1993.

EE-613 DYNAMIC ANALYSIS OF ELECTRICAL MACHINES

Electromechanical Energy conversion: Flux, reluctance, flux linkages and inductance. Energy balances relationships, energy in coupling field, mechanical energy and torque in linear single **D.C. Machines:** and doubly excited electromechanical systems.

Voltage and torque equations, time domain block diagrams and state equations, transfer function and characteristic equations. Solution of dynamic characteristics for step change in voltage and torque.

Theory of Reference Frames: Types of reference frames, transformation of stationary circuit variables to arbitrary reference frame, advantages of transformation. Transformation between reference frames.

Symmetrical Two and Three phase Induction Machines : Voltage equations, winding inductance and torque in machine variables. Analysis in stationary reference frames. Dynamic and steady-state performance.

Two and three phase synchronous Machines : Voltage equations, winding inductance and torque in machine variables. Analysis in Rotor reference frame. Dynamic and steady-state performance. Unbalanced operation of induction and synchronous machines.

Books:

1.	Krause, Paul C.,	Analysis of Electric Machinery, McGraw Hill.
2.	Krause Paul C. Wasynczukoleg,	Electromechanical Motion Devices, McGraw Hill.

EE-617 HIGH PERFORMANCE AC DRIVES

Direct torque control and sensor less control of Induction machine. DTC control strategy, sensor less control. Control of Permanent magnet Machine: Modeling of PMSM and BLDC, Drive operation with inverter, Operating modes, direct torque control and sensor less control.

Switched reluctance motor drives: Construction and design of SR motor, converter for SR machine, General purpose SRM drive, Direct torque control. Control of multiphase ac drives: modeling of five –phase motor (induction and PM), Five phase inverters.

Books:

1.	Mukhtar Ahmad	High performance AC drives, modeling analysis and control Springer Verlag 2010.
2.	R Krishnan	Electric motor drives, modeling analysis and control, Prentice Hall 2001
3.	R Krishnan	Switched Reluctance motion drives CRC press 2001

EE-618 HYBRID ELECTRIC VEHICLES

Electrical vehicle systems: Configurations, requirements, circuit topology, electrical-mechanical system, energy storage systems. Internal-combustion engine characteristics.

Automotive power systems: Advanced motor drives for vehicular applications, multi-converter vehicular power electronic systems, constant power loads, negative impedance instability and control, ac/ dc vehicular power systems,

Hybrid electrical vehicle systems: Configurations, requirements, advance energy storage systems. Fuel-cell based power generation, hydrogen combustion characteristics, flashback control techniques, safety aspects and system development, performance in HEV and P-HEV systems.

Gas & liquid fuel systems: Bio-gas, producer gas & their characteristics, system development for engine application, LPG & LNG and their fuel supply system, emission studies and control.

Ethanol & methanol, fuel composition, fuel Induction techniques, applications to engines and automotive conversions, biodiesel formulation techniques, application in diesel engines, di-methyl ether, properties, fuel supply system, emission studies and control.

Energy Storage Systems: Energy storage systems, different battery systems and battery charging, system planning, operating features and performance calculations, selected topics.

Books:

1.	A. Emadi, M. Ehsani& J.M. Miller	Vehicle Electric Power Systems, Marcel Dekker Inc. New York.
2.	D.P. Kothari	Renewable Energy Sources & Emerging Technologies, PHI Learning, N.Delhi
3.	R.D. MiddleBrook& S.M. Cuk	Advances in Switched Mode Power Conversion, Vol. I, II and III; Teslaco, Pasadema.
4.	N. Mohan	Power Electronics; Principles, Analysis and Design, John Wiley.
5.	Pressman	Switching Power Supply Designs, Mc-Graw Hill Intl.

EE-621 ADVANCE POWER ELECTRONICS

Switch-Mode Inverters:

Basic concepts of VSI, single phase half bridge, full bridge and three phase bridge inverters, PWM modulation strategies, Sinusoidal PWM, Space vector modulation, Selective Harmonic Elimination method, Other inverter switching schemes, blanking time, Current source inverters.

Multi Level Inverter:

Need for multilevel inverters, Three level and four level inverter operation and analysis. N level inverter topology Applications of multilevel inverters and control. Four leg inverters.

Resonant Converters:

Basic resonant circuit concepts, Load resonant converters, series and parallel loaded, Resonant switch converters - ZVS, ZCS, comparison of resonant converters.

Miscellaneous Converters:

Synchronous rectifiers, matrix converters, multilevel converters topologies.

Books:

1.	Ned Mohan et al	“Power Electronics” John Wiley (SEA), 3 rd Ed
2.	M. H. Rashid	“Power Electronics” PHI Learning
3.	G. K. Dubey et al	“Power Semi Conductor Controllers” Wiley Eastern
4.	R W Erickson and D Maksimovic	“Fundamental of Power Electronics” Springer, 2 nd Edition
5.	M.H.Rashid	“Hand book of Power Electronics”, Academic Press, 2001
6.	Joseph Vithayathil	“Power Electronics”, Tata McGraw Hill

EE-623 DIRECT ENERGY CONVERSION

Conventional Energy Sources-Global & National Energy Scenarios, Environmental Aspects and Global Warming, Classification of Renewable Energy Sources, Solar Technology and Applications, Photo Electrochemical Conversion of Solar Energy, Mini, Micro and Pico Hydro Plants, Ocean Wave, Tidal and Ocean Thermal Energy Conversion, Magneto Hydrodynamic Power Generation, Environmental Aspects and Efficiency enhancement, Liquid Metal MHD, Thermoelectric and Thermionic Converters.

Books:

1.	Reddy	Solar Power Generation Technology, New Concepts & Policy
2.	T .Abbasi& S.A. Abbasi	Renewable Energy Sources Their Impact On Global Warming
3.	Rowe	Thermoelectrics And Its Energy Harvesting, 2 Volume Set
4.		Research Papers And Internet Search

EE-624 ENERGY AUDITING AND MANAGEMENT

Energy Auditing: Definition, Energy Audit, need and types of energy audit. Energy audit approach, understanding energy costs, bench marking, matching energy use to requirement, optimizing the input energy requirements, energy substitution, energy audit instruments.

Energy Management; Energy Action Planning: Key elements, Energy policy purpose, perspective, contents, formulation and ratification. Energy Monitoring and targeting, data and information- analysis, techniques- energy consumption, production, cumulative sum of differences (CUSUM).Measurements and verification.Energy auditing case studies.

Books:

1.	Amit Kumar Tyagi	Handbook on Energy Audits and Management, TERI.
2.		Bureau of Energy Efficiency (BEE) Study material for Energy Managers and Auditors Book-1: General Aspects of Energy management & Energy Audit.
3.		BEE Study material for Energy Managers and Auditors Book-2: Energy Efficiency in Thermal Utilities.
4.		BEE Study material for Energy Managers and Auditors Book-3: Energy Efficiency in Electrical Utilities.
5.		BEE Study material for Energy Managers and Auditors Book-4: Energy Performance Assessment for equipment and Utility systems.
6.	Dale R. Patrick et al	Energy conservation guide book, 2 nd edition, CRC Press
7.		Research papers and Internet search.

EE-625 WIND AND SHP SYSTEMS

Wind Energy Systems: Introduction, basic laws and concepts of aerodynamics, general theories of wind machines, description and performance of the horizontal - axis wind machines, site analysis and selection.

Wind Power Generating Systems: Wind electrical power generating systems and their characteristics, turbine control systems-pitch & stall, electrical generation systems - PM generators, induction generators including doubly fed systems and their control, selected topics.

Small Hydro Systems: Overview of micro, mini and small hydro, site selection and civil works, penstocks and turbines, speed and voltage regulation, selected topics.

Hybrid Renewable Energy Systems: Wind and solar hybrid stand-alone power systems, control of hybrid power systems with and without grid connection, hybrid and distributed generation-solar PV, wind, SHP, DG and their combinations, zero-grid power buildings, selected topics.

Energy Storage Systems: Energy storage systems, different battery systems and battery charging, system planning, operating features and performance calculations, selected topics.

Books:

1.	B.H. Khan	Non-Conventional Energy Sources, TMH, New Delhi.
2.	Bhadra, Kestha & Banerjee	Wind Electrical Systems, Oxford University Press, New Delhi
3.	M.R. Patel	Wind & Solar Power Systems, Taylor & Francis, Boca Raton
4.	G. Boyle	Renewable Energy Systems, Oxford University Press, New Delhi
5.	D.P. Kothari	Renewable Energy Sources & Emerging Technologies, PHI Learning, New Delhi

EE 626

DISTRIBUTED POWER GENERATION SYSTEMS

Renewable Energy Power Systems: Development of renewable energy systems-solar thermal, solar PV, wind, small hydro-power, bio-fuel & bio-waste, gassifiers, tidal, geo-thermal, their merits & demerits, reliability, need of cogeneration.

Hybrid Co-generation: Solar PV, wind, SHP, DG and their combinations; PV, wind and hydro based stand-alone hybrid power systems, control of hybrid power systems with and without grid connection, system planning, operating features and performance, zero-energy buildings.

Wind and DG stand-alone hybrid power systems, control of hybrid power systems with and without grid connection.

Power electronic systems: Grid interactive systems, grid tied systems, inverters, FACTS and application of its devices, smart homes, power management and smart grid, intelligent metering.

Energy Storage Systems: Energy storage systems, different battery systems and battery charging, system planning, operating features and performance calculations, selected topics.

Books:

1.	B.H. Khan	Non-Conventional Energy Sources, TMH, New Delhi.
2.	R. M. Mathur & R. K. Verma,	Thyristor-based FACTS Controller for Electrical Transmission system, IEEE Press/ John Wiley & Sons, New York.
3.	N.G. Hingorani & L. Gyugyi Understanding FACTS, IEEE Press, New York.	Understanding FACTS, IEEE Press, New York.
4.	L. Freris & D. Infield	Renewable Energy in Power Systems, John Wiley & Sons, Singapore.
5.	G. Boyle	Renewable Energy Systems, Oxford University Press, New Delhi.
6.	D.P. Kothari	Renewable Energy Sources & Emerging Technologies, PHI Learning, New Delhi.
7.	Bhadra, Kestha & Banerjee	Wind Electrical Systems, Oxford University Press, New Delhi.
8.	M.R. Patel	Wind & Solar Power Systems, Taylor & Francis

EE-627 PE CIRCUITS MODELLING AND SIMULATION

Principles of steady state converter analysis: circuit modeling, losses and efficiency, Converter dynamics and control, state space averaging, circuit averaging and average switch model with example of a converter, converter transfer functions, controller design.

Review of non-linear circuit simulation, methods of transient simulation, Dynamic performance of switched mode power converters, closed loop control of power converters.

Books:

1.	Ned Mohan et al	“Power Electronics” John Wiley (SEA), 3 rd Ed
2.	Robert W Erickson et al	“Fundamental of Power Electronics” 2 nd edition Kluwer Academic Publishers, USA, 2001
3.	M. B. Patil et al	“Simulation of Power Electronic Circuits” Narosa Publishing House, 2009

EE-628 SOLAR ENERGY CONVERSION

Solar radiation – Review, Models for radiation analysis and beam radiation calculations, Solar concentrators, Tracking mechanisms: single axis and double axis tracking, Solar thermal technologies, Material and product/technology overview, Emerging technologies, solar thermal power plants.

Solar PV technologies overview - stationary and concentrated PV, inverter and control technologies, master slave inverter system design, standalone systems, grid connected systems, hybridization, synchronization and power evacuation, Techno-economic analysis of solar thermal and solar PV power plants, Environmental considerations, GHG calculations, Jawaharlal Nehru National Solar Mission

Books:

1. VVN Kishore (Edited) Renewable Energy Engineering and Technology, TERI Press, 2008
2. C. S. Solanki Solar Photovoltaics – Fundamentals, Technologies and Applications (PHI Learning)
3. JA Duffie and WA Beckman Solar Engineering of Thermal Processes, Third Edition (John Wiley & Sons)
4. S Sukhatme and J Nayak Solar Energy: Principles of Thermal Collection and Storage, Third Edition (Tata McGraw Hill, 2008)
5. Softwares TRNSYS, RETScreen, Solar advisor

EE- 631 POWER APPARATUS AND SYSTEM MODELLING

Modeling of synchronous generator: Introduction, Park’s transformation, dqo variables; modeling of synchronous generator with damper windings; Modeling of transformers, transmission lines and loads; Modeling of Governors for Thermal and Hydro power systems; Modeling of Excitation systems.

Books:

1.	A.A. Foud & P.M. Anderson	Power System Stability and Control, Vol. F. Latest Indian Edition, Galgotia Press, New Delhi.
2.	L.P. Singh	P.S. Analysis & Dynamics, Wiley Eastern, Delhi.
3.	P. Kundur	Power System Stability and Control, Mc-Graw Hill.
4.	K.R. Padiyar	Power System Dynamics: Stability and Control, John Wiley & Sons.

EE-631N POWER SYSTEM STATE ESTIMATION

Weighted least square state estimation, Network observability analysis, bad data detection and estimation, Robust state estimation, Network parameter estimation, Synchronized phasor measurements, application of ampere measurement for state estimation

Books:

1.	Mukhtar Ahmad,	Power System State Estimation Artech House 2012
2.	A Abur, and A Gomez,	Power system state estimation, theory and implementation CRC press 2004
3.	A. Monticelly	State estimation in electric power systems:a generalized approach” Springer

EE-632 POWER SYSTEM ANALYSIS

Algorithms for the formation of bus admittance and impedance matrices. Power flow solutions: Gauss-Seidel, Newton-Raphson, decoupled and fast decoupled techniques. Optimal load flow. Three-phase Y_{BUS} and Z_{BUS} matrices, short circuit studies using three-phase Z_{BUS} . Contingency and security studies. Modern energy control centres and introduction to SCADA in power systems.

Books :

1.	G.W. Stagg & A.H. Al-Abiad	Computer Methods in Power Systems, Mc - Graw Hill
2.	Haadi Sadat	Power System Analysis. TMH, India
3.	M.A. Pai	Computer Techniques in Power System Analysis, Tata McGraw Hill, N. Delhi

EE-632N SMART GRID

Introduction to Smart Grid, Smart Grid features and functions, Smart Grid Architecture, Distributed Generation, Electric and plug-in hybrid Vehicles, Communication and measurement in smart grid, SynchroPhasor Measurement Units (PMUs) in smart grid, Interoperability and standards, Worldwide developments and case studies, Smart Grid maturity model, Indian Smart Grid

Books:

1.	James Momoh	Smart Grid: Fundamentals of Design and Analysis, Wiley, IEEE Press, 2012.
2.		Publications of IEEE Power and Energy Society

EE-633POWER SYSTEM STABILITY

Power System Stability: Basic concepts of angular and voltage stability.

Angular stability: Analysis of single machine and multi-machine systems for transient stability – digital simulation and energy function methods. Small signal stability (dynamic stability) – modeling for single machine and multi-machine systems. Eigen value and time domain analysis. Mitigation using power system stabilizer and FACTS controllers. Introduction to sub synchronous resonance.

Voltage stability: P-V and Q-V curves, static analysis, sensitivity and continuation method. Dynamic analysis.

Books :

1.	P. Kundur	Power System Stability and Control, Mc - Graw Hill.
2.	K. R. Padiyar	Power System Dynamics, Stability & Control, Interline Publishers, Bangalore.
3.	P. Saur and M. A. Pai	Power System Dynamics & Stability, Prentice Hall
4.	G.W. Stagg & A.H. Al-Abiad	Computer Methods in Power System, Mc - Graw Hill.

EE-633N POWER QUALITY

Electric power quality phenomena- IEC and IEEE definitions - power quality disturbances-voltage fluctuations-transients-unbalance-waveform distortion power frequency variations. Voltage variations, Voltage sags and short interruptions – flicker, longer duration variations - sources – range and impact on sensitive circuits-standards – solutions and mitigations – equipment and techniques. Transients – origin and classifications – capacitor switching transient – lightning-load switching – impact on users – protection – mitigation. Harmonics – sources – definitions & standards – impacts - calculation and simulation – harmonic power flow - mitigation and control techniques – filtering – passive and active. Power Quality conditioners – shunt and series compensators-DStatcom-Dynamic voltage restorer-unified power quality conditioners-case studies.

Books:

1.	Heydt, G.T.	Electric Power Quality, Stars in a Circle Publications, Indiana, 2nd edition 1994.
2.	Bollen, M.H.J.	Understanding Power Quality Problems: Voltage sags and interruptions IEEE Press, New York, 2000.
3.	Arrillaga, J, Watson, N.R., Chen, S.	Power System Quality Assessment, Wiley, New York, 2000.

EE-634POWER SYSTEM OPERATION AND CONTROL

Economic dispatch studies, development of loss formula, optimal power flow. Optimum scheduling of hydro-thermal power systems; short range and long range scheduling. Control of voltage, frequency and tie-line power flows, Q-V and P-f control loops. Mechanism of real and reactive power control. Single and multi-area AGC. Net interchange tie-line bias control. Optimal, sub-optimal and decentralized controllers. Online computer control. Data acquisition systems. Emergency control, preventive control, system wide optimization, SCADA.

Books :

1.	Haadi Sadat	Power System Analysis. TMH, India
2.	O.I. Elgerd	Elect. Energy Systems - An Introduction, Mc- Graw Hill.
3.	R.N. Dhar	Computer Aided P.S. Operation and Analysis.

EE-634N POWER SYSTEM RESTRUCTURING AND DEREGULATION

Fundamentals of restructured system, Market Architecture, Load Elasticity, Social welfare maximization, OPF: Role in vertically integrated systems and in restructured markets, Congestion Management, Optimal Bidding, Risk assessment and Hedging, Transmission Pricing and Tracing of power, Ancillary Services, Standard Market Design, Distributed Generation in restructured markets, Developments in India, IT applications in restructured markets, Working of restructured power systems : PJM.

Books:

1.	Lorrin Philipson & H. Lee Willis	Understanding electric utilities and de-regulation, Marcel Dekker Pub., 1998
2.	Steven Stoft	Power system economics: designing markets for electricity, Jhon Wiley & Sons. 2002
3.	Kankar Bhattacharya, Jaap E. Daadler & Math H.J. Boolean	Operation of restructured power systems, Kluwer Academic Pub., 2001
4.	Mohammad Shahidehpour & Muwaffaq Alomoush,	Restructured electrical power systems: operation, trading and volatility, Marcel Dekker Pub., 2001

EE-635N MODERN PS PROTECTION TECHNIQUES

Review of principles of power system protection, protection of reactors and capacitors, rectifiers and thyristors, HVDC protection, special characteristics of relays, carrier current protection, relay test bench: static and dynamic testing, computer aided relaying, digital signal processing aspects, relay coordination, numerical relaying algorithms, introduction to adaptive relaying.

Books:

1.	S.P. Patra, S.K. Basu & S. Chowdhury	Power System Protection, Oxford/IBH Publication.
2.	B. Ram & D.N. Vishwakarma	Power System Protection & Switchgear, TMH.
	A.R. Vane Warrinton (Vol. I & II)	Protective Relays Their Theory & Practice, Chapman & Hall.
3.	L.P. Singh	Digital Protection Wiley Eastern Ltd.
4.	J.L. Blackburn	Protective Relaying and Application, Marcel Dekker, New York

EE-636N POWER SYSTEM PLANNING AND RELIABILITY

Load Forecasting: Introduction, Classification of Load, Load Growth Characteristics, Peak Load Forecasting, Extrapolation and Co-Relation methods of load Forecasting, Energy Forecasting, Reactive Load Forecasting, and Impact of weather and factors affecting load Forecasting, Annual, Monthly and Total Forecasting.

System Planning: Objectives and Factors affecting to System Planning, Short, Medium and Long Term Planning, Reactive Power Planning.

Generation and Transmission planning: Objectives of generation planning, Factors affecting Generation Planning, Objectives of transmission planning Network Reconfiguration,

Power System Reliability: Concepts, terms and definitions, outage, failure rate, and outage rate availability, unavailability, Reliability models. Reliability function, mean time to failure, Hazard rate function.

Reliability of Systems: Serial and parallel configuration. Combined series and parallel systems, System structure factation, minimal cuts and minimal paths.

Generating Capacity: Basic probability methods and frequency and duration method: Introduction, Generation system model, capacity outage probability table, recursive algorithm, Evaluation of: loss of load indices, Loss of load expectation, Loss of energy

Composite generation and transmission system:Data requirement, system and load point indices, Impact of component outage on the system reliability, application to simple system.

Books:

1.	Roy Billinton& R.N. Allan	Reliability Evaluation of Power System; Plenum Press.
2.	R.L. Sullivan	Power System Planning; Tata McGraw Hill.
3.	Mahalanabis, Ahson& Kothari	Computer Aided P.S. Analysis & Control, Tata McGraw Hill.
4.	X. Wang & J.R. McDonald	Modern Power System Planning; McGraw Hill.

EE-638N FACTS DEVICES

Concept of power flow and stability; Basic theory of line compensation; Line compensation by passive type of reactive power compensators: TCR, TSC, FC-TCR, TSC-TCR and Series capacitor; Active type compensators and FACTS Devices: STATCOM, TCSC, GCSC, SSSC, UPSC, IPFC, TCVR and TCPAR.

Load compensation: Passive load compensation; Application of DSTACOM, DVR and UPQC in Distribution system, Custom power based equipments.

Books:

1.	N.G. Hingorani and L. Gyugyi	“Understanding FACTS”, IEEE Press, New York.
2.	R.MohanMathur and Rajiv K. Varma, “Thyristor	Based FACTS Controller for Electrical Transmission System”, IEEE Press, John Wiley and Sons. 2002.
3.	K.R. Padiyar	FACTS Controllers in Power Transmission and Distribution”New Age International, 2009.
4.	R.M. Mathur (Edited)	“Static Compensators for Reactive Power Control” ContextPublication, Winnipeg, 1984.
5.	T.J.E. Miller	“Reactive Power Control in Power System, John Wiley and Sons. 1982.

EE-639N HVDC POWER TRANSMISSION

HVDC Transmission: Review of basic concepts, comparative advantages over HVAC. System control, voltage stability with HVDC links. Multi-terminal DC systems types, control and applications, power flow analysis in AC/DC system.Flexible AC transmission (FACTS) technology. FACTS devices and controllers: SVC, STATCOM, TCSC, TCPAR, UPFC. Modeling of FACTS Controllers; System static performance improvement with FACTS controllers.

Books :

1.	K.R. Padiyar	HVDC Power Transmission Systems Technology and System Interaction; Wiley Eastern.
2.	N.G. Hingorani& L.I. Gyugyo	Understanding FACTS: Concepts and Technology of Flexible AC Transmission systems; Standard Pub.
3.	C.W. Taylor	Power System Voltage Stability; McGraw Hill

EE-641 OPTIMAL CONTROL SYSTEMS

Introduction: Problem formulation, system representation, various constraints, performance criterion. Optimization through calculus of variation - Unconstraint and constraint minimization problems, Hamilton formulation and Bolza Problems, Linear quadratic regulator problem, Maximum principle and its application, Dynamic programming techniques, Computational methods of optimization.

Books :

1.	Ian McCausland	Introduction to Optimal Control, John Wiley.
2.	Donald E. Kirk	Optimal Control Theory - An Introduction, Prentice Hall
3.	A.P. Sage	Optimal System Control, Prentice Hall.
4.	H. Kwakernaak, E.R. Siwan	Linear Optimal Control System, Wiley, N.Y.
5.	M.Gopal	Modern Control System Theory, Wiley Eastern, N. Delhi 1984.

EE-642 IDENTIFICATION AND ESTIMATION

Identification and Estimation in Dynamic System Analysis, Identification- Parametric and Non Parametric, Parameter Estimation, Probability Concepts in Estimation, Accuracy of Estimation, Least Square and Maximum Likelihood Estimation, Kalman Filter and Extended Kalman Filter, Estimation in optimal Control, Applications.

Books:

1.	Adriaan van den Bos	Parameter Estimation for Scientists and Engineers Wiley-Interscience, 2007
2.	John L. Crassidis, John L. Junkins	Optimal Estimation of Dynamic Systems, CRC Press, 2004
3.	Rolf Isermann · Marco Munchhof	Identification of Dynamic Systems, Springer-Verlag, 2011

EE-644N STOCHASTIC PROCESSES

Probabilistic concepts; Random variables; Random Processes – Temporal and Spectral Characteristics; Power density spectrum and its properties; Stochastic models; Filtering and Prediction – Filter Structures, Wiener Filters, Stochastic Models, Minimum mean square error, Linear Prediction.

Books:

1.	Peyton Z. Peebles Jr.	Probability, Random Variables and random Signal Principles, 4 th edition, Tata McGraw Hill, New Delhi, 2010
2.	George R. Cooper and Clare D. McGillem	Probabilistic Methods of Signal and System Analysis, Oxford University Press, 2007.
3.	Albero Leon-Garcia	Probability, Statistics, and Random Processes for Electrical Engineering (Third Edition), Pearson-Prentice Hall, 2008.
4.	Simon Haykins	Adaptive Filter Theory, Wiley, 2009
5.	Monsoon H Hayes	Statistical Digital Signal Processing and Modeling, Wiley India Pvt Ltd, 2008

EE-647 FUZZY LOGIC BASED CONTROL

Review of fuzzy set and fuzzy logic; Fuzzy if-then rule; Fuzzy Inference System (FIS): Mamdani, Takagi-Sugeno-Kang (TSK), etc; Simple Fuzzy Logic Control (FLC): Architecture, Design Parameters, Fuzzification, Inference, Defuzzification; Scaling factors and effect of their variations; Fuzzy self-tuning control: Architecture, Tuning, choice of membership, performance comparison with respect to disturbance; Non-linear Fuzzy Control: Fuzzy Knowledge Based Control (FKBC) as a non-linear element, PID-like FKBC, Sliding Mode FKBC, Sugeno FKBC; Control of non-linear Systems and Systems with Time-Delays; ; Fuzzy Adaptive Control and Fuzzy State Feedback Control schemes.

Books:

1.	H. Zhang and D. Liu	“Fuzzy Modeling and Fuzzy Control”, Birkhäuser, Boston, 2006
2.	L. Wang	“A Course in Fuzzy Systems and Control”, Upper Saddle River, NJ: Prentice Hall, 1997
3.	D. Driankov, H. Hellendoom, and M. Reinfrank	“An Introduction to Fuzzy Control” , 2nd Ed., Springer-Verlag, New York, 1996
4.	K. M. Passino and S. Yurkovich	“Fuzzy Control”, Addison Wesley, 1998
5.	K. Tanaka and H. O. Wang	“Fuzzy Control Systems Design and Analysis”, John Wiley and Sons, New York, 2001
6.	H. Ying	“Fuzzy Control and Modeling: Analytical Foundation and Applications”, IEEE Press, New York, 2000

EE-648 ROBUST AND ADAPTIVE CONTROL

Overview of classical control and introduction to robust control, Features, Analysis Tools, Lyapunov stability theorems, Lyapunov’s second method for stability, Analysis of robustness, Design of robust control systems using worst case polynomial and Routh-Hurwitz criteria, Types of Adaptive Control strategies. Design system and decoupled performance bounds- State feedback architecture-Output feedback architecture.

Books:

1.	K. Ogata	Modern Control Engineering
2.	S.H. Zak	Systems and Control, Oxford Univ. Press, 2003.
3.	H.K. Khalil	Nonlinear Systems, Prentice Hall, N.J., 2002.
4.	B C Kuo	Digital Control System

EE-651 ADVANCE INSTRUMENTATION

Generalised Measurement Systems: System concept of measurement schemes, Generalized performance characteristics of measurement systems.

Error Analysis: types of errors, Methods of error analysis, uncertainty analysis, statistical analysis, and propagation of errors.

Sensors & Transducers: Classification, selection of Transducer, transducer conditioning, transducer selection and specification, capacitive transducer, inductive transducer, resistive transducer, electromagnetic transducer, magnetostrictive transducer, photosensors, hall effect sensors.

Data Acquisition: Introduction to data acquisition, Sampling fundamentals, Input/Output techniques and buses. ADC, DAC, Digital I/O, Data acquisition interface requirements. Signal conditioning, DAQ hardware configuration.
Radiation Detection: Ionization Chamber, Geiger Muller Counter, Proportional Counter, scintillation Counters.
 Methods of data Transmission: General telemetry systems, DC & AC telemetry system, Modulation, Pulse telemetry systems, Digital telemetry.

Books:

1.	D. Partanabis	Instrumentation and control
2.	D. Partanabis	Sensors and transducers
3.	E. O. Doebelin	Measurement Systems
4.	E. Frank	Electrical Measurement Analysis
5.	Foard & Hauge	A.C. Bridge Methods
6.	B.S. Sonde	Transducer and Display Systems
7.	W. D. Cooper	Electrical Instrumentation & measurement Techniques

EE-652 PROCESS INSTRUMENTATION

Introduction: Basic process control systems, Process load and process time lags, Types of process - single and multiple capacity, Feed forward, cascade, ratio, Override, and Batch process controls. Review and selection of various control actions.

Controllers and Final Control Element: Electrical, Electronic, Pneumatic, Hydraulic, Electro-Pneumatic, electro-hydraulic type controllers, Comparison of controllers. Actuators: Electrical, Pneumatic and Hydraulic, Control valves design and types: linear, equal percentage and quick opening valve their characteristics,

Process Control: Process loop tuning, Ziegler Nichol's, Cohen-coon & Frequency response methods, Data loggers, Direct Digital Control (DDC). Supervisory Control and Data Acquisition Systems (SCADA).

Programmable logic controller (PLC) basics: Definition, overview of PLC systems, input/output modules, power supplies, isolators. Ladder logic diagram, General PLC programming procedure. Auxiliary commands and functions, Introduction of Distributed control systems (DCS)- case studies.

Process Industries Instrumentation: Computer aided control of Steam Power Plant, Pulp and paper industry, Nuclear reactor, chemical industries instrumentation.

Books :

1.	C.D. Johnson	Process Control Instrumentation Technology, Prentice Hall India.
2.	D.M. Considine	Process Instrumentation and Controls Hand, McGraw Hill Book Co. 1965
3.	D. Patranabis	Principles of Process Control, Tata McGraw Hill Book Co. 1981
4.	D.R. Conghanower and LB. Koppel	Process System Analysis and Control, McGraw Hill Book Co. 1981
5.	John. W. Webb Ronald A Reis ,	Programmable Logic Controllers – Principles and Applications, Third edition, Prentice Hall Inc., New Jersey, 1995
6.	Singh S.K	Computer Aided Process control/PHI - 2007

EE-653 DIGITAL INSTRUMENTATION

Introduction to digital Techniques: Counting techniques and various types of counters, merits and demerits of digital techniques.

Digital measuring instruments: Digital voltmeter, digital multi meter, digital methods for the measurement of power and energy, digital LCR meter.

Measurement of various electrical quantities i.e. capacitance, inductance, low and high frequency measurement.

Logic Analyzer: Wave analyzer, frequency selective wave analyzer, heterodyne wave analyzer, harmonic distortion analyzer, spectrum analyzer, digital fourier analyzer.

Measurement of various non-electrical quantities using digital methods: force, pressure, temperature, velocity, humidity, moisture, speed, displacement.

Digital recorders and display system

Books:

1.	H. S. Kalsi	Electronic instrumentation
2.	Klaas B. Klaassen	Electronic measurement and instrumentation
3.	David A Bell	Electronic instrumentation and measurements
4.	T S Rathore	Digital measurement Techniques
5.	A J Bouwens	Digital Instrumentation

EE-655 BIO-INSTRUMENTATION

Physiology: Cell and its structure, Resting and Action Potentials, Propagation of Action Potentials; Nervous system – CNS – PNS – Nerve cell – Synapse – Cardio pulmonary system – Physiology of heart and lungs – Circulation and respiration; Bioelectric Potentials - ECG, EEG, EMG, MEG; Bioelectric Signal recording machines; Electrophysiological measurements: Biopotential Electrodes - Micro, needle and surface electrodes; Lead systems and recording methods – Typical waveforms; Bioelectric amplifiers; Interference in Biosignals; Transducers: Transducers for biomedical applications– Different types — Selection criteria; Medical Imaging – X-ray, computer tomography, magnetic resonance imaging.

Books:

1	R.S.Khandpur	Hand Book of Bio-Medical instrumentation, Tata McGraw Hill, Publishing Co Ltd., 2003.
2	Leslie Cromwell, Fred J Weibell, Erich A. Pfeiffer,	Biomedical Instrumentation and Measurements, 2 nd edition, Prentice Hall of India.
3	J. J. Carr & M Brown	Introduction to Biomedical Equipment Technology
4	John G Webster	Medical Instrumentation, John Wiley & Sons, 2005

EE-656 MICRO-ELECTROMECHANICAL SYSTEMS(MEMS)

Historical Background: Silicon Pressure Sensors, Micromachining, Micro Electro Mechanical Systems Micro Fabrication and Micromachining: Integrated Circuit Processes, Bulk Micromachining: Isotropic Etching and Anisotropic Etching, Wafer Bonding, High Aspect – Ratio Processes (LIGA) Physical Microsensors: Classification of Physical Sensors, Integrated, Intelligent, or Smart Sensors, Sensor Principles and Examples: Thermal Sensors, Electrical Sensors, Mechanical Sensors, Chemical and Biosensors Microactuators: Electromagnetic and Thermal Microactuation, Mechanical design of Microactuators, Microactuator examples, Microvalves, Micropumps, Micromotors, Microactuators Systems: Success Stories, Ink-Jet Printer Heads, Micro-mirror TV Project Surface Micromachining: One or two Sacrificial Layer Processes, Surface Micromachining requirements, Polysilicon Surface Micromachining, other Compatible Materials, Silicon Dioxide, Silicon Nitride, Piezoelectric materials, Surface micromachined Systems:

Success Stories, Micromotors, Gear Trains, Mechanisms Application Areas: All-Mechanical Miniature Devices, 3-D Electromagnetic Actuators and Sensors, RF/Electronics Devices, Optical/Photonic devices, Medical Devices e.g. DNA-chip, Micro arrays.

Books:

1.	Stephen D. Senturia,	Micro System Design” by Kluwer Academic Publishers, 2001.
2.	Marc Madou	Fundamentals of Microfabrication” by CRC Press, 1997.
3.	Gregory Kovacs	Micromachined Transducers Sourcebook” WCB McGraw-Hill, Boston, 1998.
4.	M.-H. Bao	Micromechanical Transducers: Pressure Sensors, Accelerometers and Gyroscopes”, by Elsevier, New York, 2000.

EE-657 PHASOR MEASUREMENT TECHNIQUES

Introduction to synchrophasors, Phasor measurement unit, wide area measurement systems, optimal PMU placement, Applications of phasor measurement, phasor measurement and state estimation, Phasor measurement in smart grid, PMUs in Indian power grid, worldwide developments and case studies.

Books:

1.	A. G. Phadke, J. S. Thorp	Synchronized Phasor Measurements and their Applications” Springer, 2008.
2.	Mukhtar Ahmad	Power System State Estimation”, Springer, 2012
3.	M. B. Patil et al	Publications of IEEE Power and Energy Society

EE-658 INTELLIGENT INSTRUMENTATION

Introduction, software based instruments, Virtual Instrumentation, Architecture Advantage of VI techniques Transducers and Sensors Type of sensors, Sensor Standards and Protocols, Sensor Performance Characteristics, Intelligent Sensors.

Data Acquisition: Introduction to data acquisition system, A/D and D/A converters, Sample and hold circuit, MUX and DEMUX, Signal transmission, Introduction to DAQ cards..

Books:

1.	Barney	Intelligent Instrumentation Prentice hall India
2.	J. John, S Gupta	Virtual Instrumentation using LABVIEW

EE-661 INSULATION SYSTEM

Dielectrics and insulating materials, application of insulating materials in power industry. Significance of tests in dielectrics and insulants. Use of physical and statistical models. Causes of over voltages and their effect on insulation. Gas insulated switchgear and substations, SF₆ technology. Vacuum as insulant. Properties, application and breakdown of composite dielectrics. Partial discharges , their effect and recurrence. Brief review of Nanodielectrics.

Books:

1.	F.H Kreuger	Discharge detection in high voltage equipment Temple Press Ltd. London, 1964
2.	Craggs& Meek	Breakdown in gases, Pergamon Press, London, 1980
3.	T S Ramu&Nagamani	Partial Discharge Based Condition Monitoring of High Voltage Equipment , New Age Publisher, New Delhi, 2010
4.		IEEE Transactions on Dielectrics and Insulation

EE – 661N CONDITION MONITORING OF POWER SYSTEM EQUIPMENTS

Preventive maintenance and its need, Diagnostic testing, Necessity of Condition monitoring, Causes of Insulation degradation, Basic testing techniques.

Traditional Condition assessment techniques for Oil paper composite insulation, Moisture in oil paper Composite insulation.

Dielectric response measurement, Polarization mechanisms in dielectrics, Polarization and Depolarization Current measurement, Dielectric response function and insulation model.

Condition monitoring of transformers, switchgears, insulators.

Books:

1. Ryan, Hugh M, “ High Voltage Engineering & testing”, 2nd edition, Shankar Book Agency Pvt. Ltd. For , IET, ISBN 978-81-908588-7-8.
2. Ramu T S & Nagamani H N, “ Partial Discharge based Condition monitoring of high voltage equipment” New Age Publisher 2010, ISBN 978-81-224-3092-9
3. James, Ron E & Qi Su, “ Condition Assesment of High Voltage Insulation Power system equipment”, IET

EE- 663 HIGH VOLTAGE TESTING TECHNIQUES

Need and importance of impulse testing. Study of impulse voltage and current generators; Method of wave shaping and oscillographic measurement; Volt-time characteristics of rod-rod, sphere-sphere, rod-plane gaps. Volt-time characteristics of insulators, bushings, lightning arresters, current testing of lightning arresters; Testing of dielectrics, insulating materials; Testing of transformers, Capacitors and cables.

Books:

1.	D M Kazarno	Testing of Electrical Insulating Materials, MIR Publications Moscow
2.	F.H Kreuger	Discharge detection in high voltage equipment Temple Press Ltd. London, 1964
3.	Craggs& Meek	High Voltage Laboratory Technique, Butterworth, London
4.		IEEE Transactions on Dielectrics and Insulation
5.		Recent standards

EE- 664 HIGH VOLTAGE GENERATION & MEASUREMENT

Generation of High Direct Voltages - Simple rectifier circuits, cascaded circuits: Cockroft-Walton circuit, Electrostatic generators; Generation of High Alternating Voltages - Testing transformers, cascaded transformers, resonant transformers; Generation of Impulse Voltages and Currents - Single stage and multistage impulse generator circuits, Tripping and control of impulse generators. High Voltage Measurement techniques - Peak Voltage Measurement by spark gaps; Chubb-Fortescue Method; potential dividers; impulse voltage and current measurements, Layout and clearances of High Voltage Lab.

Books/References:

1. E. Kuffel, , W.S. Zaengl, High Voltage Engineering Fundamentals, Elsevier India and J. Kuffel Pvt. Ltd, 2005
2. M.S. Naidu and V. High Voltage Engineering, Tata McGraw-Hill Publishing Kamaraju Company Ltd., New Delhi.
3. Craggs& Meek High Voltage Laboratory Technique, Butterworths, London
4. IEEE Transactions on Dielectrics and Insulation

EE – 664N LIGHTNING PHYSICS & LIGHTNING PROTECTION

Atmospheric electricity and lightning surges; Lightning flash mechanism and strokes transmission, reflection, refraction and attenuation of waves on lines, cables etc. Effect of line termination with resistance, inductance, capacitance or any combination of R, L and C, problems of over voltages in transformers. Behaviour of alternators under the action of a voltage surge.

Lightning transients on over head systems. Lightning performance of lines. Earth wire and protection against direct strokes. Tower footing resistance and counter poise. Back flashover, station protection, protective methods for plant equipments. Surge diverters.

1. “High Voltage Engineering Fundamentals” by E. Kuffel and W.S. Zaengl, Pergamon Press, 1984.
2. “Insulation Co-ordination in H.V. Electric Power System” by W. Diesendorf, Butterworth & Co., 1974.

EE- 666N ELECTRICAL INSULATION FOR ROTATING MACHINES

Rotating Machine Insulation Systems: Stator and Rotor Winding Insulation System Components, Historical Development of Insulation Materials and Systems, Stator and Rotor Winding Insulation Systems in Current Use, Core Laminations and Their Insulation; Principles of Winding Failure, Repair and Rewinding; Core Lamination Insulation Failure and Repair; General Principles of Testing and Monitoring; Off-Line Rotor and Stator Winding Tests, In-Service Monitoring of Stator and Rotor Windings, Core Testing; Maintenance Strategies

Books/References:

1. G. C. Stone, E A. Boulter Electrical Insulation For Rotating Machines: Design,
I. Culbert & H. Dhirani Evaluation, Aging, Testing, and Repair
IEEE Press, 2004
2. IEEE Transactions on Dielectrics and Insulation

EE- 667 INSULATION TECHNOLOGY FOR SUPERCONDUCTORS

Superconductivity- critical magnetic field, Meissner effect, Low and High temperature Superconductors, Electric power application of Superconductivity; Properties of cryogenic fluids: breakdown characteristics under uniform & non- uniform fields, area and volume effects; dielectric loss; Electrical insulating materials at cryogenic temperature: dielectric behavior, breakdown strength, Impulse characteristics, internal discharges & ageing; Recent progress in electrical insulation systems.

Books/References:

1. Dr. AdirLuiz Superconductivity Theory and Applications, InTech
2. K.Fosshiem Handbook on Superconducting Tech., World Scientific Pub. Company
3. M.S.Naidu H.V. Engineering, Tata McGraw Hill
4. IEEE Transactions on Dielectrics and Insulation
5. Journal of Applied Physics-D

EE-667N POWER TRANSFORMER ENGINEERING

Liquid dielectrics, Conduction and breakdown in pure and commercial liquids, ageing in mineral oils, Liquid-Solid system, Partial Discharges in Power Transformers, Dissolved Gas Analysis, Types and causes of failures in power transformers, Schedule of tests and their procedures, Insulation condition monitoring.

Books:

1.	M.S. Naidu & V. Kamaraju.	“H.V. Engineering”, Tata McGraw Hill Co, New Delhi, 3 rd Ed. 2007.
2.	R .Arora& W .Mosch	“H. V. Insulation Engineering” New Age International Publishers Ltd, Wiley Eastern, New Delhi, 1995.
3.	I.Dasgupta,	“Design of Transformers”, Tata McGraw Hill Co., N.Delhi, 2002.

EE- 668N EHV/UHV POWER TRANSMISSION ENGINEERING

Electrical power transmission by HVAC and HVDC, Overhead transmission lines, Bundled conductors, Mechanical vibration of conductors, Surface voltage gradient on conductors, Corona & associated power loss, Radio-noise and Audio-noise & their measurement, Fields under transmission lines, Overhead line insulators, Insulator performance in polluted environment, EHV cable transmission - underground cables and GIL, High Voltage substations-AIS and GIS, Grounding of towers and substations, Over voltages in power systems, Insulation Co-ordination.

Books/References:

1. R.D. Begamudre Extra High Voltage AC Transmission Engg., Wiley Eastern Limited, 1990
2. Transmission Line Reference Book 345 kV & above, Electrical Power Research Institute, (EPRI), 1982.
3. Power Engineer’s Handbook, 6th Edition, TNEB Engineers’ Association, October 2002.

EE- 669 PARTIAL DISCHARGES IN POWER APPARATUS

Partial discharges– definition, types of partial discharges and its occurrence; recurrence and magnitude of discharges - quantities related to the magnitude of discharges. Object of discharge detection, Electrical and non-electrical discharge detection circuits; Noise suppression during Partial discharge measurements, Evaluation of discharges, Equipment specific diagnosis and reliability assessment.

Books/References:

1. F.H Kreuger Partial Discharge detection in High Voltage Equipment, Butterworths& Co. Ltd., 1989
2. T.S. Ramu& H.N. Nagamani Partial Discharge Based Condition Monitoring of High Voltage Equipment, New Age International, 2010
3. IEEE Transactions on Dielectrics and Insulation

EE-671N BIO-SIGNAL PROCESSING

Introduction to Biomedical Signals - Examples of Biomedical signals - ECG, EEG, EMG - Tasks in Biomedical Signal Processing. Origin of bio-potentials - Review of linear systems - Fourier Transform and Time Frequency Analysis of biomedical signals- Processing of Random & Stochastic signals - spectral estimation - Properties and effects of noise in biomedical instruments - Filtering in biomedical instruments; Basic ECG - Electrical Activity of the heart- ECG data acquisition - ECG parameters & their estimation - ECG Signal Processing - Noise & Artifacts; The Electroencephalogram - EEG rhythms & waveform - categorization of EEG activity - recording techniques - EEG applications. Modeling and analysis of EEG, Artifacts in EEG & their characteristics and processing.

Books:

- 1 F. M. Rangayyan Biomedical Signal Analysis: A Case-Study Approach, Wiley, 2002.

- | | | |
|---|----------------------|---|
| 2 | D. C. Reddy | Biomedical Signal Processing: Principles and Techniques , Tata McGraw Hill, New Delhi, 2005 |
| 3 | E. N. Bruce | Biomedical Signal Processing and Signal Modeling, Wiley, 2009 |
| 4 | L. Sörnmo, P. Laguna | Bioelectrical Signal Processing in Cardiac & Neurological Applications, Elsevier |

EE-678 OPTIMIZATION TECHNIQUES

Classification and formulation of optimization problems, classical optimization techniques, single variable and multivariable optimization, unconstrained optimization techniques solution by Lagrange multiplier, Kuhn –Tucker conditions.

Unconstrained Non-linear Programming Classification, Fibonacci method, quadratic interpolation method.
 Unconstrained optimization techniques invariable, conjugate direction, gradient and variable metric methods, Powell,s method and Steepest Descent method.
 Constrained nonlinear programming, penalty function method
 Linear Programming Solution of system of simultaneous linear equations, Simplex method.
 Dynamic programming.

Books:

1.	SS Rao	Engineering Optimization : Theory and Practice New age publications 1998
2.	G Hadley	Linear Programming

EE-679 SOFT COMPUTING

Soft Computing techniques and applications, Neural Networks: Biological neuron and artificial neural models, Neural network architectures, Activation functions, Learning rules, Supervised and Unsupervised networks; Fuzzy sets: Operation on Fuzzy sets, Fuzzy relations and Fuzzy composition; Membership functions; Fuzzy If-Then rules, Fuzzy inference systems, Fuzzification and Defuzzification, Fuzzy control; Genetic Algorithm, Genetic modeling.

Books:

1.	Simon Haykin	Neural Networks: A Comprehensive Foundation, 2 nd edition, Prentice Hall of India.
2.	Satish Kumar	Neural Networks: A Classroom Approach, 2 nd edition, McGraw Hill Education, 2012.
3.	Timothy J Ross	Fuzzy Logic with Engineering Applications, 3 rd Edition, Wiley, 2011.
4.	Chuen-Tsai Sun, Eiji Mizutani, Jyh-Shing Roger Jang	Neuro-Fuzzy and Soft Computing, PHI Learning, 2009
5.	Davis E. Goldberg	Genetic Algorithms: Search, Optimization and Machine Learning, Pearson, 2002.
6.	F. Herrera	Genetic Algorithms and Soft Computing, Physica-verlag, 1996