CENTURION UNIVERSITY OF TECHNOLOGY & MANAGEMENT
ODISHA-761211, INDIA,
Web Site: -www.cutm.ac.in

B.Tech Programme in Engineering & Technology – New Regulation
(2012 – 13 Admitted Batch onwards)

Branch: Electrical Engineering

CENTURION UNIVERSITY OF TECHNOLOGY &MANAGEMENT:ODISHA
B.TECH PROGRAMME IN ENGINEERING & TECHNOLOGY –New Regulations

(2012-13 Admitted Batch onwards)

ELECTRICAL ENGINEERING:: B.TECH IV YEAR

7th Semester				*8th Semester*			
Theory				*Theory*			
Code	*Subject*	*L-T-P*	*Credits*	*Code*	*Subject*	*L-T-P*	*Credits*
PCEL 4101	*Power System Operation & Control*	*3-1-0*	*4*	*PCEL 4201*	*Power System Protection*	*3-1-0*	*4*
	Professional Elective 1	*3-1-0*	*4*		*Professional Elective 3*	*3-1-0*	*4*
	Professional Elective 2	*3-1-0*	*4*		*Professional Elective 4*	*3-1-0*	*4*
	Free Elective - III	*3-1-0*	*4*		*Free Elective - IV*	*3-1-0*	*4*
Total Theory		*12-4-0*	*16*	**Total Theory**		*12-4-0*	*16*
Practical/Sessional				*Practical/Sessional*			
PLEL 4105	*Power System Analysis Lab*	*0-0-3*	*2*	*PLEL 4205*	*Project-3*	*0-0-6*	*4*
PLEL 4106	*Seminar*	*0-0-3*	*2*				
PLEL 4107	*Project-2*	*0-0-6*	*4*				
	Total Practical/Sessional	*0-0-12*	*8*		*Total Practical/Sessional*	*0-0-6*	*4*
TOTAL SEMESTER CREDITS			*24*	*TOTAL SEMESTER CREDITS*			*20*
TOTAL CUMULATIVE CREDITS			*190*	*TOTAL CUMULATIVE CREDITS*			*210*
Total Contact Hours.			*28*	*Total Contact Hours.*			*22*

Professional Electives

Professional Elective - I	*Professional Elective - II*	*Professional Elective – III*	*Professional Elective – IV*
PEEE 4101 Advanced Control Systems (3-1-0)	*PCEE 4101 Electric Drives(3-1-0)*	*PEEE 4202 High Voltage Engineering (3-1-0)*	*PEEE 4207 Total Energy Management (3-1-0)*
PEEE 4102 Renewable Energy Systems (3-1-0)	*PEEL 4106 HVDC (3-1-0)*	*PEEE 4203 Flexible AC Transmission System (3-1-0)*	*PEEL 4202 Power Station Engineering (3-1-0)*
PEEE 4103 Industrial Instrumentation& Control(3-1-0)	*PEEL 4107 Soft Computing (3-1-0)*	*PEEE 4204 Optimal Control (3-1-0)*	*PEEE 4206 Electrical Power Quality (3-1-0)*
PEEE 4104 Electrical Safety &Security (3-1-0)	*PEEE 4108 Sensor & Transducers(3-1-0)*	*PEEE4205 Programmable Logic Controllers (3-1-0)*	*PEEE4208 Digital Control System (3-1-0)*

FREE ELECTIVES

(Offered by Electrical Engg. Department)

Odd Semesters (5th& 7th Semesters)		*Even Semesters (6th& 8th Semesters)*	
Free Elective - I (5thSem)	*Free Elective - III (7thSem)*	*Free Elective - II (6thSem)*	*Free Elective - IV (8thSem)*
FEEE 3101 Renewable Energy System	*FEEE 4101 Power Electronics*	*FEEE 3201 Power Station Generation*	*FEEE4201 Utilization of Electrical Energy*

FEEE 3102 Electrical Machines	***FEEE 4102 Advanced Control System***	***FEEE 3202 Control System***	***FEEE4202 Digital Control System***

7th SEMESTER

PCEL 4101 POWER SYSTEM OPERATION &CONTROL (3-0-0) CREDITS 4

MODULE - I(14 Hours) Fundamentals of Power System (Book No.1, Ch. 1)

Introduction, Single Subscript Notation, Double Subscript Notation, Power in Single Phase AC Circuit, Complex Power, The Power Triangle, Direction of Power Flow, Voltage and Current in Balanced Three Phase Circuits, Power in Balanced Three Phase Circuits, Per- Unit Quantities, Changing the Base in Per- Unit Quantities, Node Equations, The Single Line or One Line Diagram, Impedance and Reactance Diagrams.
The Admittance Models & Network Calculations, Branch and Node Admittances, Mutually Coupled Branches in Ybus, An Equivalent Admittance Network, Modification of Ybus, The Network Incidence Matrix and Ybus.

Module – II (14 Hours)
Power Flow Solutions
The Power-Flow Problem, The Gauss-Seidal Method, The Newton-Raphson Method, The Newton-Raphson Method, Power-Flow Studies in System Design and Operation, Regulating Transformers, The Decoupled Method. economic Operation of Power System
Distribution of Load between Units within a Plant, Distribution of Load between Plants, The Transmission-Loss Equation, An interpretation of Transformation C, Classical Economic Dispatch with Losses, Automatic Generation Control, Unit Commitment, Solving the Unit Commitment Problems.

Module – III(12 Hours)
Power System Stability
The Stability Problem, Rotor Dynamics and the Swing Equation, Further Considerations of the Swing Equations, The Power-Angle Equation, Synchronizing Power Coefficients, Equal- Area Criterion for Stability, Further Applications of the Equal-Area Criterion, Multi-machine Stability Studies: Classical Representation, Step-By-Step Solution of the Swing Curve, Computer Programs for Transient Stability Studies, Factors Affecting Transient Stability.
Load Dispatch Centre Functions Contingency Analysis Preventive, Emergency and Restorative Control

Text Books:
1. Power System Analysis- John. J. Grainger & W. D. Stevenson, Jr.,TMH Pub,15th Reprint.
2. An Introduction to Electric Energy System Theory- By O. I. Elgerd, TMH Pub, 2nd Edition.
Reference:
1. Power System Analysis- By HadiSaadat,
TMH Publications, 2002 Edition, Eighth Reprint.
2. Power System Analysis Operation and Control- By A. Chakrabarti and S. Haldar, Third Edition, PHI Publications, 6thReprint, 2010.

PLEL 4105POWER SYSTEMS ANALYSIS LAB (0-0-3) CREDITS :2

1. Fault Analysis of 3-phase Alternator
2. Determination of Xd and Xq of 3-phase salient pole Synchronous motor
3. IDMT (Inverse Definite Minimum Time) relay characteristics
4. Determination of breakdown strength of oil by variable distance electrodes.
5. Determination of transmission line parameters.
6. Fault analysis (LL, LG, and LLL) of transmission lines.

SIMULATION BASED (USING MATLAB OR ANY OTHER SOFTWARE)

1. To obtain steady-state, transient and sub-transient short-circuit currents in an alternator.

2. To formulate the Y-Bus matrix and perform load flow analysis.
3. To compute voltage, current, power factor, regulation and efficiency at the receiving end of a three phase Transmission line when the voltage and power at the sending end are given. Use Π model.
4. To perform symmetrical fault analysis in a power system.
5. To perform unsymmetrical fault analysis in a power system.
6. Conduct a power flow study on a given power system.
7. Conduct a power flow study on a given power system network using Gauss-Seidel iterative method.
8. Develop a Simulink model for a single area load frequency problem and simulate the same.
9. Develop a Simulink model for a two-area load frequency problem and simulate the same.
10. Design a PID controller for two-area power system and simulate the same.

PROFESSIONAL ELECTIVE-I

PEEE 4101 ADVANCED CONTROL SYSTEMS (3-1-0) CREDITS: 4

Module-I: (16 hours)

STATE SPACE ANALYSIS

State Space Representation, Solution of State Equation, State Transition Matrix, Canonical Forms –Controllable Canonical Form, Observable Canonical Form, Jordan Canonical Form.

CONTROLLABILITY AND OBSERVABILITY

Tests for controllability and observability for continuous time systems –Time varying case, minimum energy control, time invariant case, Principle of Duality, Controllability and observability form Jordan canonical form and other canonical forms.

Module-II (16Hours)

DESCRIBING FUNCTION ANALYSIS

Introduction to nonlinear systems, Types of nonlinearities, describing functions, describing function analysis of nonlinear control systems.

PHASE-PLANE ANALYSIS

Introduction to phase-plane analysis, Method of Isoclines for Constructing Trajectories, singular points,phase-plane analysis of nonlinear control systems

MODULE-III (16Hours)

STABILITY ANALYSIS

Stability in the sense of Lyapunov.,Lyapunov's stability and Lypanov's instability theorems. Direct method of Lypanov for the Linear and Nonlinear continuous time autonomous systems.

MODAL CONTROL

Effect of state feedback on controllability and observability, Design of State Feedback Control through Pole placement.Full order observer and reduced order observer.

TEXT BOOKS:

1. Modern Control System Theory –by M. Gopal, New Age International Publishers, 2nd edition, 1996

REFERENCE BOOKS:

1. Modern Control Engineering –by K. Ogata, Prentice Hall of India, 3rd edition, 1998
2. Control Systems Engineering by I.J. Nagarath and M.Gopal, New Age International (P) Ltd.
3. Digital Control and State Variable Methods –by M. Gopal, Tata Mc Graw-Hill Companies, 1997
4.Systems and Control by Stainslaw H. Zak , Oxford Press, 2003

PEEE 4102 RENEWABLE ENERGY SYSTEMS (3-1-0) CREDITS: 4

Module I (14 Hours)

Introduction: Fossil fuel based systems, Impact of fossil fuel based systems, Non conventional energy –seasonal variations and availability, Renewable energy –sources and features, Distributed energy systems and dispersed generation (DG)

Module II (18 Hours)

Solar Photovoltaic systems: Operating principle, Photovoltaic cell concepts, Cell, module, array, Series and parallel connections, Maximum power point tracking, Applications, Battery charging, Pumping, Lighting, Peltier cooling Solar processes and spectral composition of solar radiation; Radiation flux at the Earth's surface. Solar collectors. Types and performance characteristics. Applications

Wind Energy:Wind energy conversion; efficiency limit for wind energy conversion, types of converters, aerodynamics of wind rotors, power ~ speed and torque ~ speed characteristics of wind turbines, wind turbine control systems; conversion to electrical power: induction and synchronous generators, grid connected and self excited induction generator operation, constant voltage and constant frequency generation with power electronic control, single and double output systems, reactive power compensation; Characteristics of wind power plant. Applications:

Module III (18Hours)

Biomass Power: Operating principle, Combustion and fermentation, Anaerobic digester. Wood gassifier, Pyrolysis, Applications, Bio gas, Wood stoves, Bio diesel, Combustion engine. Application, Hybrid Systems Need for Hybrid Systems, Range and type of Hybrid systems, Case studies of Diesel-PV, Wind-PV, Microhydel-PV, Biomass-Diesel systems, electric and hybrid electric vehicles

Text Books:

1. D. P. Kothari, K. C. Singal, R. Ranjan, Renewable Energy Sources and Emerging Technologies, Prentice Hall of India, New Delhi, 2008.
2. B.H.Khan, Non-Conventional Energy Resources, Tata McGrawHill, 2009
3. S. N. Bhadra, D. Kastha, S. Banerjee, Wind Electrical Systems, Oxford Univ. Press, New Delhi, 2005.

PEEE 4103 INDUSTRIAL INSTRUMENTATION & CONTROL (3-1-0) CREDITS: 4

Module 1 (10 Hours)

Introduction: Functional Units, Classification, Performance characteristics, Dynamic Calibration, Errors: An Overview, Statistical Error Analysis, Reliability and Related Topics (Chapter 1 of Text book) Instruments for Analysis: Introduction, Gas Analysers, Liquid Analysers, X-ray Methods, Chromatography.

Module II: (10Hours)

Telemetry: Introduction, Pneumatic Means, Electrical Means, Frequency Telemetring, Multiplexing, Modulation, Modulation of Digital Data, Transmission Channels, Briefing of a Telemetry System in Operation, Wireless I/O

Module III: (12 Hours)

Power Plant Instruments: Introduction, The Power Plant Scheme, Pressure, Temperature, Flow and Level, Vibration and Expansion, Analysis, Flue Gas Analysis (Chapter 12 of Text Book)

Hazard and Safety: Initial consideration, Enclosures, Intrinsic Safety, Prevention of Ignition, Methods of Production, Analysis Evaluation and Construction.

Text Book:

1. Principles of Industrial Instrumentation, Third Edition, D Patranabis, Tata McGraw Hill Education Private Limited, New Delhi.

Reference Book:

1.Process/Industrial instrument and controls handbook,GregoryK.McMillian Editor-in-chief,Douglas Late Editor-In-Chief

PEEE4104 *Electrical Safety & Security (Course to be Developed)*

PROFESSIONAL ELECTIVE-II

PCEE 4101 ELECTRIC DRIVES (3-0-0) CREDITS - 4

Module-I(14 Hours)

Study of Motor Drives:Electrical Drives, Advantages of Electrical Drives, Electrical Motors, Power Modulators, Choice of electrical Drives, Fundamentals of Torque Equations, Speed Torque Conventions and Multi-quadrant Operation, Equivalent Values of Drive Parameters, Components of Load Torques, Nature and Classification of Load Torques, Calculation of Time and Energy Loss inTransient Operations, Steady State Stability, Load Equalization, Control of Electrical Drives, Thermal Model of Motor for Heating and Cooling, Classes of Motor Duty, Determination of Motor Rating.

Module-II (18 Hours)

Steady State Performance of DC/AC Drives:Closed Loop Control of Drives, DC Motors and their Performances, Starting, Braking, Transient Analysis, Speed Control, Methods of Armature Voltage Control, Transformer and Uncontrolled Rectifier Control, Controlled Rectifier Fed DC Drives, Chopper Controlled DC Drives. Induction Motor Drives: Speed Control, Pole Changing, Pole Amplitude Modulation, Stator Voltage Control, Variable Frequency Control from Voltage Source, Voltage Source Inverter Control, Variable Frequency Control from Current Source, Current Source Inverter Control, Current Regulated Voltage Source Inverter Control, Rotor Resistance Control, Slip Power Recovery.Synchronous Motor Drives: Synchronous Motor Variable Speed Drives, Variable Frequency Control of Multiple Synchronous Motors.

Module-III(18 Hours)

Traction Drives:Nature of Traction Load, Calculation of Traction Drive Ratings and Energy Consumption, Tractive Effort and Drive Ratings, Specific Energy Consumption, Maximum Allowable Tractive Effort, Conventional DC and AC Traction Drives, 25 kV AC Traction using Semiconductor Converter Controlled DC Motors, DC Traction employing Polyphase AC Motors, AC Traction employing Polyphase AC Motors.

Drives for Specific Applications: Drive Considerations for Textile Mills, Steel Rolling Mills, Cranes and Hoist Drives,CementMills,Sugar Mills, Machine Tools, Paper Mills, Coal Mines, Centrifugal Pumps.

Microprocessors and Control of Electrical Drives: Dedicated Hardware Systems versus Microprocessor Control,Application Areas and Functionsof Microprocessors in Drive Technology, Control of DC Drives using Microprocessors.

Text Books:

(1)Fundamentals of Electrical Drives-By G.K.Dubey, Alpha Science International Limited, Pangbourne, UK, Second Edition,2001.

(2)Electric Drives-Concepts and Applications- By VedamSubramanyam, Second Edition, Tata McGraw Hill Publication, 2010-11.

Reference Book:

(1)Modern Power Electronics and AC drives- by B.K.Bose, Pearson Education.

PEEL 4106 HIGH VOLTAGE DC TRANSMISSION (3-1-0) CREDITS: 4

MODULE-I (15 Hours)

HVDC Transmission: Introduction, Equipment required for HVDC Systems, Comparison of AC and DC Transmission, Limitations of HVDC Transmission Lines, Reliability of HVDC Systems, Comparison of HVDC Link with EHVAC Link, HVDC-VSC Transmission Systems.

HVDC Converters: Introduction, HVDC Converter Valves and Valve Assembly, HVDC-Voltage Source Converters: Principle and Operation, 3-phase 6-pulse Converters using SCRs or Thyristors, 12-pulse Bridge Converters.

6-Pulse Converter Operation and Analysis: Introduction, Conduction Sequence in 6-pulse Converter Configuration, The Ideal Commutation Process without Gate Control, DC Output Voltage, Gate Control (Phase

Control) of Valves, Analysis of Voltage Waveforms with Overlap Angle (μ), Complete Characteristics of Converter as Rectifier/Inverter, Analysis of 12-pulse
Converter, Power Flow in HVDC Links, Operation and Analysis of VSC Converters

MODULE-II (16Hours)

Control of HVDC Converter and Systems: Mechanism of AC Power Transmission, Principle of Control, Necessity of Control in case of a DC link, Rectifier Control, Compounding of Rectifiers, Power Reversal in a DC Link, Voltage Dependent Current Order Limit (VDCOL)-Characteristics of the Converter, System Control Hierarchy and Basic Philosophy, Inverter Extinction Angle Control (EAG), Pulse Phase Control, Starting and Stopping of a DC Link, Constant Power Control, Control Systems for HVDC Converters, Inverter Operation Problems, Control of VSC Converters.

Harmonics in HVDC Systems: Importance of Harmonic Study, Generation of Harmonics by Converters, Characteristic Harmonics on the DC Side, Characteristic Current Harmonics,
Characteristic variations of Harmonic Currents with Variation of α& μ, Effect of Control modes on Harmonics, Non Characteristic Harmonics, Harmonics in VSC Converters.

MODULE-III (18 Hours)

Harmonic Suppression in HVDC System-Filters: Harmonic Model & Equivalent Circuit, Use of Filters, Filter Configurations, Design of a Band-Pass Filter, Design of High-Pass Filters, Protection of Filters, DC Filters.

Faults and Protection Schemes in HVDC Systems: Nature and Types of Faults, Faults on AC Side of Converter Stations, Converter Faults, Faults on DC Side of the System, Protection against Over Currents/ Over Voltages, Protection of Filter Units.

Multi-terminal HVDC Systems : Types of Multi-terminal (MTDC) Systems, Parallel Operation Aspects of MTDC, Paralleling (Disconnecting) of Units or Converter, Control of Power in MTDC, VSC-Multi-level DC Systems.

TEXT BOOK:

1. "HVDC Transmission" By S. Kamakshaiah& V. Kamaraju, TMH Education Private Ltd., 2011, New Delhi.

Reference Book:

1. "HVDC Power Transmissions Systems: Technology & Systems Interaction", K.R. Padiyar, New Age Publication, 2005

PEEL 4107 SOFT COMPUTING (3-1-0)

MODULE-I (14 Lectures)

Introduction: Soft Computing Constituents and Conventional Artificial Intelligence, Neuro-Fuzzy and Soft Computing Characteristics.

Fuzzy Sets: Introduction, Basic Definitions and Terminology, Set Theoretic Operations, MF Formulation and Parameterization.

Fuzzy Rules & Fuzzy Reasoning: Extension Principle and Fuzzy Relations, Fuzzy If-Then Rules, Fuzzy Reasoning.

Fuzzy Inference Systems: Mamdani Fuzzy Models, Sugeno Fuzzy Models, Tsukamoto Fuzzy Models, Other Considerations.

MODULE-II (18 Lectures)

Neural Networks: Neuron Abstraction, Neuron Signal Functions, Mathematical Preliminaries, Neural Networks Defined, Architectures: Feed forward and Feedback, Salient Properties and Application Domains of Neural Networks, Multi-layered Network Architectures, Back-propagation Learning Algorithm, Practical Considerations in Implementing the BP Algorithm, Structure Growing Algorithms, Universal Function Approximation and Neural Networks, Applications of Feed Forward Neural Networks, Reinforcement Learning, Radial Basis Function Networks, Regularization Theory Route to RBFNs, Generalized Radial Basis Function Network, Learning in RBFNs, Associative Learning, Hopfield Network, Content Addressable

Memory, Bidirectional Associative Memory, Self Organizing Feature Maps, Applications of the Self Organizing Map.

MODULE-III (18 Lectures)

Regression & Optimization: System Identification: an Introduction, Least Squares Estimator, Geometric Interpretation of

LSE, Recursive Least Squares Estimator.

Derivative-Free Optimization: Genetic Algorithms, Simulated Annealing, random Search, Downhill Simplex Search.

Adaptive Neuro-Fuzzy Inference Systems (ANFIS): ANFIS Architecture, Hybrid Learning Algorithm.

TEXT BOOK:

1. "Neuro-Fuzzy and Soft Computing" By J.-S.R.Jang, C.-T.Sun& E. Mizutani, PHI
2. "Neural Networks: A Classroom Approach" By Satish Kumar, TMH Education

Reference Book:

1. "Neural Networks Fuzzy Logic & Genetic Algorithms; Synthesis & Applications, S.Rajasekaran& G.A. VijayaLaxmi

Pai, Prentice Hall, India, May'2006- LakshmiPai

2.Principle of Soft Computing, S.N. Sivanandan& S.N. Deepa, Wiley India Edition,2010.

PEEE 4108 SENSORS AND TRANSDUCERS (3-1-0) CREDITS: 4

Module –1 (10 Hours)

Elements of a general measurement system; Static Characteristics: systematic characteristics, statistical characteristics, calibration; Dynamic characteristics of measurement systems: transfer functions of typical sensing elements, step and frequency response of first and second order elements, dynamic error in measurement systems. (Bentley: Chapters 1-4)

Module-2 (10 Hours)

Sensing elements: Resistive sensing elements: potentiometers, Resistance Temperature Detector (RTD), thermistors, strain gages.

Capacitive sensing elements: variable separation, area and dielectric; Inductive sensing elements: variable reluctance and LVDT displacement sensors;

Electromagnetic sensing elements: velocity sensors, Thermoelctric sensing elements: laws, thermocouple characteristics, installation problems, cold junction compensation. IC temperature sensor

Elastic sensing elements: Bourdon tube, bellows, and diaphragms for pressure sensing, force and torque measurement.

Module-3(10 Hours)

Signal Conditioning Elements:

Deflection bridges: design of resistive and reactive bridges, push-pull configuration for improvement of linearity and sensitivity

Amplifier: Operational amplifiers-ideal and non-ideal performances, inverting, carrier systems, phase sensitive demodulators and its applications in instrumentation

Text Books:

1. Principles of Measurement Systems- J.P. Bentley (3/e), Pearson Education, New Delhi, 2007.
2. Introduction to Measurement and Instrumentation- A.K. Ghosh(3/e), PHI Learning, New Delhi, 2009.
3. Transducers and Instrumentation- D.V.S. Murthy (2/e), PHI Learning, New Delhi, 2009

8th SEMESTER

PCEL 4201 POWER SYSTEM PROTECTION (3-1-0) CREDITS 4

MODULE-I (16 Hours)

Introduction and Basic Principles: Basic Idea of relay protection, Nature and causes of faults, Zones of protection, Primary and back-up protection, Basic principle of operation of protective system, Methods of discrimination, Derivation of single phase quantity from three phase quantity, Components of Protection.

Relay (Principle, Construction and Characteristics): Relay classification, Principal Types of Electromagnetic relays, Theory of Induction relay torque, Relay design and construction, General Equations of Comparators and Electromagnetic Relays, Over Current relays, Directional relays, Distance relays, Differential relays.

MODULE-II (16 Hours)

Feeder Protection:

Overcurrent, Distance and Pilot Protection Schemes. Apparatus Protection: Transformer Protection, Generator Protection, Motor Protection, Bus zone protection schemes.

Static Relays: Comparators and different relays.

Amplitude comparator, Phase Comparator, Coincidence type phase comparator, Basic elements of a static relay, Over Current Relays, Differential Protection, Static distance Protection.

MODULE-III (18 Hours)

Numerical relays:

Block Diagram of Numerical Relay, Signal Sampling &Processing , Numerical Over-current protection, Numerical Transformer differential Protection, Numerical distance Protection of Transmission Line

Switchgears: Auto reclosing fundamentals, Circuit breaker rating, Circuit constants and circuit conditions, Theory of Circuit interruption, Restriking voltage transients, characteristics of Restriking Voltage, Interaction between breaker and circuit, Current chopping, Automatic switch, Air-break circuit breakers, Oil circuit breakers, Air-blast circuit breakers, Vacuum circuit breakers, SF6 circuit breakers, DC circuit breakings.

Text Book(s):

1) Power System Protection and Switchgear–B Ravindranath& M Chander–New Age International Publishers.
2) Fundamentals of Power system Protection–Y G Paithankar& S R Bhide, PHI Pub.

PROFESSIONAL ELECTIVE-III

PEEE 4202 HIGH VOLTAGE ENGINEERING (3-1-0) CREDITS : 4

MODULE-1 (18 Hours)

INTRODUCTION TO HIGH VOLTAGE TECHNOLOGY AND APPLICATIONS

Electric Field Stresses, Gas / Vaccum as Insulator, Liquid Dielectrics, Solids and Composites, Estimation and Control of Electric Stress, Numerical methods for electric field computation, Surge voltages, their distribution and control, Applications of insulating materials in transformers, rotating machines, circuit breakers, cable power capacitors and bushings.

BREAK DOWN IN GASEOUS AND LIQUID DIELECTRICS

Gases as insulating media, collision process, Ionization process, Townsend's criteria of breakdown in gases, Paschen'slaw.Liquid as Insulator, pure and commercial liquids, breakdown in pure and commercial liquids.

BREAK DOWN IN SOLID DIELECTRICS

Intrinsic breakdown, electromechanical breakdown, thermal breakdown, breakdown of solid dielectrics in practice, Breakdown in composite dielectrics, solid dielectrics used in practice.

MODULE-2 (16 Hours)

GENERATION OF HIGH VOLTAGES AND CURRENTS

Generation of High Direct Current Voltages, Generation of High alternating voltages, Generation of Impulse Voltages, Generation of Impulse currents, Tripping and control of impulse generators.

MEASUREMENT OF HIGH VOLTAGES AND CURRENTS

Measurement of High Direct Current voltages, Measurement of High Voltages alternating and impulse, Measurement of High Currents-direct, alternating and Impulse, Oscilloscope for impulse voltage and current measurements.

MODULE-3 (16 Hours)

OVER VOLTAGE PHENOMENON AND INSULATION CO-ORDINATION

Natural causes for over voltages – Lightning phenomenon, Overvoltage due to switching surges, system faults and other abnormal conditions, Principles of Insulation Coordination on High voltage and Extra High Voltage power systems.

NON-DISTRUCTIVE TESTING OF MATERIAL AND ELECTRICAL APPARATUS

Measurement of D.C Resistivity, Measurement of Dielectric Constant and loss factor, Partial discharge measurements.

HIGH VOLTAGE TESTING OF ELECTRICAL APPARATUS

Testing of Insulators and bushings, Testing of Isolators and circuit breakers, Testing of cables, Testing of Transformers, Testing of Surge Arresters, Radio Interference measurements.

TEXT BOOKS:

1. High Voltage Engineering by M.S.Naidu and V. Kamaraju – TMH Publications, 3rd Edition
2. High Voltage Engineering: Fundamentals by E.Kuffel, W.S.Zaengl, J.Kuffel by Elsevier, 2nd Edition.

REFERENCE BOOKS:

1. High Voltage Engineering by C.L.Wadhwa, New Age Internationals (P) Limited, 1997.
2. High Voltage Insulation Engineering by RavindraArora, Wolfgang Mosch, New Age International (P) Limited, 1995.

PEEE 4203 FLEXIBLE AC TRANSMISSION SYSTEM (3-1-0) CREDITS : 4

MODULE-I (16 Hours s)

FACTS concept and General System Considerations: Transmission Interconnections, Flow of Power in an AC System, What limits the Loading Capability, Power Flow and Dynamic Stability Considerations of a Transmission Interconnection, Relative Importance of Controllable Parameters, Basic Types of FACTS Controllers, Basic Description and Definitions of FACTS Controllers. Static Shunt Compensation: Objectives of Shunt Compensation, Methods of Controllable VAR Generation, Static VAR Compensators, SVC and STATCOM.

MODULE-II (16 Hours)

Static Series Compensators: Objective of Series Compensation (GCSC, TSSC, TCSC), Variable Impedance Type Series Compensators, Switching Converter Type Series Compensators (SSSC) Static Voltage and Phase Angle Regulators

: Objectives of Voltage and Phase Angle Regulators, Approaches to Thyristor-Controlled Voltage and Phase Angle Regulators (TCVRs and TCPARs).

MODULE-III (14 Hours)

Combined Compensators: Introduction, Unified Power Flow Controller (UPFC), The Interline Power Flow Controller (IPFC), Generalized and Multifunctional FACTS Controllers.

TEXT BOOK:

1. Understanding FACTS: Concepts & Technology of Flexible AC Transmission Systems" By N.G.Hingorani&L.Gyugyi, IEEE Press, Standard Publishers Distributors, Delhi.

Reference Book:

1) Facts Controllers in Power Transmission & Distribution by K.R.Padiyan, New Age Intermational.

2) Modelling& Simulation in Power Networks, Enrique Acha, ClandioEsquival&H.A.Perez,CACamcho, John Wiley & Sons.

PEEE 4204 OPTIMAL CONTROL (3-1-0) CREDITS: 4

Module-I :(15 Hours)

Performance Indices: Selection of Performance Index, Calculus of variations: Variation and its properties, Euler-Lagrange Equation. Linear Quadratic Regulator: Formulation of Algebraic Riccati Equation (ARE), solving the ARE using the Eigenvector Method, Optimal systems with prescribed poles, Linear Quadratic Regulator for Discrete Systems on an infinite Time Interval.

Module -II :(15 Hours)

Dynamic Programming: Discrete Time Systems, Discrete Linear Quadratic Regulator Problem, Continuous Minimum Time Regulator Problem, The Hamilton Jacobi Belman Equation. Pontryagin's Minimum Principle: Optimal control with constraints on inputs.

Module - III :(15 Hours)

Optimal Observers-the Kalmanfilter: The linear Quadratic Gaussian (LQG) problem, Loop Transfer Recovery (LTR). H∞Control: H∞Control Solution, Sub-optimal linear regulators: Continuous Time Systems, Discrete Time Systems, Introduction to Stochastic Optimal Linear Estimation and Control.

Text Books:

1. Systems and Control by Stanislaw h.Zak,Oxford University Press, Publication (2003).
2. Design of Feedback Control Systems by Raymond T. Stefani, B.Shahian, Clement J.Savant, Jr. Gene H. Hostetter, 4th
edition (2002), Oxford University Press Publication.
3. Modern Control System Theory by M.Gopal, Second edition (2000), New Age International (P) Ltd. Publishers.

Reference:

1. Linear Optimal Control by Jeffrey B.Burl, Prentice Hall Publication (1999).
2. Control Theory (Multivariable and Non linear Methods) by Torkel Glad and Lennart Ljung, Taylor & Francis Publications (2009).
3. Control Systems Theory (with Engineering Application) by Sergey, Edward Lysters (2006).

PEEE4205 *Programmable Logic Controller: (Syllabus to be developed)*

PROFESSIONAL ELECTIVE-IV

PEEE4207 *Energy Audit (Course to be Developed)*

PEEL 4202 POWER STATION ENGINEERING (3-1-0) CREDITS:4

MODULE-1: (14 Hours)

Introduction to different sources of energy and general discussion on their application to generation, Indian Energy Scenario. Load duration curves, Load Factor, Capacity Factor, Reserve Factor, Demand Factor, Diversity Factor, Plant Use Factor, Base Load, Intermediate Load and Peak Load Plants.

ECONOMICS OF POWER GENERATION: Construction costs, fixed cost and Depreciation, Fuel cost, Economic scheduling principle, Annual Operating Costs, Effect of Load Factor on cost per kWh. NUCLEAR POWER STATION: Introduction to fission & fusion, reactor construction, controlled chain reaction, operational control of reactors, Brief study of various types of reactors (Boiling water, pressurized water, heavy water, breeder) , Location and layout of nuclear power plant.

MODULE-2: (18 Hours)

HYDEL POWER STATION: Selection of site for hydro-electric power plant. Hydrology: Hydrological cycle, precipitation, run-off and its measurement, hydrograph, flow duration and mass curves, Estimation of amount stored by a dam across the river,

Storage and Pondage. Turbines: Operational principle of Kaplan and Francis Turbine and Pelton wheel, Speed and Pressure Regulation, Work done, efficiency Essential Elements of a Hydro-electric Power Plant: Catchment area, Reservoir, Dam, Head Gate, Spillways, Pen stock, Surge Tanks, Scroll case, Draft tubes and Tail Race, Power House, Classification of Hydroelectric Power Plants. Governors, Plant auxiliaries.

MODULE-3: (18 Hours)

THERMAL POWER STATION: Selection of site for thermal power plant. Overall Block Diagram indicating the air circuit, coal and ash circuit, water and steam circuit, various types of steam turbines, ash and coal handling system, High Pressure and High capacity water tube boilers, Economizer, Superheaters, De-Superheater, Re-heater, Air Pre-heater. Draft System: Natural, Induced Forced and Balance Draft, PA fan, FD fan, ID fan, Chimney Condensers, Feed water heaters, Evaporators, Make-up water, Bleeding of steam, Cooling water system. Electrostatic Precipitator: Basic working Principle and constructional details (Nag-6.10) Governors, Plant auxiliaries.

TEXT BOOKS AND REFERENCES:

1. P. K. Nag, "Power Plant Engineering", 3rd Edition, Tata McGraw Hill Publication
2. Bernhardt G. A. Skrotzki, William A. Vopat, 'Power Station Engineering and Economy',
2nd Edition, Tata McGraw Hill Publication
3. M. V. Deshpande, Elements of Electrical Power Station Design, PHI
4. Arora &Domkundwar, 'A Course in Power Plant Engineering', DhanpatRai and sons.
5. R. K. Rajput, 'A Text Book of Power Plant Engineering', 3rd Edition, Laxmi Publishing.

PEEE 4206ELECTRICAL POWER QUALITY (3-1-0)CREDITS: 4

MODULE-1(16 Hours)

Introduction: power quality (PQ) problem, Voltage sag, Swell , Surges, Harmonic, over voltages, spikes, Voltage fluctuations, Transients, interruption overview of power quality phenomenon , Remedies to improve power quality, power quality monitoring. Interruptions: Definition, Difference between failure, outage, causes and origin of interruptions, limits for the interruption frequency, limitsfortheinterruption duration , costs of interruption, overview of Reliability , evaluation to power quality, comparison of observations and reliability evaluation.

MODULE-2 (18 Hours)

Voltage Sag: Characterization of voltage sag, definition, causes of voltage sag, voltage sag magnitude,monitoring, theoretical calculation of voltage sag magnitude voltage sag calculation in nonradialsystems, meshed systems, voltage sag duration. PQ considerations in Industrial Power systems:voltagesageffects,equipment behavior ofpowerelectronicloads,inductionmotors,synchronousmotors,computers,consumerelectronics, adjustable speed AC drives and its operation. Mitigation of AC drives, Adjustable speed DCdrive and its operation, mitigation methods of DC drive…

MODULE-3 (16 Hours)

Mitigation of Interruptions and Voltage Sags: Overview of mitigation methods- form fault totrip,reducing the number of faults, reducing the fault clearing time changing the power system, installing mitigation equipment, improving equipment immunity, different events and mitigation methods. System equipment interface- voltage source converter, series voltage controller, shunt controller, combined shunt and series controller. Power Quality and EMC Standards: Introduction to standardization, IEC Electromagnetic compatibility standards, European voltage characteristics standards, PQ surveys.

Reference Book:

1. "Understanding Power Quality Problems" by Math H J Bollen, IEEE Press.
2. Electrical power quality –R C Dugan, M.F,MGranghar, H.W.Beaty-TMH.

PEEE 4208 DIGITAL CONTROL SYSTEMS (3-1-0) CREDITS - 4

MODULE-1 (16 Hours)

SAMPLING AND RECONSTRUCTION

Introduction, Examples of Data control systems – Digital to Analog conversion and Analog to Digital conversion, sample and hold operations.

THE Z – TRANSFORMS

Introduction, Linear difference equations, pulse response, Z – transforms, Theorems of Z – Transforms, the inverse Z – transforms, Modified Z- Transforms

Z-PLANE ANALYSIS OF DISCRETE-TIME CONTROL SYSTEM

Z-Transform method for solving difference equations; Pulse transforms function, block diagram analysis of sampled – data systems, mapping between s-plane and z-plane.

MODULE 2 (16 Hours)

STATE SPACE ANALYSIS

State Space Representation of discrete time systems, Pulse Transfer Function Matrix solving discrete time state space equations, State transition matrix and it's Properties, Methods for Computation of State Transition Matrix, Discretization of continuous time state – space equations

CONTROLLABILITY AND OBSERVABILITY

Concepts of Controllability and Observability, Tests for controllability and Observability. Duality between Controllability and Observability, Controllability and Observability conditions for Pulse Transfer Function

MODULE-3 (18 Hours)

STABILITY ANALYSIS

Mapping between the S-Plane and the Z-Plane – Primary strips and Complementary Strips – Constant frequency loci, Constant damping ratio loci, Stability Analysis of closed loop systems in the Z-Plane.Jury stability test – Stability Analysis by use of the Bilinear Transformation and Routh Stability criterion.

DESIGN OF DISCRETE TIME CONTROL SYSTEM BY CONVENTIONAL METHODS

Transient and steady – State response Analysis – Design based on the frequency response method – Bilinear Transformation and Design procedure in the w-plane, Lead, Lag and Lead-Lag compensators and digital PID controllers.

STATE FEEDBACK CONTROLLERS AND OBSERVERS

Design of state feedback controller through pole placement – Necessary and sufficient conditions, Ackerman's formula. State Observers – Full order and Reduced order observers.

TEXT BOOKS:

1. Discrete-Time Control systems - K. Ogata, Pearson Education/PHI, 2nd Edition

REFERENCE BOOKS:

1. Digital Control Systems, Kuo, Oxford University Press, 2nd Edition, 2003.
2. Digital Control and State Variable Methods by M.Gopal, TMH