2012 – 2013
M.TECH. AUTUMN (I SEMESTER) EXAMINATION
(ELECTRICAL ENGINEERING)
POWER SYSTEM & DRIVES / INSTRUMENTATION & CONTROL
MATHEMATICS

Maximum Marks : 60
Duration : Three Hours

"Students governed by the old ordinances will be examined out of 75 marks and their obtained marks shall be proportionately raised."

Note: Answer any FIVE questions.

1. (a) In the figure given below, assume that the probability of each relay being closed is p and that each relay is open or closed independently of each other. Find the probability that current flows from L to R.

(b) Urn 1 contains x white and y red balls. Urn 2 contains z white an v red balls. A ball is chosen at random from urn 1 and put into urn 2. Then a ball is chosen at random form urn 2. What is the probability that this ball is white?

(c) A certain item is manufactured by three factories, say 1, 2 and 3. It is known that 1 turns out twice as many items as 2, and that 2 and 3 turn out the same number of items (during a specified production period). It is also known that 2 percent of items produced by 1 and 2 are defective while 4 percent of those manufactured by 3 are defective. All the items produced are put into one stockpile, then one item is chosen from the stockpile and is found to be defective. What is the probability that it was produced in factory 1?

2. (a) The diameter on an electric cable, say X, is assumed to be a continuous random variable with pdf $f(x) = 6x(1 - x)$, $0 \leq x \leq 1$.

(i) Check that the above is a pdf.

(ii) Obtain an expression for the cdf of X.

(iii) Determine a number b such that $P(X < b) = 2P(X > b)$.

(iv) Compute $P \left( \frac{1}{2} < \frac{1}{3} < X < \frac{2}{3} \right)$.
(b) Suppose that the joint pdf of the two dimensional random variable \((X, Y)\) is given by
\[
f(x, y) = x^2 + \frac{xy}{3}, \quad 0 < x < 1, \quad 0 < y < 2
\]
= 0, elsewhere

Compute the following:

(i) \(P\left( X > \frac{1}{2} \right)\),  
(ii) \(P(Y < X)\),  
(iii) \(P\left( Y < \frac{1}{2} \mid X < \frac{1}{2} \right)\).

3. (a) Let \(X\) be a binomially distributed random variable with parameter \(p\), based on \(n\) repetitions of an experiment. Prove that \(E(X) = np\).

OR

(a’) Let \(X\) be a random variable. If \(V(X)\) denotes the variance of \(X\), prove that
\[
V(X) = E(X^2) - [E(X)]^2.
\]

(b) If \((X, Y)\) is a two-dimensional random variable and if \(X\) and \(Y\) are independent then show that
\[
V(X + Y) = V(X) + V(Y).
\]

(c) Suppose that the two-dimensional random variable \((X, Y)\) has joint pdf
\[
f(x, y) = kx(x - y), \quad 0 < x < 2, \quad -x < y < x
\]
= 0, elsewhere

(i) Evaluate the constant \(k\)
(ii) Find the marginal pdf of \(X\)
(iii) Find the marginal pdf of \(Y\)

4. (a) Consider the process \(X(t) = A_1 + A_2 t\) where \(A_1, A_2\) are independent r.v’s with \(E(A_i) = a_i, \text{var} (A_i) = \sigma_i^2, \ i = 1, 2\). Prove that the process is evolutionary.

(b) Consider the process \(X(t) = A \cos \omega t + B \sin \omega t\), where \(A, B\) are uncorrelated r.v’s each with mean 0 and variance 1 and \(\omega\) is a positive constant. Prove that the process is covariance stationary.

(c) Consider the process \(\{X(t), t \in \mathbb{T}\}\) whose probability distribution, is given by
\[
P\{X(t) = n\} = \frac{(at)^{n-1}}{(1 + at)^{n+1}}, \ n = 1, 2, \ldots
\]

\[= \frac{at}{1 + at}, \ n = 0
\]

Prove that the process \(\{X(t)\}\) is not stationary.

Contd....3
The points of trisection of a string are pulled aside through a distance $b$ on opposite sides of the position of equilibrium, and the string is released from rest. Find an expression for the displacement of the string at any subsequent time and show that the mid-point of the string always remains at rest.

Find particular solutions of the Laplace equation $\frac{\partial^2 u}{\partial x^2} + \frac{\partial^2 u}{\partial y^2} = 0$ by the method of separation of variables.

Using Fourier sine integral, show that

$$\int_0^\infty \sin \pi \lambda \sin \lambda x d\lambda = \begin{cases} \frac{1}{2} \pi \sin x, & 0 \leq x \leq \pi \\ 0, & x > \pi \end{cases}$$

Solve the integral equation

$$\int_0^\infty f(x) \cos \lambda x \, dx = e^{-\lambda}$$

using integral transform method.

If $F(s)$ and $G(s)$ are the complex Fourier transforms of $f(x)$ and $g(x)$ respectively, then show that

$$\int_0^\infty F(x) G(x) \, e^{-isx} \, ds = \int_0^\infty g(t) f(x - t) \, dt.$$

Find the ordinary and singular points of the differential equation

$$(1 - x^2) \frac{d^2 y}{dx^2} - 6x \frac{dy}{dx} - 4y = 0$$

Solve this equation near the ordinary point $x = 0$. Give the interval in which the solution will be valid.

Solve the differential equation

$$\frac{d^2 y}{dx^2} + \cot x \frac{dy}{dx} + 4y \csc^2 x = 0$$

By using substitution $Z = e \log \tan (x/2)$.

OR

Using method of Frobenius, obtain two linearly independent solutions of the differential equation

$$x^2 \frac{d^2 y}{dx^2} + x(x - 1) \frac{dy}{dx} + (1 - x)y = 0$$

about $x = 0$. Contd.....4
8. (a) For the Legendre polynomial $P_n(x)$, prove that

$$\int_{-1}^{1} P_m(x)P_n(x)\,dx = 0, \text{ if } m \neq n$$

$$= \frac{2}{2n+1}, \text{ if } m = n$$

Hence prove that

$$\int_{-1}^{1} \frac{P_n(\mu)}{\sqrt{1-2\mu \, h + h^2}} \, d\mu = \frac{2h^n}{2n+1}.$$ 

(b) For an integral $n$, prove that

$$J_n(x) = \frac{1}{\pi} \int_{0}^{\pi} \cos (n\theta - x \sin \theta) \, d\theta.$$ 

(c) Prove that

$$\int_{0}^{\infty} e^{-ax} J_0(bx) = \frac{1}{\sqrt{a^2 + b^2}}.$$ 

OR

(c') (i) Prove that

$$\frac{1+z}{z(1-2xz+z^2)^{1/2}} - \frac{1}{z} = \sum_{n=0}^{\infty} \left\{ P_n(x) + P_{n+1}(x) \right\} z^{n+1}.$$ 

(ii) Express $x^3 + 2x^2 - x - 3$ in terms of Legendre polynomials. [4+4+4]
"Students governed by the old ordinances will be examined out of 75 marks and their obtained marks shall be proportionately raised."

Answer any FOUR questions only.
Symbols have their usual meanings.
Assume suitable data, if not given.

1. (a) Under what conditions regenerative braking is possible in a separately excited dc motor fed by a fully controlled rectifier without changing connections of field or armature terminals?

1. (b) The no-load speed of a single-phase fully controlled rectifier fed separately excited dc motor drive remains constant for $\alpha < 90^\circ$ and decreases as $\alpha$ is increased beyond $90^\circ$. Explain.

1. (c) A separately excited dc motor, controlled by dual converter with non-simultaneous control, is operating in forward motoring mode. Briefly explain the steps to be followed for changing the operation to reverse motoring mode.

1. (d) Explain why dc shunt motor is not used in solar photovoltaic dc drives.

2. A 220 V, 1500 rpm, 11.6 A separately excited motor has the armature resistance and inductance of 2 $\Omega$ and 28.36 mH, respectively. This motor is controlled by a single-phase rectifier with controlled flywheeling. The ac source voltage is 230 V, 50 Hz. Identify the mode of operation and calculate the developed torque for $\alpha_n = 0$, $\alpha = 60^\circ$ and speed of (i) 1050 rpm, (ii) 891 rpm.

3. (a) Draw the circuit of a separately excited dc motor is controlled by a three-phase fully controlled rectifier. The machine is operating as a motor with firing angle $\alpha = 30^\circ$. Draw the waveforms of armature voltage and armature current for continuous and discontinuous conduction modes. Clearly indicate the conduction interval of each thyristor. Find the expressions for average armature voltage in each case.

3. (b) A 220 V, 1500 rpm, 11.6 A separately excited motor with armature resistance of 2
Ω is controlled by a single-phase fully-controlled rectifier with an ac source voltage of 230V at 50 Hz.

i. What should be the value of firing angle to get rated torque at 1000 rpm?

ii. Calculate the motor speed at rated torque and $\alpha = 160^\circ$ for the regenerative braking in the second quadrant.

4. What are the advantages of simultaneous control over non-simultaneous control on dual converter controlled dc drive? With the help of neat diagrams, explain the working of a closed-loop dual converter controlled dc drive with simultaneous control.

5. (a) Draw the circuit of a chopper that can be used to operate a dc motor both in forward motoring and forward braking modes. Draw and explain the waveform of the armature current, armature voltage and the source current when the motor is operating on no-load. Clearly indicate the conduction intervals of each semiconductor controlled device. Explain how these waveforms are changed if the motor is loaded to draw rated armature current.

5. (b) A 230 V, 500 rpm, 90 A separately excited motor has the armature resistance and inductance of 0.115 Ω and 11 mH, respectively. The motor is controlled by a class C chopper at 400 Hz. with a source voltage of 230 V.

i. Calculate the motor speed when it is operating in forward motoring mode at duty ratio $\delta = 0.5$ and half the rated torque.

ii. What will be the motor speed when regenerating at $\delta = 0.5$ and rated torque.

6. With the help of a block diagram, explain the working of a single-quadrant, closed-loop dc drive employing current limit control. Explain how the following may be realized:

1. speed sensor
2. current sensor
3. PI controller with current limiter
Note: Answer any four questions

<table>
<thead>
<tr>
<th>Q.1</th>
<th>The single-phase full converter shown in Fig. 1 is operated with PWM control. Draw the waveforms of input voltage, input current, and output voltage for 3-pulses per half cycle. Derive the expression for $V_{dc}$ (output voltage), and input current. The load current is assumed to be continuous, and has an average value of $I_a$. Explain how gate signals are generated for the switches.</th>
</tr>
</thead>
</table>

![Fig. 1. 1-ph Full converter](image)

2(a) With the help of circuit diagram of a forward converter (derived from step-down converter), obtain the expression for output voltage. What is the effect of transformer?
magnetizing current on the duty ratio?

(b) Discuss the advantages of using switched mode power supplies as compared to linear power supplies.  

Q.3. Draw the circuit diagram of series loaded resonant converter (half bridge configuration), and draw the waveforms of inductor current and capacitor voltage in discontinuous conduction mode. Explain the difference in working in continuous and discontinuous mode.

Q.4(a) With the help of simple circuit illustrate the basic concept of resonant-dc-link inverter with zero voltage switching.  

(b) A ZCS resonant converter shown in Fig.2 delivers a maximum power of 400 mW at $V_o=4V$. The supply voltage is $V_d = 12V$. The maximum operating frequency $f_{max} = 50 k\text{Hz}$. Determine the values of $L$ and $C$, $i_m/i_o=1.5$.

Fig 2 ZCS converter

Q5 (a) Describe the operation of UPFC. Explain its working and show that it is a complete compensator.
(b) Describe the operation of a switching converter (VAR controller) with minimum energy storage element.

Q6: Write notes on the following topics.

(i) Application of power electronics in wind energy conversion.

(ii) PQ problems and solutions for voltage mitigation

(iii) STATCOM
Maximum Marks: 60
Duration: Three Hours

"Students governed by old ordinance will be examined out of 75 and their obtained marks shall be proportionately raised"

Notes: Answer Q. No. 1 (which is compulsory) and any FOUR questions from the remaining questions.
Symbols and abbreviations have their usual meanings.
Assume suitable data if missing.

1. Answer any THREE of the following:

   (a) Derive from fundamental, the expression for mutual-inductances between the coils of stator phases a, b, c of a synchronous machine.

   (b) Show that Park's transformation is power invariant. Justify the use of Park's transformation in synchronous machine modeling.

   (c) State different methods of modelling the loads in power system. Describe any one type of load models. With the help of relevant expression(s) describe a general load model.

   (d) With the help of block diagram explain the operation of IEEE Type I Excitation system. Derive the state-space representation of this system.

2. Write the voltage equations of stator and rotor coils of an alternator, shown in Fig. 1, in terms of terminal voltages, coil currents and flux linkages. What are the natures of variations of different inductances of the machine with respect to the rotor position? With the help of Park's transformation transform the above voltage equation.

3. (a) Electric torque of a synchronous machine is given by

   \[ T_e = \frac{1}{2} \left[ i_s^1 \left( \frac{\partial L_{ss}}{\partial \theta} \right) i_s^1 + 2 \cdot i_s^1 \left( \frac{\partial L_{rs}}{\partial \theta} \right) i_r \right] \]

   Transform this relation using Park's transformation and express \( T_e \) in terms of d- and q-axes quantities.

(b) What types of steam turbine systems are commonly used? Differentiate between Tandem Compound and Cross Compound types of steam turbine systems and give the block diagram models of single heat type in both the cases.
4. (a) A synchronous machine is connected to a sinusoidal balanced voltage source of angular frequency \( \omega_0 \) and line-to-line voltage of \('V'\). Find the expressions of the currents in d- and q-axes and the electrical torque in terms of the machine parameters.

(b) How transmission lines are modeled? Apply Kron’s transformation to find the state equations in D-Q axes.

5. (a) With the help of suitable neat diagram explain the working of a static VAR compensator. Discuss its control characteristics. Describe, with the help of relevant block diagram, the model of the controller used in the system.

(b) Mention the functional block diagram of speed governing system of Hydro-turbines and explain its operation. Also discuss its transfer function model.

6. With the help of appropriate diagram explain the working of potential source controlled rectifier type of Static Excitation System. What will be the block diagram representation of it? Choose a proper state and give its state equations.

7. Write short notes on any TWO of the following:

(a) Self inductances of stator windings of synchronous machine.

(b) Choice of voltage and power base of stator and rotor windings of an alternator for p.u. quantities.

(c) For salient pole synchronous machine the relative values of \( X_d' \), \( X_q' \) and \( X_d \).

(d) Modelling of Steam Governor’s.

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Fig. 1: A Three phase salient pole synchronous machine
Note: Answer FOUR questions.
Assume suitable data, if any.
Symbols have their usual meaning.

1. (a) Form bus-incidence and branch path incidence matrices ‘A’ and ‘K’ respectively for the network shown in Fig.1. Show that $A_b K^t = U$. Take ground as reference. [12]

(b) Write performance equations of a primitive network in admittance and impedance form. [03]

2. Prove $\hat{Y}_{br} \cdot \hat{Z}_{loop} = U$, where $\hat{Y}_{br}$ and $\hat{Z}_{loop}$ are branch admittance and loop impedance matrices respectively for the augmented network. [15]

3. (a) Assuming that the Bus Impedance matrix is known for a partial network, derive the necessary relations to calculate the elements of modified Bus impedance matrix, if the new added element is a link. [10]

(b) Explain how would you modify $Z_{Bus}$ for removal of elements. [05]

4. (a) Explain how do you represent a three-phase network component in admittance form. [02]

(b) Show that for a 3-phase to ground fault admittance matrix is given by the following:

$$Y_f = \frac{1}{3} \begin{bmatrix}
y_0 + 2y_F & y_0 - y_F & y_0 - y_F \\
y_0 - y_F & y_0 + 2y_F & y_0 - y_F \\
y_0 - y_F & y_0 - y_F & y_0 + 2y_F
\end{bmatrix}$$

$$y_o = \frac{1}{Z_p + 3Z_g}$$

Where $Z_p$ is fault impedance for each phase to neutral and $Z_g$ is impedance from neutral to ground.

Contd.....2
5. (a) What are the usual assumptions made in the short circuit studies? 
(b) Derive expressions for the fault current and voltages during fault for a single-line-to-ground fault at one of the buses in a large power system using Theremin's equivalent of the system.

(b) Explain the term 'Contingency Analysis' with reference to power systems.

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Figure 1
1(a) What is an “optimal control problem”? What are the various requirements which are to be fulfilled for formulating an optimal control problem? Illustrate your answer with suitable example.

(b) Obtain the equation of the curve \( x(t) \) which start from origin and terminates on another curve \( y(t) = t^2 - 1 \) and should have minimum length as shown in Fig. 1.

\[ \begin{align*}
\text{Fig. 1} \\
 x(t) \\
 y(t) \\
 x(0) = 0, \quad x(t) = \frac{3}{2} \\
y(0) = \frac{\pi}{4}, \quad y(t) = \frac{\pi}{4} \\
\end{align*} \]

2(a) Discuss the free end point problem of calculus of variation. Derive the condition of transversality for different special cases.

(b) \[
J(x) = \int_0^\infty \left[ (x_1^2(t) + x_1(t)x_2(t) + x_2^2(t)) \right] dt
\]

The function \( x_1 \) and \( x_2 \) are independent, and the boundary conditions are.

\[
\begin{align*}
x_1(0) &= 0 \\
x_1\left(\frac{\pi}{4}\right) &= 2 \\
x_2(0) &= \frac{3}{2} \\
x_2\left(\frac{\pi}{4}\right) &\text{ free}
\end{align*}
\]

3(a) Discuss the Hamiltonian formulation of “BOLZA” problem. Derive the necessary condition required to be satisfied to obtain the solution.
3(b) A plant is described by
\[\dot{x}_1(t) = x_2(t)\]
\[\dot{x}_2(t) = u(t)\]
Find the control input which minimize a performance measure
\[J = \frac{1}{2} \int_0^2 u^2(t) \, dt\]
Using method of Hamiltonian. The boundary conditions are
\[x_1(0) = 1, \quad x_2(0) = 1\]
\[x_1(2) = 0, \quad x_2(2) = 0\]

4(a) Describe a linear quadratic regulator problem. Discuss its solution using Matrix Riccati equation.
(b) Find the extremal for the functional
\[J(x) = \int_{t_0}^{t_f} \sqrt{1 + \dot{x}_1^2(t)} \, dt\]
The boundary condition \(t_0=0, x(0)=0\) are specified, \(t_f\) and \(x(t_f)\) are free, but \(x(t_f)\) is required to lie on the line \(\theta(t) = -4t + 5\).

5(a) Describe the dynamic programming method of solving a discrete linear regulator problem?
(b) Derive the necessary condition for \(u\) to be an optimal control using Pontryagin minimum principle

6(a) Consider the system having the state equations
\[\dot{x}_1(t) = x_2(t)\]
\[\dot{x}_2(t) = -x_2(t) + u(t)\]
With the initial condition \(x(t_0) = x_0\), the performance measure to be minimized is
\[J(u) = \int_{t_0}^{t_f} \frac{1}{2} [x_1^2(t) + u^2(t)] \, dt\]
\(t_f\) is specified, and the final state \(x(t_f)\) is free.
Determine control that minimizes \(J\)
(i) When \(u(t)\) is not bounded.
(ii) When \(-1 \leq u(t) \leq 1\) for all \(t \in [t_0, t_f]\)

(b) Derive the recurrence relation of dynamic programming. How can it be used to solve an optimal control problem? Explain.
M. TECH. (I SEMESTER) EXAMINATION
(ELECTRICAL ENGINEERING)
FUZZY THEORY AND APPLICATIONS
(EE-646)

Maximum Marks: 60
Duration: Three Hours

"Students governed by old ordinance will be examined out of 75 and their obtained marks shall be proportionately raised"

Note:
(i) **Question No. 1 is compulsory.** Also answer any **Four** of the remaining questions. Marks of each question and its parts are indicated.
(ii) Symbols and abbreviations have their usual meanings.
(iii) Assume suitable value for missing data, if any.

1. Answer any **FOUR** of the following: \((4 \times 4 = 16)\)

   (a) Explain the terms Modus Ponens and Modus Tollens.

   (b) Sketch the block diagram of Fuzzy Inference System (FIS) and explain the functioning of each of its blocks.

   (c) Describe the axioms for T-norm and S-norm operators and give more general types of T-norm and S-norm operator.

   (d) Explain the importance of scaling factor in Fuzzy Logic Controller.

   (e) Two Fuzzy numbers \(A\) and \(B\) are defined for \(\forall x \in \mathbb{R}\). Define \((A - B)\), \(\text{Min}(A, B)\), and \(\text{Max}(A, B)\) and give an example for each.

   (f) Describe Composition of two Relations \(R_1\) on \((X \times Y)\) and \(R_2\) on \((Y \times Z)\) and properties of Composition of relations.

2. (a) Explain graphically any **THREE** the following terms associated with respect to fuzzy sets: \(3 \times 3 = 9\)

   (i) Universe of Discourse (UoD), Nucleus and support.

   (ii) Algebraic, bounded and drastic product.

   (iii) Fuzzy complement, Union and Intersection.

   (iv) Cylindrical extension and projection.

   (b) With the help of an appropriate curve(s) explain the properties of fuzzy sets.

3. Two Fuzzy numbers \(A\) and \(B\) are defined for \(\forall x \in \mathbb{R}\) as follows:

\[
\mu_A(x) =
\begin{cases}
0 & x \leq -2 \\
x / 2 + 1 & -2 < x \leq 0 \\
-x / 6 + 1 & 0 \leq x \leq 6 \\
0 & 6 < x
\end{cases}
\]

\(\text{contd. } \quad 2\)}
and
\[ \mu_B(x) = \begin{array}{ll}
0 & x \leq -4 \\
\frac{x}{7 + 4} & -4 \leq x \leq 3 \\
-\frac{x}{2} + \frac{5}{2} & 3 \leq x \leq 5 \\
0 & 5 \leq x
\end{array} \]

Find \((A + B), (A - B), (A \cdot B),\) and \(\min(A, B)\) in expression form. Also draw the graph for all operations.

**OR**

3'. Let two Fuzzy numbers \(A\) and \(B\) are defined as:

\[
\begin{array}{ccccccc}
A &=& 0 & 0.1 & 0.8 & 1 & 0.3 & 0 \\
\hline
2 & 3 & 4 & 5 & 6 & 7
\end{array}
\]

\[
\begin{array}{cccc}
B &=& 0 & 0.4 & 1 & 0.7 & 0 \\
\hline
2 & 3 & 4 & 5 & 6
\end{array}
\]

Calculate: (a) \(A + B\)  (b) \(B - A\)  (c) \(\text{Max}(A, B)\), and (d) \(A \cdot B\)

4. (a) Explain interval of confidence and \(\alpha\)-cut set with respect to a fuzzy set. (03)

(b) Elaborate the use of FIS as P, PI and PID controllers. (08)

5. (a) List the performance indices used to optimize a controller and their effect on overall system performance. (03)

(b) For the rule “If \(X\) is \(A\) then \(Y\) is \(B\)”, where:

\[
A = \frac{0.1}{x_1} + \frac{0.8}{x_2} + \frac{1.0}{x_3}
\]

and,

\[
B = \frac{0.1}{y_1} + \frac{0.4}{y_2} + \frac{0.9}{y_3}
\]

Obtain the Fuzzy relation using the following Implications. Also comment upon the result:

(i) Kleene-Dienes  (ii) Luckasiewicz

(iii) Godel  and  (iv) Mamdani

6. (a) What are the different types of Linguistic hedges? Elaborate them. (04)

(b) Compare the interpolation ability of Mamdani model, TSK model and Generalized model. (07)

7. Write short notes on any **TWO** of the following: (11)

(a) Basic Building Block of FIS.

(b) MF Generator using CMOS

(c) Current Replica Circuit using CMOS

(d) Multiplier and divider circuits using CMOS
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Any Four

Answer all questions.
Assume suitable data, if missing.
Symbols used have their usual meaning.

Q.1 (a) Explain the static characteristics of a measuring instrument with suitable example. (7)

(b) Explain input-output configuration of a generalized instrumentation system. What are the methods of correction of interfering input? (8)

Q.2 (a) Which type of error can be removed by statistical analysis? Explain how statistical analysis can be performed. (7)

(b) A voltmeter and an ammeter are to be used to determine the power dissipation in a resistor. Both instruments are guaranteed to be accurate within ±1% at full scale deflection. If the voltmeter reads 100V on its 150V range and the ammeter reads 55 mA on its 100mA range, determine the limiting error for the power calculated. (8)

Q.3 (a) With the help of diagram explain the operation of galvanometer type recorder. (7)

(b) What is the difference between electroluminescent display and electrophoretic image display? (8)

Q.4 (a) What is a transducer? Explain the basic requirements of a transducer. (7)

(b) What is data acquisition system? With the help of block diagram explain micro-controller based data acquisition system. (8)

Q.5 (a) Explain the advantages of digital indicating instruments over their analog counterpart. (7)

(b) Explain clearly the construction of 10 section single layer inductive voltage divider. Show that the ratio of voltages is independent of circuit parameter. (8)

Q.6 (a) What is purpose of signal conditioning of inputs? How it can be performed? (7)

(b) Differentiate between wave analyzer and spectrum analyser with neat sketch. (8)
2012-2013
M.TECH (1st SEMESTER) EXAMINATION
(ELECTRICAL ENGINEERING)
(Instrumentation and control)
PROCESS INSTRUMENTATION
(EE-652)

Maximum Marks: 60
Duration Three Hours
Students governed by the old ordinances will be examined out of 75 marks and their obtained marks shall be proportionately raised”.

Answer All Questions
Assume suitable data, if missing

Q 1(a) Differentiate between
1. Feed Back and Feed forward control
2. Single variable and Multivariable control
3. Cascade control and Ratio control

(b) Given the error in Fig 1, plot the graph of a PD and PID controller output as function of time. If Kp = 5.0, Ki = 0.7.0 \( Kd = 0.5 \) and \( P_{I0} = 25\% \).

6

Q2(a) With neat sketch, explain Electrical proportional controller. Mention its advantages and limitations.

(b) Define Rangeability? An equal percentage control valve has Rangeability of 32 if the maximum flow rate is 100 m\(^3\)/hr, find the flow rate at 2/3 and 4/5 open settings.

OR

Q2*(a) Derive the transfer function of an electronic PID controller. Explain the effect of integral and derivative controllers on the system performance.

6

contd .... 2
(b) Draw a neat sketch of Hydraulic proportional controller and explain its operation.

Q3(a) What is an actuator? Explain the pneumatic actuators commonly used in process industry.

OR

Q3'(a) With neat sketch, explain the control valves used in process industry.

Q3(b) A 5 cm diameter cylindrical tank is emptied by a constant out flow 1.0 m$^3$/min. A two position controller is used to open and close a fill valve with an open flow of 2.0 m$^3$/min. For level control the neutral zone is 1 m and the set point is 12 m calculate (i) cycling period and (ii) plot the liquid level versus time curve.

Q4(a) Explain computer supervisory control and direct digital control in a process and mention their advantages and limitations.

(b) For the system shown in figure (2) Specify the gain and phase margins. Is the system stable? If the nominal proportional gain is 11.5, determine the gain that will just provide a gain margin of at least 0.56 and phase margin of at least 40 degree.

OR

Q4'(a) What does tuning a control system mean? What are different tuning methods for feedback control system? Explain Transient response method.

(b) Write technical note on display systems.

Q5(a) Explain with diagram the commonly adopted techniques of Boiler control of a power plant.

Q5(b) What are parameters required to be controlled in paper pulp preparation? How they are controlled? Explain with neat sketch.

OR

Q5'(b) Write technical notes on Industrial Automation.
Fig (1)

% Error

2%

Time (Seconds)

Fig (2)

Angular frequency (rad/sec)
Note: (i) Answer any four questions.
(ii) Question No.1 is compulsory.
(iii) Symbols used have their usual meanings.

Q 1 (a) An overhead transmission line is struck by a lightning current of 5 kA. What happens to the line if it is:
(i) 400 KV 3-phase overhead line.
(ii) 220 KV 3-phase overhead line.
(iii) 132 KV 3-phase overhead line.

(b) Discuss the following example: Two arrester materials have the characteristics of \( IoV^6 \) and \( IoV^{40} \). For current variations from 10 A to 100000 A, determine the ratio of voltages at these currents to establish that ZnO lightning arrester is a better choice compared to SiC lightning arrester.

(c) Define BIL and discuss the use of V-t curves for insulation coordination.

Q.2 Discuss different types of lightning arrestors on the basis of their structures and describe in details the construction, working, merit and demerit of MOVs. Compare the characteristics of MOVs with SiC arrestors.

Q.3 Discuss Townsend's primary and secondary ionization coefficients. Derive the growth of current equation when both \( \alpha \) and \( \gamma \) processes are present. Explain the assumptions made.

Q.4 Differentiate between disruptive discharge and partial discharge. Derive equations to correlate the thickness of sheet insulation and its relative permittivity with that of inception voltage. State the assumptions made.

Q.5 Describe the use of SF\(_6\) as an arc quenching media in closed gas system and puffer type circuit breakers.

Q.6 Write notes on any three of the following
(i) Breakdown characteristics of different insulation on a graph.
(ii) Multiplying factors used for selecting insulation for a 400KV overhead transmission line
(iii) Insulation coordination scheme for 400KV overhead transmission system
(iv) Breakdown of solid insulation due to thermal instability.
2012-13
AUTUMN (I SEMESTER) EXAMINATION
M.TECH (Electrical)
(HIGH VOLTAGE ENGINEERING)
POWER SYSTEM MONITORING (EE-675)
Credits: 04

Maximum Marks: 60
Duration: Three Hours

"Students governed by the old ordinances will be examined out of 75 marks and their obtained marks shall be proportionately raised".

Note:
1. Answer FIVE questions.
2. Symbols and abbreviations have their usual meanings.

1. (a) What is meant by "preventive maintenance"? Discuss its need.
(b) What are the various in-service indicators of oil impregnated materials used in power system apparatus?
(06)

2. (a) Discuss the various measurable parameters employed to characterize the condition of insulating materials.
(b) What are the recommended tests for HV rotating machine stator? Briefly discuss the AC hipot test and DC hipot test.
(06)

3. (a) What is meant by partial discharge? Briefly explain the sources, forms and effects of partial discharge.
(b) Discuss various time domain measurements for assessing the quality of insulating materials.
(06)

4. (a) Using a schematic diagram discuss essential components of a partial discharge measuring circuit.
(b) What are the possible defects that may occur in (i) XLPE power cables (ii) Power capacitors (iii) HV bushings?
(06)

contd... 2
5. (a) What are the limitations of electrical partial discharge measurement when applied to test objects with large capacitance? (06)
(b) Explain using a schematic diagram, the principle of acoustic partial discharge detection. Also, discuss the relationship between electrical partial discharge and acoustic partial discharge. (06)

6. (a) Discuss the oscillating wave test and very low frequency testing of cables. (06)
(b) What are the attractive features of GIS over traditional substations? Discuss the particle initiated breakdown in GIS. (06)

7. (a) What are the various parameters that are used for assessing condition of outdoor insulators? (06)
(b) Using circuit diagrams discuss the calibration of partial discharge measuring circuit and detector. (06)
M.TECH. (I SEMESTER) EXAMINATION
(ELECTRICAL ENGINEERING)

Maximum Marks - 60
Credit - 04

Time - 3 Hours

Students governed by the old ordinances will be examined out of 75 marks and their obtained marks shall be proportionately raised.

TE: (i) Answer any FOUR questions.

(ii) Abbreviations and symbols used have their usual meanings.

(iii) Assume suitable value for missing data, if any.

(a) Show that the circuit in fig 1 is equivalent to a single (7) capacitor. Find its capacitance in terms of L and α.

![Fig 1]

(b) Prove that the network shown in fig 2 is equivalent to 1 ohm (8) resistor. Assume, inductor is flux controlled, capacitor is charge controlled and all initial conditions are zero.

![Fig 2]

2 (a) Define indefinite admittance matrix (IAM) for the network (6) shown in fig 3 find IAM:

(i) When all nodes are accessible.

(ii) Node “d” is suppressed

![Fig 3]

(b) Determine the transfer function matrix H(s) for the network (9) shown in fig 4. u1, u2 are the inputs and y1, y2 are the outputs.

contd ... 2
Q3(a) For the graph shown in fig 5, show that $B_fQ_f^T=0$.  

(b) The gyrator circuit and its corresponding graph are shown in fig 6(a) and 6(b) respectively. Use admittance matrix method to find branch voltage vector $V_b(s)$. $\alpha$ is gyrator constant and conductances of resistors are represented by $G$.
4(a) Distinguish between proper tree and a normal tree. Also write the sequence of numbering the branches of the network for state variable formulation.

(b) Obtain the state equation of the network shown in fig7 in normal form. Assume resistors, capacitor, and inductors are voltage, charge and flux controlled respectively with characteristics:
\[ v_1 = f_1(q_1), v_2 = f_2(q_2), i_g = f_3(q_3), i_4 = f_4(v_4) \text{ and } i_5 = f_5(v_5) \]

45(a) Find the total solution of the differential equation
\[
\begin{bmatrix}
\dot{x}_1 \\
\dot{x}_2 \\
\dot{x}_3
\end{bmatrix} =
\begin{bmatrix}
1 & 0 & 0 \\
0 & 1 & 0 \\
0 & 1 & 2
\end{bmatrix}
\begin{bmatrix}
x_1 \\
x_2 \\
x_3
\end{bmatrix} +
\begin{bmatrix}
1(t) \\
0 \\
0
\end{bmatrix};
\begin{bmatrix}
x_1(0) \\
x_2(0) \\
x_3(0)
\end{bmatrix} =
\begin{bmatrix}
0 \\
0 \\
1
\end{bmatrix}
\]
Where \( 1(t) \) denotes the step unit function.

(b) Write a short note on application of Newton-Raphson method for the analysis of nonlinear resistive network.

6(a) Test whether the given polynomial is Hurwitz or not?
\[ F(s) = 2s^6 + s^5 + 13s^4 + 6s^3 + 56s^2 + 25s + 25 \]

(b) Test if \( Y(s) = \frac{s(s^2+2)(s^2+4)}{(s^2+1)(s^2+3)} \) is a reactance function, if yes realize it in Foster first form.