RAJIV GANDHI PROUDYOGIKI VISHWAVIDYALAYA, BHOPAL

PROGRAMME: B.E. Electrical Engineering, VIII Semester

Course: EE801 Control Systems

COURSE CONTENTS

Unit-I

Modeling of dynamic systems: Electrical, Mechanical and hydraulic systems, Concept of transfer function, Simulation of differential equations in analog computer, State space description of dynamic systems: Open and closed loop systems, Signal flow graph, Mason's formula, Components of control systems: Error detectors (Synchros & Potentiometer), Servomotors (AC & DC), techo generators, power amplifier, steeper motors

Unit-II

Time - domain analysis of closed loop systems: Test signals, time response of first and second order systems, Time domain performance specifications, Steady state error & error constants Feedback control actions: Proportional, derivative and integral control.

Solution of state equation: Eigen values & eigenvectors digitalization state transitive matrix, stability Routh-Hurwit stability analysis.

Unit-III

Characteristics equation of closed loop system root loci, construction of loci, Effect of adding, poles and Zeros on the loci, Stability by root loci.

Unit-IV

Frequency, Domain analysis, Bode plots, Effect of adding, poles and Zeros, Polar plot, Nyquist stability analysis, Relative stability : Gain and phase margins.

Unit-V

Frequency- Domain compensation : lead lag, Lag-lead compensation, Design of compensating networks

List of Experiments

Time response of second order system.
Characteristics of Synchros.
Effect of feedback on servomotors.
Determination of transfer function of A-C servomotor
Determination of transfer function of D-C motor.
Formulation of PI & PD controller and study of closed loop responses of 1st and 2nd order dynamic systems.

Reference:

1. Automatic Control System – B.C. Kuo, PHI, New York, 1975.
2. Control System Engineering Norman N Nise Wiley India
3. Modern Control Engineering: K. Ogata, PHI. New Delhi, 1992.
4. Digital Control Systems – B. C. Kuo, Oxford Pub.
5. Discrete-Time Control Systems – K. Ogata. PHI. New Delhi
6. Advanced Control Systems N Sarkar PHI Learning
7. Control system –K Padmanabhan I K International

RAJIV GANDHI PROUDYOGIKI VISHWAVIDYALAYA, BHOPAL

PROGRAMME: B.E. Electrical Engineering-VIII Semester

Course: EE802 Power System Protection

COURSE CONTENTS

Unit-I Fault Analysis

Faults in power systems, single line diagram, equivalent impedance diagram, per unit reactances. Analysis (using matrices) of power systems by symmetrical components under:

(a) Three phase short circuit.
(b) Line to line fault.
(c) Line to ground fault.
(d) Double line to ground fault.

Sequence networks and their inter connections for different types of faults, effects of fault impedance. Current Limiting Reactors: Applications, types, construction and location of current limiting reactors, short circuit calculation using reactors.

Unit-II Relays

General considerations, sensing of faults, construction of electro-magnetic attraction and induction types relays, Buchholz and negative sequence relay, concept of reset, pick up, inverse time and definite time characteristics, over current , over voltage, directional, differential and distance relays on R-X diagram. Static Relays: Introduction, advantage and limitation of static relays, static over current, directional, distance and differential relays.

Unit-III Protection

Types & detection of faults and their effects, alternator protection scheme (stator,rotor, reverse power protection etc.). Power transformer protection (external and internal faults protection), generator-transformer unit protection scheme, bus bar protection. Transmission line protection (current/time grading, distance), Pilot relaying schemes, power line carrier protection.

Unit-IV

Switchgear

Theory of current interruption- energy balance and recovery rate theory, arc quenching, recovery and restriking voltages. Types of circuit breakers. bulk oil and minimum oil, air break and air blast, sulphur hexa fluride (SF6) and vacuum circuit breakers. Rating selection and testing of circuit breakers/operating mechanisms. LT switchgear, HRC fuses, types construction and applications.

Unit-V

Modern Trends In Protection

Electronic relays, static relays functional circuits: comparators, level detectors, logic and training circuits,

microprocessor and computer based protection schemes, software development for protection, security &reliability.

List of Experiments:

Operating Characteristics of

1) Over Voltage Relays
2) IDMT Relays
3) Percentage based differential relays
4) Determination of instantaneous relays
5) Buchholz relays
6) Solid state over current relays

References:

1Van A. R & Warrington C., " Protective Relays : Their Theory and Practice", Vol 1 &2, Chapman and Hall.
2. Paithankar & Bhide – Fundamentals of Power System Protection –PHI Learning
3.Paithankar Y. O.," Transmission Network Protection: Theory and Practice", Marcel Deicker, Inc.
4.GEC Measurements," Protective Relays : Application Guide", GEC Measurements.
5.Masson R.J., Art & Science of Protective Relaying.
6.J & P Switchgear handbook Ravindra Nath B., and Chandar M., Power systems protection and switchgear
7.Rao Sunil S, Switchgear and protection. 7Crane P.H.C.,
Switchgear Principle.
9.The Elementary Council, "Power System Protection", Vol.1,2 &3, Peter Peregrinus Ltd.
10. Badriram & Vishwakarma, Power System Protection.
11. Ravi10Ravindranath & Chander, Power System Protection & switchgear.
12. Singh – Swithgear and Power System Protection –PHI Learning

RAJIV GANDHI PROUDYOGIKI VISHWAVIDYALAYA, BHOPAL

PROGRAMME: B.E. Electrical Engineering, VIII Semester

Course: EE 8301 Advanced Electrical Drives

COURSE CONTENTS

Unit-I Review of electric motors & Solid state converters: Speed control techniques of DC, Induction & synchronous motor, Converters, inverters, chopper and cyclo converter operation, Effects of power electronic equipments on load side & supply side.

Unit-II Review of closed loop controllers, sensors & transducers : PI, PID, Variable structure. AC, DC & Pulse tacho- generators.

Unit-III DC Drives : Converter & chopper fed DC drive, Reversing, Starting, Regenerative breaking , Four quadrant operation, High power application.

Unit-IV AC Drive: Inverter & cyclo converter fed drive, Vector control, Sensor less operation, Linear electrical motor concept, Synchronous motor Drive

Unit-V

Special Drives: Switched reluctance & permanent magnet brushless DC Operation, Converters, Characteristics &Control, PLC based drives.

Unit-VI

Servo drives & stepper motor- AC& DC Servomotor, Stepper motor, Control techniques, Controllers, Microstepping, Sensorless operation.

Unit-VII

Power Quality & energy Conservation- Line Side pollution, standards, Harmonic elimination techniques in converter, Filters, Energy efficient electric motors, Pay back periods, Energy conservation through sold state control.

Reference:

- Ned Mohan, T.M. Undeland, W.P. Robbins, Power Electronics-Converters, Applications and design", John Wiley & Sons.
- J.M.D. Murphy, F.O. Turnbull, "Power Electronic Control of AC motors", Pergamon Press.
- P.C. Sen, D.C. drive, Pergamon Press
- Sivanagaraju–Power Semiconductor Drives –PHI Learning
- B.K. Bose, Power Electronics & AC drive prentice Hall.
- Dubey G.K. "Power semi Conductor controller drives, Prentice Hall. Vedam Subramanyam, "Electrical Drives".
- T.J.E. Miller, Switched Reluctance & P.M. B.L. DC motor, Pergamon Press
- P.V. Rao, "Power semiconductor Drives", BS Publications.

RAJIV GANDHI PROUDYOGIKI VISHWAVIDYALAYA, BHOPAL

PROGRAMME: B.E. Electrical Engineering, VIII Semester

Course: EE8302 Process Control

COURSE CONTENTS

Unit I

Special characteristics of process systems large time constants, interaction, multistaging, pure lag; control loops for simple systems and their Dynamics & stability.

Unit II

Generation of control action in electronic and pneumatic controllers. Control valves, valve positioners, relief and safety valves, relays, volume boosters, pneumatic transmitters for process variable. Tuning of controllers - Zeigler Nichols and other techniques.

Unit III

Different control techniques and interaction of process parameters e.g. feed forward, cascade, ratio, over- ride controls Batch continuous process controls. Feed forward Control schemes.

Unit IV

Various process schemes / unit operations and their control schemes e.g. distillation columns, absorbers, heat exchangers, furnaces, reactors, mineral processing industries, etc. Use of control schemes for process optimization.

Unit V

Advanced control strategies with case studies. Use of DDC and PLC. Introduction to supervisory control. Conversion of existing control schemes in operating plants, data loggers.

References:

Dale Patrick, Stephen Fardo, "Industrial Process Control System".
Shinskey F.G., "Process Control System", III Ed., McGraw Hill.
Smith C.A. & A.B. Corripio, "Principle & Practiced Automatic Process Control",
J. Willey. Rao M & S.Qiv, "Process Control Engg.", Gorden & Breach.

RAJIV GANDHI PROUDYOGIKI VISHWAVIDYALAYA, BHOPAL

PROGRAMME : BE Electrical Engineering-VIII Semester

Course: EE8303 Computer Application to Power Systems

Course Contents

Unit I

Models of power system components, network model using graph theory, formation of Z bus, transmission line models, regulating transformer, line loadability, capability curves of alternator.

Unit II

Control of load bus voltage using reactive power control variable, SVC & SVS, Regulated shunt compensation, series and shunt compensation, Uniform series and shunt compensation and effect on loadability of transmission lines.

Unit III

Sensitivity analysis- General sensitivity relations, generation shift distribution factors, line outage distribution factors, compensated shift factors, sensitivity associated with voltage-VAR, sensitivities relating load bus voltage changes in terms of PV bus voltage changes, sensitivity relating changes in reactive power generation for changes in PV Bus Voltage.

Unit IV

Power system security - Security functions, Security level, contingency analysis, security control, economic dispatch using LP formulation, pre-contingency and post-contingency, corrective rescheduling.

UnitV Voltage stability - Difference between voltage and angle stability, PV Curve for voltage stability assessment, proximity and mechanism, modal analysis using reduced Jacobian, participation factor, effect of series and shunt compensation on voltage stability , effect of load models.

References:

- Power Generation, Operation and Control by A.J. wood and B.F. Wollenberg John Wiley & Sons Inc. 1984.
- Computer methods in power systems analysis - by stage G.W. and E.L. Abiad A.H. Mc Graw Hill. Computer Techniques in Power Systems Analysis- Pai M.A. Tata Mc Graw Hill.
- Computer Modeling of Electrical Power Systems, Arrillaga J. Arnord C.P Harker B.J. John Wiley &Son
- Computer Aided Power Systems Analysis Kusic G.L.- 2nd Edition, CRC Press
- Modern Power Systems Analysis Nagrath I.J. and Kothari D.P. Tata Mc Graw Hill.
- Power System Analysis Grainger J.J. & Stevnson W.D. Mc Graw Hill.
- Power System Stability and control -P Kundur ,IEEE Press 1994.
- Advance Power Systems Analysis and Dynamics Singh L.P. JohnWiley.
- Chakrabarti –Power System Analysis operation & Control – PHI Learning

RAJIV GANDHI PROUDYOGIKI VISHWAVIDYALAYA, BHOPAL

PROGRAMME: BE Electrical Engineering-VIII Semester

Course: EE 8401 Renewable & Non Conventional Energy Systems

COURSE CONTENTS

Unit - I

Renewable Energy Systems

Energy Sources, Comparison of Conventional and non-conventional, renewable and non-renewable sources. Statistics of world resources and data on different sources globally and in Indian context. Significance of renewable sources and their exploitation. Energy planning, Energy efficiency and management.

Unit - II

Wind Energy System

Wind Energy, Wind Mills, Grid connected systems. System configuration, working principles, limitations. Effects of wind speed and grid conditions. Grid independent systems - wind-battery, wind- diesel, wind-hydro biomass etc. wind operated pumps, controller for energy balance.Small Hydro System Grid connected system, system configuration, working principles, limitations. Effect of hydro potential and grid condition. Synchronous versus Induction Generator for stand alone systems. Use of electronic load controllers and self excited induction generators.Wave Energy System: System
configuration: grid connected and hybrid Systems.

Unit - III

Solar Radiation

Extraterrestrial solar radiation, terrestrial solar radiation, Solar thermal conversion,

Solar Phototonic System

Solar cell, Solar cell materials, efficiency, Characteristics of PV panels under varying insulation. PV operated lighting and water pumps, characteristics of motors and pumps connected to PV panels.

Biomass Energy System: System configuration, Biomass engine driven generators, feeding loads in stand-alone or hybrid modes, Biomass energy and their characteristics.

Unit - IV

Energy from oceans

Ocean temperature difference, Principles of OTEC, plant operations,

Geothermal Energy

Electric Energy from gaseous cells, Magneto-hydro generated energy, Non hazardous energy from nuclear wastes, Possibilities of other modern non-conventional energy sources.

Unit - V

Electric Energy Conservation

Energy efficient motors and other equipment. Energy saving in Power Electronic controlled drives. Electricity saving in pumps, air-conditioning, power plants, process industries, illumination etc. Methods of Energy Audit.

Measurements systems; efficiency measurements. energy regulation, typical case studies, various measuring devices analog and digital, use of thyristers.

References:

1. John Twidell & Toney Weir, Renewable Energy Resources, E & F N Spon.
2. El-Wakil, Power Plant Technology, McGraw Hill.
3. Rai G D, Non-conventional Energy Resources, Khanna.
4. F Howard E. Jordan, "Energy-Efficient Electric Motor & their Application-II", Plenum Press, New York USA
5. Anna Mani, "Wind Energy Resource Survey **in** India-Ill", Allied Publishers Ltd., New Delhi,
6. S.P. Sukhatme: Solar Energy, TMH-4e,
7. Dr. A. Ramachandran, Prof B.V Sreekantan & M F.C. Kohli etc, "TERI Energy Data Directory & Year book 1994-95", Teri Tata Energy Research Institute, New Delhi,
8. Solanki –Renewable Energy Technologies – PHI Learning
9. Sawhnew –Non Conventional Energy Resources – PHI Learning

RAJIV GANDHI PROUDYOGIKI VISHWAVIDYALAYA, BHOPAL

PROGRAMME : B.E. Electrical Engineering-VIII Semester

Course: EE8402 Power System Planning & Reliability

UNIT-I

Review of Probability Theory Element of probability theory Probability Distribution, Random variable, Density and distribution functions. Mathematical expectation. Binominal distribution, Poisson distributions, Normal distribution, Exponential distribution, Weibull distribution.

UNIT-II

Reliability of Engineering Systems

Component reliability, Hazard models, Reliability of systems wit non-repairable components, series, Parallel, Series-Parallel, Parallel-series configurations. Non-series-parallel configurations, minimal tie-set, minimal cut-set and decomposition methods. Repairable systems, MARKOV process, Long term reliability, Power System reliability.

UNIT-III

Reliability of Engineering Systems

Reliability model of a generating unit, State space methods, Combing states, sequential addition method, Load modeling, Cumulative load model, merging of generation and load models, Loss of load probability, Percentage energy loss, Probability and frequency of failure, Operating reserve calculations.

UNIT-IV

Power Network Reliability

Weather effect on transmission lines, Common mode failures, Switching after fauls, three, state components, Normally open paths, Distribution system reliability.

UNIT-V

Composite System Reliability

Bulk Power supply systems, Effect of varying load, Inter connected systems, correlated and uncorrelated load models, Cost and worth of reliability.

References:

- J. Endreny, Reliability Modeling in Electric Power Systems, John Wiley & Sons.
- Roy Billinton & Ronald, N allan, Reliability Evaluation of Power Systems, Plenum Press, New York.

RAJIV GANDHI PROUDYOGIKI VISHWAVIDYALAYA, BHOPAL

PROGRAMME : B.E. Electrical Engineering-VIII Semester

Course: EE8403 EHV A.C. and D.C. Transmission

COURSE CONTENTS

UNIT-I

Constitution of EHV a.c. and d.c. links, Kind of d.c. links, Limitations and Advantages of a.c. and d.c. transmission, Principal application of a.c. and d.c. transmission, Trends in EHV a.c. and d.c. transmission, Power handling capacity. Converter analysis garetz circuit, Firing angle control, Overlapping.

UNIT-II

FACTS devices, basic types of controller, series controller, static synchronous series compensator(SSSC), thyristor-controlled series capacitor(TCSC), thyristor controlled series reactor(TCSR), shunt controller (STATCOM), static VAR compensator(SVC), series-series controller, combined series-shunt controller, unified power flow controller(UPFC), thyristor controlled phase shifting transformer(TCPST).

UNIT-III

Components of EHV d.c. system, converter circuits, rectifier and inverter valves, Reactive power requirements, harmonics generation, Adverse effects, Classification, Remedial measures to suppress, filters, Ground return. Converter faults & protection harmonics misoperation, Commutation failure, Multiterminal D.C. lines.

Unit-IV

Control of EHV d.c. system desired features of control, control characteristics, Constant current control, Constant extinction angle control. Ignition Angle control. Parallel operation of HVAC & DC system. Problems & advantages.

Unit-V

Travelling waves on transmission systems, Their shape, Attenuation and distortion, effect of junction and termination on propagation of traveling waves. Over voltages in transmission system. Lightning, switching and temporary over voltages: Control of lighting and switching over voltages

Reference:

1. S. Rao,- "EHV AC & DC Transmission" Khanna pub.
2. Kimbark,-" HVDC Transmission" jodhn willy & sons pub.
3. Arrillaga,- "HVDC Transmission"2sn Edition ,IEE londan pub.
4. Padiyar, -"HVDC Transmission" 1t Edition ,New age international pub.
5. T.K. Nagsarkar,M.S. Sukhiza, -"Power System Analysis", Oxford University
6. Narain.G. Hingorani, l. Gyugyi-"Undustanding of FACTS concept and technology", John Wiley & sons
7. P.Kundur- "H.V.D.C. Transmission" McGraw Hill Pub.

Course: EE803 Major Project

COURSE GUIDELINES

The objectives of the course 'Major Project' are

To provide students with a comprehensive experience for applying the knowledge gained so far by studying various courses.

To develop an inquiring aptitude and build confidence among students by working on solutions of small industrial problems.

To give students an opportunity to do some thing creative and to assimilate real life work situation in institution.

To adapt students for latest developments and to handle independently new situations.

To develop good expressions power and presentation abilities in students.

The focus of the Major Project is on preparing a working system or some design or understanding of a complex system using system analysis tools and submit it the same in the form of a write-up i.e. detail project report. The student should select some real life problems for their project and maintain proper documentation of different stages of project such as need analysis, market analysis, concept evaluation, requirement specification, objectives, work plan, analysis, design, implementation and test plan. Each student is required to prepare a project report and present the same at the final examination with a demonstration of the working system (if any).

The faculty and student should work according to following schedule:

i) Each student undertakes substantial and individual project in an approved area of the subject and supervised by a member of staff.

ii) The student must submit outline and action plan for the project execution (time schedule) and
the same be approved by the concerned faculty.

iii) At all the steps of the project, students must submit a written report of the same.

EE -804 - MODELLING & SIMULATION LAB

1. Study of various Electrical Toolbox i.e Power System,Power Electronics, Control system,
   Electrical Measurement ,Flexible AC Transmission.
2. Developing Simulation Models for single and three phase Rectifier, Inverter, and Converter for different load models.
3. Developing Simulation Models using FACTs Devices i.e STATCOM, SVC, TCSC,SSSC, IPFC ,UPFC in power system transmission lines.

REFERENCE

1. Shailendra Jain "Modeling **and Simulation** using **MATLAB Simulink"** wiley india & sons