

## **MEPS – 101 ADVANCE MATHEMATICS**

### **UNIT 1**

Solution of Partial Differential Equation (PDE) by separation of variable method, numerical solution of PDE (Laplace, Poisson's, Parabola) using finite difference methods, Elementary properties of FT, DFT, WFT, Wavelet transform, Haar transform.

### **UNIT 2**

Probability, compound probability and discrete random variable. Binomial, Normal and Poisson's distributions, Sampling distribution, elementary concept of estimation and theory of hypothesis, recurred relations.

### **UNIT 3**

Stochastic process, Markov process transition probability transition probability matrix, just and higher order Markov process, Markov chain. Queuing system, transient and steady state, traffic intensity, distribution queuing system, concepts of queuing models (M/M/1: Infinity/ Infinity/ FC FS), (M/M/1: N/ Infinity/ FC FS), (M/M/S: Infinity/ Infinity/ FC FS)

### **UNIT 4**

Operations of fuzzy sets, fuzzy arithmetic & relations, fuzzy relation equations, fuzzy logics. MATLAB introduction, programming in MATLAB scripts, functions and their application.

### **UNIT 5**

Introduction and definition of reliability, derivation of reliability functions, Failure rate, Hazard rate, mean time t future & their relations, concepts of fault tolerant analysis, Elementary idea about decision theory and goal programming.

### **Reference Books:**

1. Higher Engineering Mathematics by B.V. Ramana, Tata Mc Hill.
2. Advance Engineering Mathematics by Ervin Kreszig, Wiley Eastern Edd.
3. Applied Numerical Methods with MATLAB by Steven C Chapra, TMH.
4. Introductory Methods of Numerical Analysis by S.S. Shastri,
5. Numerical Solution of Differential Equation by M. K. Jain
6. Numerical Mathematical Analysis By James B. Scarborough
7. Fourier Transforms by J. N. Sheddon
8. Fuzzy Logic in Engineering by T. J. Ross
9. Fuzzy Sets Theory & its Applications by H. J. Zimmersoms

## **MEPS – 102 Power System Dynamics Analysis and Control**

### **UNIT 1**

INTRODUCTION TO POWER SYSTEM STABILITY PROBLEM: Basic concepts and definitions: Rotor angle stability, voltage stability and voltage collapse, Midterm and long-term stability, Classification of stability, states of operation and system security system dynamic problems.

### **UNIT 2**

REVIEW OF CLASSICAL METHOD: System model, some mathematical analysis of steady state stability, analysis of transient stability, simplified representation of excitation control.

### **UNIT 3**

MODELING OF SYNCHRONOUS MACHINE: Introduction, synchronous machine, parks transformation, analysis of steady state performance per unit equivalent circuits of synchronous machine, determination of parameters of equivalent circuits, measurements for obtaining data, saturation models, transient analysis of a synchronous machine.

### **UNIT 4**

EXCITATION AND PRIME MOVER CONTROLLERS: Excitation system Modeling, system representation by state evasions, prime move control systems.

### **UNIT 5**

TRNMISSION LINE, SVC AND LOADS: D-Q transformation using L-B variables, static var compensators, loads Dynamics of a synchronous generator connected to estimate bus: system model, synchronous machine model, calculation of initial conditions, inclusion of SVC Model, Analysis of single machine system, Small signal analysis with block diagram representation, synchronizing and damping torque analysis, small signal model, nonlinear oscillators.

**UNIT 6 APPLICATION OF POWER SYSTEM STABILIZERS:** Basic concepts, control signals, structure and tuning of PSS, field implementation and operating experience 8 Hours.

### **Reference Books:**

1. K.R. Padiyar, Power system dynamics, stability and control, BS Pub. Hydbd
2. P Kunder, Power system stability and control, TMH.
3. P. W. Sauer & M A Pai: Power system dynamics and stability: Pearson.

## **MEPS – 103 Advance Power System Protection Relays**

### **Unit 1**

Protective Relays: Relaying review, characteristics and operating equations of relays. CT's and PT's differential relay, over-current relay, reverse power relay, distance relays, applications of relays.

### **Unit 2**

STATIC RELAYS: Introduction, advantages and disadvantages, classification logic ckts, smoothing circuits, voltage regulator square wave generator, time delay ckts level detectors, summation device, sampling circuit, zero crossing detector, output devices. COMPARATORS: Replica Impedance, mixing transformers, general equation of phase and amplitude comparator, realization of ohm, impedance and off set impedance characteristics, duality principle, static amplitude comparators, coincidence circuit, Hall effect devices, Magneto receptivity, zener diode phase comparator multi input comparators.

### **Unit 3**

Generator and transformer protection: Protective devices for system. Protective devices for stator, rotor, and prime mover of generator, percentage differential relays protection, three winding transformer protection, earth fault protection, generator transformer unit protection.

### **UNIT 4**

Bus bar and transmission line protection: Distance protective schemes, directional wave detection relay. Phase compensation carrier protection. High impedance differential scheme, supervisory and check relay, Some features of 500 KV relaying protection.

### **Unit 5**

Modern trends in power system protection: Different types of digital and computer aided relays, Microprocessor based relays, auto-reclosing, frequency relays, under and over frequency relays, di/dt relays. Algorithms for transmission line, transformer & bus bar protection; out-of-step relaying Introduction to adaptive relaying & wide area measurements

### **Reference Books:**

1. Power System Protection and Switchgear, B.Ram – Tata Mc-Graw Hill Pub.
2. Switchgear and Protection, M.V.Deshpande - Tata Mc-Graw Hill Pub.
3. Power System Protection & Switchgear, Ravindra Nath, M.Chander, Willy P
4. Computer Relaying for power system, Arun Phadke, James Thorp, Johns W P
5. Power System Protection, M.A.Date, Bharti Prakashan, Vallabh Vidya N,(Guj).

## **MEPS – 104 Power Electronics Applications in Power System**

### **UNIT I**

Power System components models formation of bus admittance matrix, algorithm for formation of bus impedance matrix. Reactive power capability of an alternator, transmission line model & loadability, Reactive power transmission & associated difficulties, Regulated shunt compensation, Models of OLTC & Phase shifting transformer, load flow study.

### **UNIT II**

Sensitivity analysis: Generation shift distribution factors, line outage distribution factors, Compensated shift factors. Power systems security levels, contingency selection & evaluation, security constrained economic dispatch. Pre-contingency corrective rescheduling.

### **UNIT-III**

Voltage stability: Proximity indicators e.g. slope of PV curve, Minimum Eigen value of reduced load flow Jacobian participation factors based on modal analysis and application.

### **UNIT-IV**

Flexible ac transmission system, reactive power control, brief description and definition of FACT's controllers, shunt compensators, configuration and operating characteristics of TCR, FC-TCR, TSC, Comparisons of SVCs.

### **UNIT-V**

Thyristor controlled series capacitor (TCSC) Advantages of the TCSC, Basic principle and different mode of operation, analysis variable reactance model and transient stability model of TCSC.

### **Reference Books:**

1. Modern power system analysis D.P. Kothari, I.J. Nagrath, TMH, 2003
2. Power generation operation and control, A.J. Wood, B.F Woolenberg, John W
3. Understanding facts: Concepts and technologies of flexible AC transmission system IEEE Press, 2001 N.G. Hingorani, L. Gyugyi
4. Power system stability and control IEEE press P. Kundur, 1994
5. Thyristor Based FACTS controllers for electrical Transmission systems- R.M. Mathur, R.K. Verma, Wiley inter science, 2002

## **MEPS – 105 Advance Course In Electrical Machines**

### **UNIT 1**

Review: Primitive machine, voltage and torque equation. Concept of transformation, change of variables, m/c variables and transform variables. Application to D.C. machine for steady state and transient analysis, equation of cross field commutator machine.

### **UNIT 2**

Induction Machine: Voltage, torque equation for steady state operation, Equivalent circuit, Dynamic performance during sudden changes in load torque and three phase fault at the machine terminals. Voltage & torque equation for steady state operation of 1- $\phi$  induction motor & scharge motor.

### **UNIT 3**

Synchronous Machine: Transformation equations for rotating three phase windings, Voltage and power equation for salient and non salient alternator, their phasor diagrams, Simplified equations of a synchronous machine with two damper coils.

### **UNIT 4**

Operational Impedances and Time Constants of Synchronous Machines : Park's equations in operational form, operational impedances and G(P) for a synchronous machine with four Rotor Windings, Standard synchronous machine Reactances, time constants, Derived synchronous machine time constants, parameters from short circuit characteristics.

### **UNIT 5**

Approximate Methods for Generator & System Analysis: The problem of power system analysis, Equivalent circuit & vector diagrams for approximate calculations, Analysis of line to line short circuit, Application of approximate method to power system analysis.

### **Reference Books:**

1. Analysis of Electric Machinery - P.C.Krause
2. The General theory of Electrical Machines - B.Adkins
3. The General theory of AC Machines - B.Adkins & R.G.Harley
4. Generalised theory of Electrical m/c - P.S.Bhimbra
5. Electro Mechanical Energy Conversion - White & Woodson

## **MEPS – 106 Power Electronics Laboratory**

Suggestive list of experiments

1. Study of characteristics of various power electronics devices.
2. Study of characteristics of various power electronic converters.
3. Application of power electronics in speed control of various electrical machines.

## **MEPS – 107 POWER SYSTEM LABORATORY**

Suggestive list of experiments

1. Study of Bucholz relay.
2. To determine the characteristics of inverse time current relay.
3. To determine the dielectric strength of transformer oil.
4. Separation of eddy current & iron losses of single phase transformer.
5. To perform slip test on synchronous machine and to determine d-axis & q-axis reactances.
6. To measure the direct axis subtransient reactance of synchronous machine.
7. To measure the quadrature axis subtransient reactance of synchronous