Ph.D. Course work

Pre-Ph.D. Examination Syllabus

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING,
K L UNIVERSITY,
VADDESWARAM - 522502, ANDHRA PRADESH, INDIA.
# List of Pre-Ph.D Courses approved by

## DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

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KL UNIVERSITY
Pre-Ph.D. Examination
ELECTRICAL MACHINE MODELING AND ANALYSIS
SYLLABUS

Unit I: Basic concepts of Modeling
Basic Two-pole Machine representation of Commutator machines, 3-phase synchronous machine with and without damper bars and 3-phase induction machine, Kron’s primitive Machine - voltage, current and Torque equations.

DC Machine Modeling
Mathematical model of separately excited D.C motor – Steady State analysis-Transient State analysis-Sudden application of Inertia Load-Transfer function of Separately excited D.C Motor-Mathematical model of D.C Series motor, Shunt motor-Linearization Techniques for small perturbations

Unit II: Reference frame theory
Real time model of a two phase induction machine- Transformation to obtain constant matrices-three phase to two phase transformation-Power equivalence.

Dynamic modeling of three phase Induction Machine
Generalized model in arbitrary reference frame-Electromagnetic torque-Derivation of commonly used Induction machine models- Stator reference frame model-Rotor reference frame model-Synchronously rotating reference frame model-Equations in flux linkages-per unit model

Unit III: Small Signal Modeling of Three Phase Induction Machine
Small signal equations of Induction machine-derivation-DQ flux linkage model derivation-control principle of Induction machine.

Symmetrical and Unsymmetrical 2 phase Induction Machine

Unit IV: Modeling of Synchronous Machine
Synchronous machine inductances –voltage equations in the rotor’s dq0 reference frame-electromagnetic torque-current in terms of flux linkages-simulation of three phase synchronous machine- modeling of PM Synchronous motor.

Unit V: Dynamic Analysis of Synchronous Machine
Dynamic performance of synchronous machine, three-phase fault, comparison of actual and approximate transient torque characteristics, Equal area criteria

Text Books:

Reference Books:
2. Dynamic simulation of Electric machinery using MATLAB / Simulink –Chee Mun Ong-Prentice Hall.
1) Write the Voltage & Torque equations for the Kron’s primitive machine in matrix form. What observations are made from the impedance matrix & Torque equation of this machine? (20M)

2) Obtain Mathematical modelling in matrix form for a given separately excited D.C motor? Obtain the transfer function and also write the formulae for undamped natural angular frequency & Damping factor for this machine? (20M)

3) A 3-Ph Induction motor has the following per phase parameters referred to stator:
   - Stator resistance --- 0.30ohm
   - Rotor resistance --- 0.45ohm
   - Stator & Rotor leakage reactance --- 2.1ohm each
   - Magnetising reactance --- 30.00ohm

   Find out the parameters of an equivalent 2-ph induction motor if its per phase turns are:
   (a) Same as that of the 3-phase Induction motor. (8M)
   (b) 3/2 times that of the 3-phase induction motor. (8M)
   (c) Sqrt 3/2 times that of the 3-phase induction motor. (4M)

4) Obtain the expressions for a 3-ph Induction motor (Voltage and Current) in state variable form in
   (a) Stator Reference Frame (16M)
   (b) Synchronous Reference Frame and Rotor Reference Frame Model. (4M)

5) (a) Derive the equation for Synchronous machine inductances \( L_S, L_{SR} \) and \( L_R \). (10M)
   (b) Obtain the voltage equations in the rotor’s dqo reference frame of Synchronous machines. (10M)

6) (a) Explain the dynamic performance of the synchronous machine during the sudden change in input voltage? (10M)
   (b) Evaluate the reactance offered by the Synchronous machine during the 3-phase fault conditions. (10M)

7) (a) Explain the equal area criteria for input torque change and 3-phase fault. (10M)
    (b) Obtain the Park’s Transformation matrix. (10M)

8) Write a short note on following:
    (a) Cross-field theory of 1-ph Induction machine. (10M)
    (b) Power Equivalence. (10M)
FLEXIBLE AC TRANSMISSION SYSTEMS

UNIT-I: FACTS Concept and General System Considerations

Introduction to Facts devices, Power Flow in AC system, Dynamic stability Considerations and the importance of the controllable parameters, Definitions on FACTS, Basic types of FACTS Controllers, Basic concept of voltage source converters, Single phase, three phase full wave bridge converters operation, Transformer connections for 12 pulse, 24 and 48 pulse operation.

UNIT-II: CONVERTERS

Three level voltage source converter, pulse width modulation converter, Design of PWM converter to reduce the harmonics, basic concept of current source Converters, Comparison of current source converters with voltage source converters.

UNIT-III: Static shunt Compensators

SVC and STATCOM Operation & characteristics and Control of TSC, TSR, STATCOM, Comparison between SVC and STATCOM – STATCOM for transient and dynamic stability enhancement.

UNIT-IV: Static Series Compensation

GCSC, TSSC, TCSC and SSSC Operation and Control External system Control for series Compensator SSR and its damping – Static Voltage and Phase angle Regulators - TCVR and TCPAR –Operation and Control.

UNIT-V: UPFC and IPFC


Text Books:

2. K.R.Padiyar “FACTS Controller in power Transmission and Distribution” New Age Int Publisher, 2007

Reference Books:

1. Ned Mohan et.al “Power Electronics” John Wiley & Sons
KL UNIVERSITY
Pre-Ph.D. Examination
FLEXIBLE AC TRANSMISSION SYSTEMS
Model Question Paper

Time: 3hrs
Max Marks: 100

Answer any five questions
5 X 20 = 100M

1. What are the Problems Associated with the present day Power Systems and explain how FACTS Controllers can provide the solutions. (10M)

2. a. Write about power flow in a meshed system. (10M)
   b. Comparison between Voltage Sourced Converter & Current Sourced Converter. (10M)

3. a. Classify the FACTS controllers with neat sketch. (10M)
   b. Write about basic concept of Pulse Width Modulation Converter. (10M)

4. Explain basic concept of voltage sourced converter & current sourced converter. (20M)

5. Explain single-phase full wave bridge converter operation with waveforms and derive the square-wave voltage harmonics. (20M)

6. Discuss about transformer connections for 12-, 24-Pulse operation. (20M)

7. Explain the operation of Three-Level Voltage Sourced Converter with waveforms. (20M)

8. Discuss the power flow and dynamic stability aspects of simple transmission system, what are the benefits of FACTS Controllers. (20M)
POWER ELECTRONIC CONTROL OF DRIVES
SYLLABUS

Unit-I

Unit-II
Vector control of Induction Motor: Principles of vector control, Direct vector control, derivation of indirect vector control, implementation – block diagram; estimation of flux, flux weakening operation.

Unit-III
Control of Synchronous motor drives: Synchronous motor and its characteristics- Control strategies-Constant torque angle control- power factor control, constant flux control, flux weakening operation. Load commutated inverter fed synchronous motor drive, motoring and regeneration, phasor diagrams. PMSM and BLDC control of Drives, control of Variable Reluctance Motor Drive

Unit-IV
Speed control of dc Motors-Different types of speed control techniques by using single phase & three phase ac systems closed loop control of phase controlled DC motor Drives. Open loop Transfer function of DC Motor drive- Closed loop Transfer function of DC Motor drive –Phase-Locked loop control.

Unit- V

Text Books:
1. Modern Power Electronics and AC Drives – B. K. Bose-Pearson Publications-

REFERENCES:
2. Power Electronic Circuits, Devices and Applications – M. H. Rashid – PHI.
KL UNIVERSITY
Pre-Ph.D. Examination
POWER ELECTRONIC CONTROL OF DRIVES
MODEL QUESTION PAPER

Time:3hrs
Max Marks:100

Answer any five questions {5 X 20 = 100M}

1. a. Explain about open loop transfer function of dc motor drive (12M)
   b. Explain briefly about phase locked loop control (8M)

2. Explain about the following current controllers
   a. PWM controller (12M)
   b. Hysteresis controller (8M)

3. Explain the following VFI control methods of induction motor drive
   a. Open loop v/f control (10M)
   b. Current controlled VFI (10M)

4. Discuss about following slip power recovery schemes
   a. Static Kramer drive (12M)
   b. Static scherbius drive modes of operation (8M)

5. a. Explain principle of vector control of IM (8M)
    b. Discuss about direct or feedback vector control (12M)

6. Explain about control strategies of synchronous motor
   a. constant torque angle control (10M)
   b. constant flux control (10M)

7. a. Explain load commutated inverter fed synchronous motor drive. (10M)
    b. Explain about variable reluctance motor drive (10M)

8. a. List and compare various closed loop control techniques of chopper fed DC drives (10M)
    b. Explain mathematical modeling of current control loop of chopper fed Dc drive. (10M)
SYLLABUS

POWER ELECTRONICS CIRCUITS – I

Unit I : POWER ELECTRONICS DEVICES:
power electronic devices – SCR, Theory of operation of SCR, Two transistor model of SCR, Characteristics and ratings, SCR turn on and turn off methods, Firing circuits, DIAC, TRIAC, IGBT, MOSFET and their characteristics, MCTs, MOS-controlled thyristors (MCTs) – Static Induction Thyristors (SITHs) – Power integrated circuits (PICs) – symbol, structure and equivalent circuit – comparison of their features.

Unit II : NATURAL COMMUTATED CONVERTERS:

Unit III : AC VOLTAGE CONTROLLERS:
Single phase Ac voltage controllers- with R & RL loads- Analysis & waveforms- three phase AC voltage controllers- analysis & wave forms – AC synchronous tap changers - Matrix converters, cyclo converters

Unit IV : PWM INVERTERS (single phase)
Bridge type- Single phase Inverters. MC Murray- Bedford inverter- and their analysis & wave forms – Bridge type three phase Inverters with different modes. CSI-some applications- comparison of VSI & CSI. Simple problems. PWM and their methods, Advanced modulation techniques for improved performance, stepped, harmonic injection and delta modulation, Advantages, application

Unit V : D.C - D.C. Converters.

Text books:

Reference Books:
1. Power Electronics by W.Launder
2. Industrial Electronics & Robotics by Shaler & C.Menamee
KL UNIVERSITY
Pre-Ph.D. Examination
Power Electronics Circuits-I

Model question paper
Time: 3 hours Max Marks: 100

Answer any five questions 5 X 20 = 100M

1. a) What is turn-on and turn-off characteristics and switching losses of MOSFET. Explain? 10M
   b) Describe the various methods of thyristor turn-on? 10M

2. a) Discuss the operation of three phase fully controlled rectifier supplying RL load with neat waveforms. Also derive the expression for the average output voltage? 12M
   b) A single phase bridge rectifier has a purely resistive load R=10Ω, the peak supply voltage Vm=170 v, and the supply frequency f=60HZ. Determine the average output voltage of rectifier if the source inductance is negligible? 8M

3. a) Explain the operation of three-phase cyclo converter with neat diagram? 10M
   b) Explain the operation of 1 φ AC voltage controller with RL loads? 10M

4. a) Explain the operation of matrix converter with necessary diagram? 8M
   b) Discuss the operation of single phase full controlled rectifier supplying RLE load with neat waveforms. Also derive the expression for the average output voltage? 12M

5. a) Explain the operation of 3 φ bridge inverter for 180 degree mode of operation with aid of relevant phase and line voltage waveforms? 12M
   b) The single phase full bridge inverter of resistive load R=2.4ohm and dc input voltage is 48v. Determine RMS output voltage at the fundamental frequency, output power, and the total harmonic distortion? 8M

6. a) What is PWM? Explain the various techniques involved in it? 10M
   b) Explain in detail about step up and step down choppers? 10M

7. a) With neat diagram explain the working of buck-boost switching mode regulator? 10M
   b) With neat diagram explain the working of cuk switching mode regulator? 10M

8. a) explain the criteria to be met in selection of mf for 3-phase inverters so that its harmonic profile is improved 10M
   b) Design the inductor and capacitor components to be employed in boost converter 10M
MODERN CONTROL THEORY

SYLLABUS

UNIT–I: DIGITAL CONTROL SYSTEMS

UNIT- II: STATE VARIABLE ANALYSIS OF DIGITAL CONTROL SYSTEMS
Introduction, State Descriptions of Digital Processors, State Description of sampled continuous time plants, Solution of State difference equations, Controllability and Observability

UNIT-III : NONLINEAR SYSTEMS

UNIT-IV: STABILITY ANALYSIS

UNIT- V : OPTIMAL CONTROL

TEXT BOOKS:

REFERENCE BOOKS:
(Answer any five questions of the following)

1. a) Explain reconstruction of the signal using sampler and ZOH circuit. 10M
   
   b) Obtain Z transforms of i) $e^{-at} \sin \omega t$ and ii) $\cos \omega t$. 10M

2. a) Find the difference equation of the control system shown in figure. 5M

   b) Solve the difference equation $x(k+2) - x(k+1) + 2x(k) = 4^k; x(0) = 0, x(1) = 1$ using Z-inverse Transform. 10M

3. a) The dynamics of a linear time invariant system is given by
   
   $x(k+1) = F x(k) + g u(k), \quad x(0) = X^0, \quad y(k) = c x(k) + d u(k)$
   
   Obtain the expression for the transfer function of the above system. 10M
   
   b) Find $\Phi(k)$ if the matrix $F = \begin{bmatrix} 0 & 1 \\ 0.16 & -1 \end{bmatrix}$. 10M

4. a) Explain different types of limit cycles of non-linear systems. 10M
   
   b) Derive the Describing function for Dead zone and saturation nonlinearity shown in figure. 10M
5. a) State the stability theorem of a system given by

\[ X(t) = f[X(t), t]; \dot{f}(0) = 0, X(0) = X^0 \] using Second method of Liapunove

b) Determine the stability of the linear system given by

\[
\begin{bmatrix}
\dot{x}_1 \\
\dot{x}_2
\end{bmatrix} =
\begin{bmatrix}
-1 & -2 \\
1 & -4
\end{bmatrix}
\begin{bmatrix}
x_1 \\
x_2
\end{bmatrix}
\]

7.a) State and prove Krasovskii method for the construction of Liapunov function of a nonlinear system.

b) Investigate the stability of the equilibrium point of the system

\[
\begin{align*}
\dot{x}_1 &= x_2 \\
\dot{x}_2 &= x - x^2
\end{align*}
\]

using Krasovskii method

8. a) Find an admissible control \( u^*(t) \) which causes the system

\[ X(t) = f(X(t), u(t), t); X \in \mathbb{R}^n, u \in \mathbb{R}^p \]

To follow an admissible trajectory \( X^*(t) \) and minimizes the Performance measure

\[ J = h(X(t_f), t_f) + \int_0^{t_f} g(X(t), u(t), t) dt \]

with both ends are fixed and the control is unbounded.

b) A control system is described by

\[
X = \begin{bmatrix} 0 & 1 \\ 0 & 0 \end{bmatrix} X + \begin{bmatrix} 0 \\ 100 \end{bmatrix} u, X(0) = \begin{bmatrix} 1 \\ 0 \end{bmatrix},\]

Find the feed back matrix \( K \) by minimizing the performance Index

\[ J = \int (x_1^2 + 0.25 u^2) dt \]
POWER SYSTEM ANALYSIS AND DYNAMICS

SYLLABUS

UNIT-I: POWER SYSTEM STABILITY

Basic definitions, statement of the problem, elementary model, Swing equations, power angle equations, Natural frequencies of oscillations, and single-machine-infinite bus system-Equal area criterion-classical model of a multi machines systems.

UNIT-II: RESPONSE TO SMALL DISTURBANCES

The unregulated synchronous machine, Modes of oscillations of an unregulated multi machine system, regenerated synchronous machine, Distribution of power impacts.

UNIT-III: SYNCHRONOUS MACHINE


UNIT-IV: EXCITATION SYSTEMS

Typical Excitations configurations and excitation, (Automatic) Voltage regulators, Exciter Build-up, excitation system response and computer representations of excitations systems (types 1, 2, 3 and 4).

UNIT-V: EFFECT OF EXCITATION ON STABILITY

Effect on (a) Power limits, (b) Transient stability, (c) Dynamic stability, approximate excitation system representation, supplementary stabilizing signals.

Text Books:

Reference Books:
KL UNIVERSITY
Pre-Ph.D. Examination
POWER SYSTEM ANALYSIS AND DYNAMICS
Model Question Paper

Time: 3 hours
Max Marks: 100

Answer any five questions \( 5 \times 20 = 100 \text{M} \)

1. A Generator having \( H = 6.0 \, \text{MJ/MVA} \) is delivering power 1.0 P.U to an infinite to bus through a purely reactive network when the occurrence of a fault reduces the generator output power to zero. The maximum power that could be delivered is 2.5 P.U When the fault is cleared, the original network conditions again exist. Determine the critical clearing angle and critical clearing time. \( \text{(20M)} \)

2. (a) A 50 Hz four pole turbo generator rated 500 MVA, 22 KV has an inertia constant of \( H = 7.5 \, \text{MJ/MVA} \). Find (a) the kinetic energy stored in the rotor at synchronous speed. \( \text{(6M)} \)

   (b) the angular acceleration if the electrical power developed is 400 MW when the input rotation losses is 740000 h.p (c) if the acceleration is constant for a period of 15 cycles find the change in \( \delta \) in electrical degrees in the period and the speed in r.p. m at the end of 15 cycles. \( \text{(6M+8M)} \)

3. The data for the power system is given below in fig 1.0

\[
\begin{align*}
\text{Area 1} & : E_1 = 1.0 \angle \delta \\
\text{Tie line} & : 0.300 + j1.8 \text{P.U.} \\
\text{Area 2} & : E_2 = 1.0 \angle 0 \\
\text{Sending} & : + \\
\text{Receiving} & : - \\
\end{align*}
\]

Fig. 1.0
The systems data are given in PU on a 1000MVA base the capacity of area 1 is 20000 MW and that of area 2 is 14000 MW the inertia constants of the machines with the two areas are about equal.

(a) Find the equations of power for $P_1$ and $P_2$  

(b) Find the operating conditions when $P_1 = 100$ MW. This would correspond approximately to a 100M.W Tie line flow from area 1 to area 2.  

(C) Find the synchronizing power coefficients. 

4. A salient pole synchronous generator having the following per unit reactance’s $X_d = 1.15$  
$X_d = 0.37$; $X_q = 0.75$; $X_q = 0.75$. Is delivering current of 1.0 PU at 0.91 P.F lagging through a circuit breaker to an infinite bus having a voltage of 1.0 P.U of the circuit breaker is then opened

(a) How long may it be kept before being reclosed without loss of synchronism?  

(b) If this generator undergoes a three phase fault at its terminals which is cleared 0.2 sec later the exciter voltage is constant. Calculate $E_{1q}$ for rated load.  

5. The following data pertain to an exciter 

<table>
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<tr>
<th>Rated Voltage</th>
<th>250Volts</th>
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<tr>
<td>Rated out put</td>
<td>100 KW</td>
</tr>
<tr>
<td>Rated Speed</td>
<td>1800 rpm</td>
</tr>
<tr>
<td>Number of poles</td>
<td>6</td>
</tr>
<tr>
<td>Type of armature</td>
<td>simplex lap winding</td>
</tr>
<tr>
<td>Number winding of armature slots</td>
<td>108</td>
</tr>
<tr>
<td>Number of conductors per slot</td>
<td>4</td>
</tr>
<tr>
<td>Coefficient of dispersions shunt wound</td>
<td>1.15</td>
</tr>
<tr>
<td>Number of field turns per pole</td>
<td>-1500</td>
</tr>
<tr>
<td>Number of field circuits</td>
<td>-1</td>
</tr>
<tr>
<td>Field resistance</td>
<td>- 14.6 ohm</td>
</tr>
</tbody>
</table>

The magnetization curve is given in Fig2.0
6. The block diagram shown in fig 3.0 represents the machine terminal voltage at no load.

\[ V_{\text{ref}} \xrightarrow{\frac{10}{1+0.1s}} \frac{k}{1+0.2s} \xrightarrow{\text{exciting}} V_t \]

(a) Find the response of the terminal voltage if $V_{\text{ref}} = 1$ P.U. if $K=1$ \hspace{1cm} (10M)

(b) Find the highest value of $K$ for which the system does not lose stability. \hspace{1cm} (10M)

7. In fig 1 $\delta_1=30^0$, $H=2$: Find the swing equation if the mechanical input $P_m=1.0$ per unit; and find its solution. Missing data (if any) can be suitably assumed. \hspace{1cm} (20M)

8. (a) Explain the concept of equal area criterian. How can it be used to study transient stability \hspace{1cm} (10 M)

    (b) A generator operating at 50Hz delivers 1pu power to an infinite bus through a transmission circuit in which resistance is ignored. A fault takes place reducing the maximum power transferable to 0.5 pu. Whereas before the fault, this power was 2 pu and after the clearance of the fault it is 1.5 pu. By use of EAC determine the Critical clearing angle \hspace{1cm} (10 M)
POWER QUALITY

SYLLABUS

Unit I: Introduction
Introduction of the Power Quality (PQ) problem, Terms used in PQ: Voltage, Sag, Swell, Surges, Harmonics, over voltages, spikes, Voltage fluctuations, Transients, Interruption, overview of power quality phenomenon, Remedies to improve power quality, power quality monitoring

Unit II: Long Interruptions

Unit III: Short Interruptions
Definition, origin of short interruptions, basic principle, fuse saving, voltage magnitude events due to re-closing, voltage during the interruption, monitoring of short interruptions, difference between medium and low voltage systems. Multiple events, single phase tripping – voltage and current during fault period, voltage and current at post fault period, stochastic prediction of short interruptions.

Unit IV: Voltage sag – characterization – Single phase
Voltage sag – definition, causes of voltage sag, voltage sag magnitude, monitoring, theoretical calculation of voltage sag magnitude, voltage sag calculation in non-radial systems, meshed systems, voltage sag duration - Three phase faults, phase angle jumps, magnitude and phase angle jumps for three phase unbalanced sags, load influence on voltage sags.

Unit V: Mitigation of Interruptions and Voltage Sags
Overview of mitigation methods – from fault to trip, 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.

Text books:

Reference Book:
Model Question Paper

KL UNIVERSITY
Pre-Ph.D. Examination
POWER QUALITY

Time: 3 hours Max Marks: 100

Answer any five questions 5 X 20 = 100M

1. a) Explain the different Issues of power quality. 12M
   b) Explain the responsibilities of the suppliers and users of electrical power. 8M

2. a) what is an interruption? Clearly differentiate ‘Failure’, ‘Outage’ and ‘Interruption’. 10M
   b) Explain about i) origin and causes of short interruptions ii) fuse saving. 10M

3. Briefly explain the changes in voltage and current during fault period and post fault Period in single phase tripping. 20M

4. A) Describe the procedure for estimating the voltage sag performance. 8M
   b) Explain briefly how sag duration is measured. 12M

5. a) Distinguish different mitigation methods from fault to trip. 10M
   b) Explain the role of combined series and shunt controller for voltage mitigation. 10M

6. a) Explain voltage sag calculation in non-radial system. 10M
   b) What is meant by impulsive transient and oscillatory transient? Explain the causes and effects. 10M

7. a) Explain the methods of monitoring short interruption. 8M
   b) Define the phase term ‘phase single jump’. Derive an expression for magnitude jump versus distance. 12M

8. a. Explain how equipment immunity can be improved 10M
   b. Describe the operation of a combined shunt and series controller 10M
AI TECHNIQUES IN POWER SYSTEMS

Syllabus

UNIT-I ARTIFICIAL NEURAL NETWORK:

UNIT-II SUPERVISED LEARNING NETWORK:

UNIT-III FUZZY LOGIC

UNIT-IV GENETIC ALGORITHMS:
Introduction- Characteristics of Genetic algorithms- Basic operators and Terminologies in GAs - search space – Effects of Genetic operators - Traditional Algorithm Vs Genetic Algorithm - Simple GA - General Genetic Algorithm

UNIT-V APPLICATION TO ELECTRICAL SYSTEMS:
ANN based Short Term Load Forecasting - load flow studies - Fuzzy Logic based Unit Commitment and Genetic Algorithm based Economic Dispatch

TEXT BOOKS:

REFERENCE BOOKS:
KL UNIVERSITY
Pre-Ph.D. Examination
AI TECHNIQUES IN POWER SYSTEMS

Model Question Paper

Time: 3 hours                                      Max Marks: 100

Answer any five questions                       5 X 20 = 100M

1. Explain how neural networks helps in problem solving techniques   20M
2. Explain the basic mathematical model of an artificial neural network.   20M
3. Describe the activations functions & Explain the terminologies of ANN   20M
4. Draw & explain the architecture of Adaline & medaline in detail.   20M
5. Explain the basic models of genetic algorithms   20M
6. Discuss some of the properties of fuzzy logic   20M
7. Explain how a neural network helps in load forecasting & describe load flow problem.   20M
8. Give detailed description of back propagation learning algorithm. Illustrate with an example   20M
DISTRIBUTION SYSTEM PLANNING & AUTOMATION

Unit-I: Distribution system planning and load characteristics:
Planning and forecasting techniques, present and future role of computer, load characteristics, load forecasting, methods of forecasting, regression analysis, correlation analysis and time series analysis, load management, tariff, diversified demand method, and metering of energy.

Unit-II: Distribution transformers:
Types, Regulation and Efficiency, use of monograms for obtaining efficiency, distribution factors, KW - KVA-Method of determining regulation.

Design of sub transmission lines and distribution substation: Introduction, sub transmission systems, distribution substation, substation bus schemes, description and comparison of switching schemes, substation location and rating, application of network flow techniques in rural distribution networks to determine optimum location of substation.

Unit-III: Design considerations on primary systems:
Introduction, types of feeders, voltage levels, radial type feeders, feeders with uniformly distributed load and non-uniformly distributed loads.

Design considerations of secondary systems: Introduction, secondary voltage levels, secondary banking existing systems improvement.

Unit-IV: Capacitors in distribution systems and distribution system protection:
Effects of series and shunt capacitors, justification of capacitors, procedure to determine optimum capacitor size and location, basic definition and types of over current protection device, objective of distribution system protection, coordination of protective devices.

Unit-V: Distribution system automation:
Reforms in power sector, methods of improvement, reconfiguration, reinforcement, automation, communication systems, sensors, automation systems architecture, software and open architecture, RTU and data communication, SCADA requirement and application functions, GIS/GPS based mapping of distribution network, communication protocol for distribution systems, integrated substation, metering systems, revenue improvement, issuing multiyear tariff and availability based tariff, Grounding system: earth and safety, nature and size of earth electrodes, design of earthing schemes.

Text Books:

Reference Books:
Answer any five questions of the following;

1. Explain
   a. Regression Analysis
   b. Correlation Theory
   c. Time Series Analysis

2. Explain the Present and Future Role of Computer

3. a. Description and Comparison of Different Switching Schemes
   b. Described the Sub Station Location and Rating.

4. a. Explain Types of Feeders in detail.
   b. Discuss Secondary Voltage Levels

5. a. Explain Economic Justification for Capacitors.
   b. Describe Types of over Current Protective Devices.

6. Explain SCADA requirements and Application Function

7. Discuss the design of Earthing Schemes.

8. Explain how the analysis done for a hexagonal and square shaped sub station service area
POWER SYSTEM PROTECTION

UNIT-I
Need for protection systems: Nature and causes of faults, types of faults, effects of faults, fault statistics, evolution of protective relays, zones of protection, primary & back up protection, essential qualities of protection, classification of protective relays and schemes, CT, PT, summation transformer, phase-sequence current segregating network.

UNIT-II

UNIT-III
Pilot wire and Carrier Current Schemes; Use of optical fibers for protection schemes. System grounding—ground faults and protection; Load shedding and frequency relaying; Out of step relaying; Re-closing and synchronizing

UNIT-IV
Static Relays: Advantages of static relays, working principles of static impedance, static reactance using phase comparator, static distance, static over current, static differential relay using amplitude comparator, use of sampling comparator.

UNIT -V
Microprocessor based protection relays—Working principles of P based over current, impedance, reactance directional, reactance (distance) & mho relays—digital relaying algorithms, various transform techniques employed like discrete Fourier, Walsh-Hadamard, Haar, microprocessor implementation of digital distance relaying algorithms—protection of lines against lightning & traveling waves.

TEXT BOOKS:

REFERENCE BOOKS:
2. Wiley & Sons.
6. 5.S. Sunil Rao, “Switch Gear & Protection”, Khanna Publisher’s, Delhi
KL UNIVERSITY
Pre-Ph.D. Examination
POWER SYSTEM PROTECTION

Model Question Paper
TIME: 3HOURS MAX MARKS:100M

Answer any 5 questions. All questions carry equal marks 5x20=100M

1. a) Why the protection system is provided in a Power System? 4M
   b) What is meant by Zones of Protection? Explain Primary and Back up Protection. 8M
   c) Why different zones of protection of a power system are overlapped. Explain with a simple example. 8M

2. a) Make a list of faults that occurs on Generator. State the protection to be used for each of such faults 10M
   b) Distinguish between Overload protection, Short circuit protection and Earth fault protection of Motor 10M

3. What is Carrier-Aided distance protection? What are its different types? Discuss briefly about Transfer Tripping Schemes. 20M

4. a) Derive a generalized mathematical model of Distance Relays for Digital Protection. 10M
   b) Describe the realization of Directional Over-current Relay using a Microprocessor. 10M

5. a) What is the use of Frequency Relays for Load Shedding? 12M
   b) Write a detailed note on Static Frequency Relay. 8M

6. a) Discuss the merits of Optical Fibre Channel which can be used as a communication link. What is its future prospect? …10M
   b) What is a Summation Transformer? Where is it used? 10M

7. a) Discuss the Time-Graded Over-current Protection for Radial Feeders and Ring Main Feeders 8M
   b) Draw the generalized program flowchart for distance relays using microprocessor. 2M

8. a) Discuss how an amplitude comparator can be converted to a phase comparator and vice versa. 10M
   b) Discuss the principle of coincidence circuit for phase comparator 10M
ELECTRIC VEHICLES

UNIT-I: Introduction to Alternate Propulsion Systems: History and working principle of hybrid vehicles, configurations of hybrid vehicles, case studies of hybrid vehicles, fuel oil reserves and depletion, the need for alternate propulsion devices, introduction to electric vehicle, introduction to hybrid vehicle.

UNIT-II: Motors and Drives: Electromagnetic force, torque production from electromagnets, working principle of DC motor, variants of DC motors, torque-speed characteristics of DC motors, speed control of DC motors, merits and limitations of DC motors, Introduction to AC motors, Induction, permanent magnet and switched reluctance motors: working principle, torque-speed characteristics and control.

UNIT-III: Battery Technology: Energy density of various energy sources and storage devices, basics of battery, working principle, construction, of lead-acid, nickel cadmium, nickel metal hydride and lithium ion batteries, high voltage battery, various configurations of battery, maintenance free and low maintenance battery, recombination battery, AGM and valve regulated battery, battery capacity, current and voltage characteristics during charging and discharging, battery modeling, Peukart Capacity and discharging, battery failure modes, good practices of battery maintenance.


UNIT-V: Design of Plug-in Electric Vehicle (EV): Requirement of drive train of EV, various configurations of drive train in EV, transmissions systems, motor sizing for EV, tractive effort and transmission requirement, general EV configuration, Energy consumption pattern in EV, driving pattern in EV, control of EV, Case studies of series and parallel hybrid vehicle design practices.

TEXT BOOKS:

REFERENCE BOOKS:
KL UNIVERSITY
Department of Electrical & Electronics Engineering
ELECTRIC VEHICLES

Pre – Ph.D (Model Paper)

Duration: 3 hrs
Max Marks: 100 M

Answer any five of the following

1) Evaluate Induction Motor, PMSM, BLDC for EV application

2) What is hybridization ratio? What are the different types of HEV’s depending on hybridization factor? Do Hybrids Make Sense Economically? Justify.

3) Explain about EV/HEV programs around the world over the last 5years, describing the various goals, power range, motor used, type of IC engine, battery source?

4) The NiMH traction battery of the Toyota Prius 2004 model has the following specifications:
   168 cells (28 modules), 201.6V nominal voltage, 6.5 Ah nominal capacity, 28 hp (21 kW) output power, 1300 W/kg specific power, 46 Wh/kg specific energy.
   i) If the battery can be discharged at a maximum rate of 100 A, and only 40% can be discharged, for how many seconds can the battery be used when fully charged?
   ii) If the battery can be charged at a maximum rate of 90 A, and the current SOC is 40%, how long does it take to charge the battery to 80% SOC?
   iii) If the leakage current is 20 mA, how many days does it take for the battery to self-discharge from 80% SOC to 40% SOC?

5) How a battery is modeled using peukart’s capacity? Why Li ion battery is compact compared to Lead acid battery of same capacity?

6) Derive the expression for maximum tractive effort of a vehicle and When does vehicle slip

7) Derive the expression for efficiency of fuel cell and compare with Carnot limit.

8) Explain the energy consumption pattern of series HEV.
NON CONVENTIONAL ENERGY RESOURCES

Unit-1
SOLAR RADIATION: Extraterrestrial solar radiation, Terrestrial solar radiation, solar thermal conversion, solar ponds, solar heating/cooling technique, solar distillation, photovoltaic energy conversion, solar cells – 4 models.

Unit-2
WIND ENERGY: Planetary and local winds, vertical axis and horizontal axis wind mills, principles of wind power, maximum power, actual power, wind turbine operation, design parameters of wind turbine.

Unit-3
ENERGY FROM OCEANS: Ocean temperature differences, principles of OTEC plant operations, wave energy, devices for energy extraction, tides, simple single pool tidal system, double pool tidal system.

Unit-4
BIO-ENERGY & GEOTHERMAL ENERGY: Bio fuels, classification, direct combustion for heat and electricity generator, anaerobic digestion for biogas, biogas digester types, power generation. Origin and types of geothermal energy, geothermal energy extraction. MICRO-

Unit-5
HYDEL ELECTRIC SYSTEMS: Power potential–scheme layout-generation efficiency and turbine part flow-different types of turbines for micro hydel electric systems.

TEXT BOOKS:

REFERENCE BOOKS:
ENERGY CONSERVATION & AUDIT

Unit-1
BASIC PRINCIPLES OF ENERGY AUDIT: Energy audit- definitions, concept, types of audit, energy index, cost index, pie-charts, Sankey diagrams, load profiles, Energy conservation schemes- Energy audit of industries- energy saving potential, energy audit of process industry, thermal power station, building energy audit.

Unit-2
ENERGY MANAGEMENT:
Principles of energy management, organizing energy management program, initiating, planning, controlling, promoting, monitoring, reporting - Energy manger, Qualities and functions, language, Questionnaire - check list for top management. Demand side management.

Unit-3
ENERGY EFFICIENT MOTORS: Energy efficient motors, factors affecting efficiency, loss distribution, constructional details, characteristics - variable speed, variable duty cycle systems, RMS hp- voltage van at ion-voltage unbalance- over motoring- motor energy audit.

Unit-4
POWER FACTOR IMPROVEMENT, LIGHTING AND ENERGY INSTRUMENTS:
Power factor - methods of improvement, location of capacitors, PF with non linear loads, effect of harmonics on PF , PF motor controllers - Good lighting system design and practice, lighting control, lighting energy audit - Energy Instruments- watt meter, data loggers, thermocouples, pyrometers, lux meters, tongue testers, application of PLC"s.

Unit-5
ECONOMIC ASPECTS AND ANALYSIS: Economics Analysis - Depreciation Methods, time value of money, rate of return, present worth method, replacement analysis, life cycle costing analysis - Energy efficient measures- calculation of simple payback method, net present worth method - Power factor correction, lighting - Applications of life cycle costing analysis, return on investment.

TEXT BOOKS:

REFERENCE BOOKS: