EXC-701 Advanced Electrical Drives

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

AC & DC Drives : Converter & chopper fed DC drive, Reversing, Starting, Regenerative breaking , Four quadrant operation, High power application. AC Drive: Inverter & cyclo converter fed drive, Vector control, Sensor less operation, Linear electrical motor concept, Synchronous motor Drive

UNIT-IV

Special Drives: Switched reluctance & permanent magnet brushless DC Operation, Converters, Characteristics &Control, PLC based drives. Servo drives & stepper motor- AC& DC Servomotor, Stepper motor, Control techniques, Controllers, Microstepping, Sensorless operation.

UNIT-V

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.

List of experiments:

1. To study the half wave, full wave & fully controlled bridge rectifier using SCR's.
2. To study various type of forced Commutation techniques.
3. To study the SCR triggering circuit.

4. To study the Characteristics and Applications of the following Devices:

5.To study the Conversion of DC to AC by using Single-phase Inverter Circuit using Power MOSFET in Bridge configuration

6. Advanced electric drives analysis control and modeling using matlab simulink

EXC-702 GENERALIZED THEORY OF ELECTRICAL MACHINE

UNIT-I

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, and equation of cross field commutator machine.

UNIT-II

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- ö induction motor & scharge motor.

UNIT-III

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-IV

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-V

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.

References:

P.C.Krause, Analysis of Electric Machinery.

B.Adkins, The General theory of Electrical Machines.

B.Adkins & R.G.Harley, The General theory of AC Machines.

P.S.Bhimbra, Generalised theory of Electrical m/c White & Woodson, Electro Mechanical Energy Conversion

List of experiments:

1.Speed Control of a D.C Shunt Motor.
2.Brake Test on a DC Shunt Motor
3.Brake Test on a DC Compound Motor
4.Open Circuit Characteristics of a DC Shunt Generator.
5.Load test on a D.C. Shunt Generator.
6.Load test on a D.C. Series Generator..
7.Load test on D.C. Compound Generator.
8.Hopkinson Test

EXC-703 Computer aided Design of Electrical Machines

Unit - I

Introduction: Design problem-Mathematical programming methods, computer aided design Mathematical formulation of the problem. Programming techniques (LP & NLP only), Methods of solution, Unconstrained optimization problems, constrained optimization problems.

Unit - II

Optimal design of DC machine:-Design of armature, Windings and field systems, Selection of variables for optimal design, Formulation of design equations, Objective function, Constraint functions, Algorithms for optimal design.

Unit - III

Optimal design of power transformer:-Design of magnetic circuit, Design of windings, Selection of variables for optimal design, Formulation of design equations, Objective function, Constraint functions, Algorithms for optimal design.

Unit - IV

Optimal design for 3-phase alternator:-Design of stator, windings, Design of Field systems for salient pole and non-salient pole machines, Selection of variables for optimal design, Formulation of design equations, Objective function, Constraint functions, Algorithms for optimal design.

Unit - V

Optimal design of 3-phase induction motor:-Design of stator, Windings Design of squirrel cage rotor, Design of slip ring rotor, Selection of variables for optimal design, Formulation of design equations, Objective functions Constraint functions, Algorithms for optimal design.

References:

P.C.Krause, Analysis of Electric Machinery.

B.Adkins, The General theory of Electrical Machines.

B.Adkins & R.G.Harley, The General theory of AC Machines.

P.S.Bhimbra, Generalised theory of Electrical m/c White & Woodson, Electro Mechanical Energy Conversion

List of experiments:

1.First the steps ofusing Simulation software in Electrical engineering 3b.State the procedure to build simple circuits

2.Draw electrical and electronic symbols using CAD and take print out

3.Draw D.C. and A.C machine parts using CAD and take print out

4.Draw winding diagram for given DC machine using CAD and take print out of (a)Lap winding and (b)Wave winding

5.Draw different types of rectifier circuit using CAD and take print out of

:(a)Single phase half wave(b)Single phase full wave

EXC-704 (A) High Voltage Engineering

UNIT-I

Introduction:-Introduction to HV technology, advantages of transmitting electrical power at high voltages, need for generating high voltages in laboratory. Important applications of high voltage.

UNIT-II

Breakdown phenomena:- Classification of HV insulating media, Properties of important HV insulating media. Gaseous dielectrics: Ionizations: primary and secondary ionization processes. Criteria for gaseous insulation breakdown based on Townsend's theory, Limitations of Townsend's theory. Streamer's theory breakdown in non uniform fields. Corona discharges. Paschen's law and its significance. Time lags of Breakdown. Breakdown in solid dielectrics: Intrinsic Breakdown, avalanche breakdown, thermal breakdown, and electro mechanic breakdown. Breakdown of liquids dielectric dielectrics: Suspended particle theory, electronic Breakdown, cavity breakdown **(bubble's theory), electro convection breakdown.**

UNIT-III

Generation of HV AC DC and Impulse Voltage and current:- HV AC-HV transformer; Need for cascade connection and working of transformers units connected in cascade, Series resonant circuitprinciple of operation and advantages. Tesla coil. HV DC- voltage doubler circuit, cock croft- Walton type high voltage DC set, Introduction to standard lightning and switching impulse voltages. Analysis of single stage impulse generator-expression for Output impulse voltage, Multistage impulse generator Components of multistage impulse generator. Triggering of impulse generator by three electrode gap arrangement. Triggering gap and oscillograph time sweep circuits. Generation of switching impulse voltage. Generation of high impulse current.

UNIT-IV

Measurement of high voltages:- Electrostatic voltmeter-principle, construction and limitation. Generating voltmeter- Principle, construction. Series resistance micro ammeter for HV DC measurements. Standard sphere gap measurements of HV AC, HV DC, and impulse voltages;Factors affecting the measurements. Potential dividers-resistance dividers capacitance dividers mixed RC potential dividers. Surge current measurement.

UNIT-V

High voltage tests on electrical apparatus:-Definitions of technologies, tests on isolators, circuit breakers, cables insulators and transformers.

Reference books: 1. E. Kuffel and W.S. Zaengl, “High voltage engineering fundamentals”,

2nd edition, Elsevier, press, 2005. 2. M.S.Naidu and Kamaraju, “High Voltage Engineering”, 3rd edition, THM, 2007.

3. L. L. Alston, “High Voltage technology”, BSB Publication, 2007..

4. Rakosh Das Begamudre, Extra High voltage AC transmission engineering, Wiley Easternlimited, 1987.

5. Transmission and distribution reference book-Westing House.C.L.Wadhwa, High voltage engineering, New Age International Private limited, 1995.

EX-704 (B) FLEXIBLE AC TRANSMISSION SYSTEMS (FACTS)

UNIT-I

Introduction: Facts basic concepts and general system considerations, power flow in ac system, definitions on facts, basic types of facts controllers, benefits from facts Technology, static var compensator (SVC): principle of operation and control strategy, thyristor controlled phase angle regulator (TCPAR): principle of operation and control strategy.

UNIT-II

Transient Stability Analysis: Analysis of Power systems installed with FACTS devices. Control with FACTS: Power Transmission Control using UPFC, power transmission control using phase shifting transformer (PST), power transmission control using SSSC.

UNIT-III

Oscillation Stability Analysis and Control with FACTS: Linearised model of power systems installed with FACTS based stabilizers, Heffron-Phillips model of a SMIB system installed with SVC, TCSC and TCPS, Heffron-Phillips model of a SMIB system with UPFC, Heffron-Phillips model of a multi-machine system installed with SVC, TCSC and TCPS.

UNIT-IV

Design of FACTS based stabilizers: Analysis of damping torque contribution by FACTS based stabilizers installed in SMIB systems, selection of installing locations and feedback signal for FACTS based stabilizers, Dynamic Voltage restorer.

UNIT-V

Power flow Controller: Unified Power Flow Controller (UPFC), principle of operation, configuration and control, simulation of UPFC, steady state model of UPFC, interline power flow controller (IPFC), principle of operation, configuration and control, static compensator (STATCOM), principle of operation and control, application for mitigation of SSR.

References:

1. “Understanding FACTS Devices” N.G. Hingorani and L. Guygi. IEEE Press Publications 2000.
2. Flexible AC Transmission System: Y.H.Song and A.T.Jhons, IEE, 1996(A Book)
3. Dr Ashok S & K S Suresh Kumar “FACTS Controllers and applications” course book for STTP, 2003.
4. Ned Mohan et.al, Power Electronics, John Wiley and Sons.
5. K. R. Padiyar, FACTS Controllers in Power Transmission and Distribution, New Age International, First Edition.

EXC- 704 (C) POWER QUALITY

UNIT-I

Introduction, power quality -voltage quality, power quality evaluations procedures term and definition: general classes of power quality problem, causes & effect of power quality disturbances.

UNIT-II

Voltage sags and interruption: sources of sags and interruption, estimating voltages sag performance, fundamental principles of of protection, monitoring sags.

UNIT-III

Transients over voltages: sources of transient over voltages, principles of over voltages protection, utility Capacitor switching transients, fundamentals of harmonics and harmonics distortion, harmonics sources from commercial load and from industrial loads.

UNIT-IV

Applied harmonics : harmonics distortion evalutions, principles for controlling harmonics, harmonics studies devices for controlling harmonic distortion, filters, passive input filter standards of harmonics.

UNIT-V

Electro-magnetic compatibility, constant frequency control, constant tolerance band control, variable tolerance band control, discontinuous current control.

Reference Books:

1. Power Quality- by R.C. Duggan
2. Power System harmonics –by A.J. Arrillga
3. Power electronic converter harmonics –by Derek A. Paice

EXC 705 (A) APPLICATION OF POWER ELECTRONICS TO POWER SYSTEMS

UNIT-I Review of transmission lines; surge impedance loading; voltage profile along radial and symmetrical lines, effect of load, Ferranti effect; role of reactive power compensators; series, shunt and unified compensation; effect on power flow and voltage profile; FACTS; Requirements of distribution systems, power quality (PQ) problems and classification, numerical indices of PQ.

UNIT-II The Static Var Compensator (SVC); TCR, FC-TCR and TSC-TCR variants: circuits, characteristics; transmission line compensation capability; dynamic model.The Static Compensator (STATCOM): circuit and steady state characteristic; effect on transmission line compensation; advantages over SVC; the D-STATCOM and its use in power quality compensation; reactive power compensator; control; active filtering for harmonic compensation; hybrid active filters.

UNIT-III The Thyristor Controlled Series Compensator (TCSC); circuit and steady-state characteristic; effect on transmission line compensation; critical aspects of operation; the NGH damper.The Dynamic Voltage Restorer (DVR); circuit and steadystate characteristic; effect on transmission line compensation; advantages over TCSC; DVR for power quality compensation; modes of control.

UNIT-IV The Unified Power Flow Compensator (UPFC); circuit and steady-state characteristic; effect on transmission line compensation; advantages over all the previous compensators; usage for power quality compensation; critical aspects of control.

UNIT-V The Interline Power Flow Controller (IPFC); circuit and steady-state characteristic; effect on transmission line compensation; advantages over the UPFC.

References:

1. N. G. Hingorani & Lazslo Gyugi, "Understanding FACTS", IEEE Press.

2. K. R. Padiyar, "FACTS Controllers in Power Transmission and Distribution", New Age International (P) Ltd. Publishers.

3. Arindam Ghosh & Gerard Ledwich, "Power Quality Enhancement Using Custom Power Devices", Kluwer Academic Publishers.

EXC 705 (B) Renewable Energy Sources

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 nonconventional 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

EXC 705 (C) Electrical Hybrid Vehicles

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Unit - I

Introduction

Conventional Vehicles: Basics of vehicle performance, vehicle power source characterization, transmission characteristics, mathematical models to describe vehicle performance. Introduction to Hybrid Electric Vehicles: History of hybrid and electric vehicles, social and environmental importance of hybrid and electric vehicles, impact of modern drive-trains on energy supplies. Hybrid Electric Drive-trains: Basic concept of hybrid traction, introduction to various hybrid drive-train topologies, power flow control in hybrid drive-train topologies, fuel efficiency analysis.

Unit - II

Electric Trains

Electric Drive-trains: Basic concept of electric traction, introduction to various electric drive train topologies, power flow control in electric drive-train topologies, fuel efficiency analysis. Electric Propulsion unit: Introduction to electric components used in hybrid and electric vehicles, Configuration and control of DC Motor drives, Configuration and control of Induction Motor drives, configuration and control of Permanent Magnet Motor drives, Configuration and control Of Switch Reluctance Motor drives, drive system efficiency. drive-train topologies, fuel efficiency analysis.

Unit - III

Energy Storage:

Introduction to Energy Storage Requirements in Hybrid and Electric Vehicles, Battery based energy storage and its analysis, Fuel Cell based energy storage and its analysis, Super Capacitor based energy storage and its analysis, Flywheel based energy storage and its analysis, Hybridization of different energy storage devices. Sizing the drive system: Matching the electric machine and the internal combustion engine (ICE), Sizing the propulsion motor, sizing the power electronics, selecting the energy storage technology, Communications, supporting subsystems

Unit - IV

Energy Management Strategies

Energy Management Strategies: Introduction to energy management strategies used in hybrid and electric vehicles, classification of different energy management strategies, comparison of different energy management strategies, implementation issues of energy management strategies.

Unit - V

Case Studies: Design of a Hybrid Electric Vehicle (HEV), Design of a Battery Electric Vehicle (BEV).

Text / References:

1. C. Mi, M. A. Masrur and D. W. Gao, "Hybrid Electric Vehicles: Principles and Applications with Practical Perspectives", John Wiley & Sons, 2011.
2. S. Onori, L. Serrao and G. Rizzoni, "Hybrid Electric Vehicles: Energy Management Strategies", Springer, 2015.
3. M. Ehsani, Y. Gao, S. E. Gay and A. Emadi, "Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals, Theory, and Design", CRC Press, 2004.
4. T. Denton, "Electric and Hybrid Vehicles", Routledge, 2016

EXC-706 (A) SOFT COMPUTING TECHNIQUES

UNIT-1 Review of probability theory: Random variable, distribution functions , function of random variable. generation of random digit, and random variants from various distribution function, Monte Carlo simulation, sampling distributions station evolution using MCS, confidence interval, coefficient of variation.

UNIT-2 - Rule and back propagation rule of training, RBF and FLN network.

UNIT-3 Draw back of classical optimization techniques, genetic algorithm; binary and real parameter GA, constraints handling in GA.

UNIT-4 Evolution strategies(ES), two members non-recombinative ES, multi member ES, recombinative ES. Optimization based on swarm intelligence particle, swarm optimization and its variants .

UNIT-5 Application of soft computing techniques to problem of electrical engineering e.g. economic dispatch, reliable optimization, ANN training using evolutionary algorithms.

References:

1. R.Y. Rubinstein Simulation and the Monte Carlo method, John Wiley & sons 1st Edition.
2. Paul. L. Mayer-Introducing probability and statical application, Addition Weslay.
3. Rajasekaran and pai- Neural Network, Fuzzy logic & Genetic Algorithms. PHI Learing
4. LiMin. Fu, Neural Networks in Computer Intelligence, 9th Reprint TMH
5. Multi objective optimization using evolutionary algorithm- Kalyanmoy Deb John Wiley & Sons Ltd.
6. Probability and Random processes for Electrical Engineering , Alberto Leon Garcia IInd Pearson .
7. Principles of soft computing- S N Shivanandan, S N Deepa Wiley India (P) Ltd, I edition 2007.
8. Hand book of genetic algorithm- Rajaserkharans, vijaya laxmi pai.
9. PSO Tutorial- Kennedy Ebuehart.
10. Sivanandam & Deepa- An Introduction to Neural Networks using Matlab 6.0 1st ed., TMH

EXC-706 (B) Reliability Evaluation of Power Systems

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 with 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.

EX-706 (C)COMPUTER APPLICATIONS TO POWER SYSTEMS

UNIT-I

Models of power system components, network model using graph theory, formation of Z bus, transmissionline 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.

UNIT-V

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:

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

EXC-707 Industrial Training - II

The following objective should be fulfilled in industrial training–II, and student must participate in any Chemical, Petrochemical, Pharmaceutical, Oil and Gas industry where they can learn to apply the Technical knowledge in real Industrial situations.

- Gain experience in writing Technical reports/projects.
- Expose students to the engineer's responsibilities and ethics.
- Expose the students to future employers.
- Understand the social, economic and administrative considerations that influence the working environment of industrial organizations.

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