2014 – 2015
M.TECH. AUTUM (I SEMESTER) EXAMINATION
(ELECTRICAL ENGINEERING)
(POWER SYSTEM & DRIVES / INSTRUMENTATION & CONTROL)
MATHEMATICS
(AM – 621-N)

Maximum Marks: 60
Duration: Three Hours

Note: Answer any FIVE questions by selecting TWO questions from Section ‘A’ and THREE questions from Section ‘B’.

SECTION – A

1. (a) (i) If p is the probability of happening of an event and p’ is the probability of happening of a second event after the first has occurred, then show that the probability that they both events should happen is pp’.

(ii) Write a short note on Rayleigh distribution.

(iii) An urn I contains 3 white and 4 red balls and an urn II contains 5 white and 6 red balls. One ball is drawn at random from one of the urns and is found to be white. Find the probability that it was drawn from urn I.

(b) In a distribution which is normal, 13% of the items are under 45 and 8% are over 64. Find the mean and variance of the distribution.

(b’) The following table gives the distribution of heights among the first year students of a university.

<table>
<thead>
<tr>
<th>Heights in inches</th>
<th>61</th>
<th>63</th>
<th>65</th>
<th>66</th>
<th>67</th>
<th>68</th>
<th>69</th>
<th>70</th>
<th>71</th>
<th>72</th>
<th>73</th>
<th>74</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequency</td>
<td>4</td>
<td>20</td>
<td>23</td>
<td>75</td>
<td>114</td>
<td>186</td>
<td>212</td>
<td>252</td>
<td>218</td>
<td>175</td>
<td>149</td>
<td>46</td>
</tr>
</tbody>
</table>

By comparing the proportion of cases lying between $\bar{x} \pm \frac{2}{3}\sigma$, $\bar{x} \pm \sigma$, $\bar{x} \pm 2\sigma$, $\bar{x} \pm 3\sigma$ for this distribution and for a normal curve, state whether this distribution may be considered normal.

(c) Fit a binomial distribution to the following frequency distribution:

<table>
<thead>
<tr>
<th>Number of successes</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequency</td>
<td>13</td>
<td>25</td>
<td>52</td>
<td>58</td>
<td>32</td>
<td>16</td>
<td>4</td>
</tr>
</tbody>
</table>

Calculate the theoretical frequencies. Find the standard deviation of both and compare them.

2. (a) Define Multiresolution analysis (MRA). Consider the space $V_j$ of all functions in $L^2(R)$ which are constant on intervals $[2^{-j}k, 2^{-j}(k + 1)]$, $j \in Z$. Show that the space $\{V_j\}$ satisfies all the requirements of MRA and construct a wavelet from above MRA.

Contd.....2
(a') (i) For any function $\phi \in L^2(\mathbb{R})$, show that the following conditions are equivalent:

(A) The system $\{\phi_{0k} = \phi(t - k) : k \in \mathbb{Z}\}$ is orthonormal.

(B) $\sum_{k \in \mathbb{Z}} \left| \hat{\phi}(w + 2k\pi) \right|^2 = 1$ almost everywhere.

(ii) State Shannon scaling function and wavelet function.

(b) Find the Fourier sine transform of $F(x)$, \[ F(x) = \begin{cases} 0 & , 0 < x < a \\ x & , a \leq x \leq b \\ 0 & , x > b \end{cases} \]

3. (a) Write a short note on the following

(i) Haar and Scaled Haar Wavelet functions

(ii) Quadratic and cubic Bezier curves.

(b) Find by the method of separation of variable the solution $u(x, t)$ of boundary value problem

$$\frac{\partial u}{\partial t} = 3 \frac{\partial^2 u}{\partial x^2}, \quad t > 0, \quad 0 < x < 2$$

$$u(0, t) = 0, \quad u(2, t) = 0, \quad t > 0$$

$$u(x, 0) = x, \quad 0 < x < 2.$$ 

SECTION – B

4. (a) Evaluate the pivotal values of the following equation taking $h = 1$ and up to one half of the period of vibration $16 \frac{d^4 u}{dx^4} = \frac{d^2 u}{dt^2}$ given that $u(0, t) = u(5, t) = 0$; $u(x, 0) = x^2(5 - x)$ and $u_t(x, 0) = 0$.

(b) Solve the elliptic equation $u_{xx} + u_{yy} = 0$ for the following square mesh with boundary values as shown in figure below. Iterate until the maximum difference between successive values at any point is less than 0.005.

```
<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>u1</td>
<td>u2</td>
</tr>
<tr>
<td></td>
<td>u3</td>
<td>u4</td>
</tr>
<tr>
<td>2</td>
<td>u5</td>
<td></td>
</tr>
</tbody>
</table>
```

Contd.....3
5. (a) Use Bender Schmidt recurrence relation to solve the equation:

\[
\frac{\partial^2 u}{\partial x^2} = \frac{\partial u}{\partial t}
\]

with the condition \( u(x, 0) = \sin \pi x \) for \( 0 \leq x \leq 1 \) and \( u = 0 \) at \( x = 0 \) and \( x = 1 \) for \( t > 0 \). Take \( h = 0.2 \), \( \lambda = 1 \) and compute the value of 4 at the internal mesh point up to two time steps.

(b) Define the wavelet with an example. Let \( \phi \) be a wavelet and \( \psi \) be a bounded integer function. Then show that the convolution function

\[
\phi \ast \psi
\]

is a wavelet.

6. (a) Define orthogonalization of causal B-spline scaling function.

(b) Discuss the scaled and translated version of wavelet \( \phi(t) = te^t \). Also discuss the application of wavelets.

7. (a) Derive Daubechies Wavelet system with three moment (a 6-tap-wavelet system).

(b) If \( z = e^{-iw} \), then \( |(z - z_j) (z - z_j)^{-1} | = | z_j |^{-1} (z - z_j)^2 \).
2014-15
M.TECH (AUTUMN SEMESTER) EXAMINATION
ELECTRICAL ENGINEERING
ADVANCED ELECTRIC DRIVES I
EE 611

Maximum Marks: 60 Credits: 04 Duration: Three Hours

Answer ANY FIVE questions.
Assume suitable data if missing.
Notations used have their usual meaning.

Q.No. Question M.M.
1(a) A separately excited dc motor is fed from a 1-phase fully-controlled rectifier. Draw the waveforms of voltage across and the current through the armature for different modes of steady-state motoring operations. Assume that speed remains constant. Also show the interval of conduction for each thyristors. [09]

1(b) The no-load speed ($\omega_{n0}$) of a single-phase fully-controlled rectifier fed separately excited dc motor drive remains constant ($\omega_{n0} = V_m / K$) for firing angle ($\alpha = 90^0$) and decreases as $\alpha$ is increased beyond $90^0$. Explain it. Here, $V_m$ is the peak value of the supply voltage and $K$ is motor constant. [03]

2(a) Consider a separately excited dc motor which is being fed from a single-phase fully-controlled rectifier. Derive the relation for its torque speed characteristics when it is operating in mode IV (a discontinuous conduction mode). Also give the circuit diagram and show the waveforms of armature voltage and armature current for this mode of operation. Mention the conditions to be satisfied for operation in this mode. [08]

2(b) A dc series motor is driving a load whose torque is proportional to the square of the speed. When supplied with 200 V it takes 100 A and runs at 1000 rpm. The total resistance of the armature and field is 0.1 $\Omega$. What voltage should be applied to the motor to reduce its speed to 500 rpm? Assume the magnetic circuit of the motor is [04]
linear, and neglect friction and windage.

3(a) A 2.4 kW, 220 V, 480 rpm, 12.8 A separately excited dc motor has an armature resistance and inductance of 2.2 Ω and 40 mH, respectively. It is fed by a single-phase fully-controlled rectifier with an ac source voltage of 240 V, 50 Hz. Identify the mode of operation and calculate the speed for $\alpha = 60^\circ$ and developed torque is 60 N-m.

3(b) Why dc shunt motor is not used in solar photovoltaic dc drives? Give the suitable characteristics to explain it.

4(a) Describe the self-control operation of synchronous motor drive.

4(b) With the help of neat circuit diagram and waveforms of gating signals, voltage and current explain the Pulse-Width Modulated operation of a separately excited dc motor fed from a single-phase converter.

4(c) Derive the transfer function of a separately excited dc motor with armature voltage control. From this show that $I_a(s) / V_a(s)$ can be approximated with a first order transfer function.

5(a) A separately excited dc motor is fed from a three-phase fully-controlled rectifier for its closed-loop speed control operation. The current loop and the speed loop use PI controllers. With the help of relevant transfer function of different components of the system and block diagram explain the procedure to design the gains of any one of the two controllers.

5(b) Prove that the average current in current-limit control operation of chopper feeding a dc motor is constant.

6(a) With the help of circuit diagram and relevant waveforms describe the operation of...
current source inverter with load commutation feeding a synchronous motor. Describe its merits and demerits.

6(b) Why a load adapter is required in solar powered drive? Explain its principle with the help of relevant characteristics.

6(c) A 2.2 kW, 220 V, 11.6 A, 1500 rpm separately excited dc motor has an armature resistance and inductance of 2 Ω and 32.5 mH, respectively. This motor is controlled by a chopper of frequency 500 Hz and the input voltage of 220 V. The motor is driving a load whose torque is proportional to the speed. At duty ratio (D) = 0.9 the motor runs at 1260 rpm. What will be the value of D and the current ripple at 800 rpm?

7(a) With the help of (i – v) and (p – v) characteristics of a solar cell explain its maximum power point operation. Discuss the different options of motors for water pumping application of PV array. What are the various possibilities for its operation with DC and AC motors? Explain them giving the relevant circuit diagram or block diagram.

7(b) Describe different types of synchronous motors used in drive applications.
### Question 1(a)
What are different types of PWM voltage-source inverters? Prove mathematically, the harmonics of output voltage of a voltage source inverter (VSI) can be minimized using PWM control?

### Question 1(b)
Explain the effects of Amplitude-Modulation Index ($M_a$) and Frequency modulation ratio ($M_f$) in PWM based inverters?

### Question 2(a)
What are merits and demerits of current-source inverters (CSI). With the help of waveforms, explain the working of a three-phase CSI?

### Question 2(b)
Explain, how is the modulating (intermediate) state-vector realized in state-vector modulation-based inverters?

### Question 3(a)
Describe with the help of waveforms and mathematical analysis, the cascaded multi-level voltage source inverter.

### Question 3(b)
Compare different types of multi-level inverters.

### Question 4(a)
Describe applications of multi-level inverter in electrical drives and power systems.

### Question 4(b)
What is significance of four-leg inverters, explain.

### Question 5(a)
What are merits and demerits of matrix converters? Explain the working principle of matrix converters.

### Question 5(b)
Show different types of switches (connections/combinations) used in matrix converters.

### Question 6(a)
The resonant converter circuit shown in figure-1, has $R = 200\Omega$, $L = 100\, mH$, $C = 100\, \mu F$ and $V_{dc} = 100V$. Select a suitable value of $N$ and find the output voltage (across $R$) at maximum switching frequency.

### Question 6(b)
With the help of wave forms, explain the working of a resonant dc link converter.
7. Write short notes on any **TWO** of the following topics: 6+6
   (a) Phase displacement control of PWM inverters
   (b) Comparison of conventional and resonant converters
   (c) Parallel-loaded LC resonant converters
   (d) Star-delta 12-pulse converters

![Figure 1](image-url)
2014-15
M.TECH (AUTUMN SEMESTER) EXAMINATION
POWER SYSTEM & DRIVES/HIGH VOLTAGE & INSULATION ENGINEERING
DIRECT ENERGY CONVERSION
EE-623

Maximum Marks: 60 Credits: 04 Duration: Three Hours

Answer any FIVE questions. Assume suitable data if missing. Notations used have their usual meaning.

Q.No. Questions M.M.
1(a) What do you mean by R/P ratio? Name the top three coal exporting countries in the world. Sketch the R/P ratio (for 2011 by region) for Asia Pacific, Middle East and North America. [6]
1(b) What is OPEC and when was it formed? Give the aims and objectives of its formation. Discuss in brief the oil crisis of 1973 and its after effects. [6]
2(a) Write notes on Jawaharlal Nehru National Solar Mission. [4]
2(b) Explain thin film technology of solar cell? Differentiate between monocrystalline and multicrystalline solar PV cells. [4]
2(c) Draw a curve efficiency versus band gap (eV) of Ge, Si, GaAs and CdTe. [4]
3(a) What do you mean by thermoelectric effect and Peltier effect? Give their applications. [4]
3(b) Discuss the basic characteristic features of thermionic converters. Give the name of materials used for it. [4]
3(c) Calculate the open-circuit voltage and maximum power output for an MHD generator having following data:
Plate area = 0.25 m²
Distance between the electrodes = 0.50 m
Flux density = 2 wb/m²
Average gas velocity = 1000 m/s
Gaseous conductivity = 10 mho/m [4]
4(a) What are Pico hydro power plants? How do you provide the hydroelectric power to even the smallest huts? [6]
4(b) Describe briefly the environmental impact of micro hydro power plants and their advantages. [6]
5(a) What are Oysters? Explain the working and facts of of Oysters. [6]
5(b) Explain how wave energy is generated and derive expressions for energy and power density of waves. [6]

contd... 2.
6(a) Describe the main features of Lockheed Martin's OTEC technology and its environmental impact.

6(b) What is Lambert's law? Discuss the variation of Ocean temperature with depth.

7(a) What are Tidal Fences? Describe the advantages of Tidal Fence over first generation tidal power plants.

7(b) Describe Tidal In-Stream Energy Conversion (TISEC) present developments and discuss:
   (i) Power train
   (ii) Maintenance
Maximum Marks: 60

Credits: 04

Duration: Three Hours

Answer any FIVE questions.
Assume suitable data if missing.
Notations used have their usual meaning.

1. Why do we transform the stator quantities (voltage or current) from abc reference to dqv reference of frame? Prove that if we choose \( K_d = K_q = \frac{2}{3} \) then the peak value of \( i_d \) and \( i_q \) and stator currents are same and if we choose \( K_d = K_q = \sqrt{\frac{2}{3}} \) in Park's Transformation Matrix, then the matrix is orthogonal.

2. A 555 MVA, 24 kV, 0.9 p.f., 50 Hz, 3 phase, 2 pole synchronous generator has the following inductances and resistances associated with the stator and field windings:

\[
\begin{align*}
I_{aa} & = 3.2758 + 0.0458 \cos(2\theta) \text{ mH} \\
I_{ab} & = -1.6379 - 0.0458 \cos \left(2\theta + \frac{\pi}{3}\right) \text{ mH} \\
I_{afd} & = 40.0 \cos \theta \text{ mH} \\
I_{ffa} & = 576.92 \text{ mH} \\
R_a & = 0.0031 \Omega \\
R_{fd} & = 0.0715 \Omega
\end{align*}
\]

(i) Determine \( L_d \) and \( L_q \) in Henrys.
(ii) If the stator leakage inductance \( l_t \) is 0.4129 mH, determine \( l_{ad} \) and \( l_{aq} \) in Henrys.
(iii) Using the machine rated values as the base values for the stator quantities, determine the per unit values of the following in the \( L_{ad} \)–base reciprocal per unit system:

\[
\begin{align*}
L_l, L_{ad}, L_{aq}, L_d, L_q, L_{afd}, L_{fda}, L_{fd}, R_a, R_{fd}
\end{align*}
\]

3. Derive stator voltage equations in dqv components. Differentiate between transformer and speed voltages. Describe the significance of speed voltages.

4. Develop block diagram representation of swing equations including damping torque. What is mechanical starting time (M)? Show that \( M = 2H \) second.

If the \( WR^2 \) of the rotor (including the turbine rotor) of the 555 MVA, 50 Hz, 3 phase, 2 pole generating unit is 654,158 lb.ft², compute the following:

(i) Moment of inertia \( J \), Kgm²
(ii) Inertia constant \( H \), MWs/MVA rating
(iii) Stored energy, MWs at rated speed
(iv) The mechanical starting time, \( s \)
5.(a) For an un-transposed transmission line, compute admittance matrices $B^{-1}$ and $B^{-1} A$. [8]
5.(b) With suitable circuit diagram, explain the modelling of a two winding transformer incorporating p.u. turns ratio 1: a . [4]
6.(a) Derive the transfer function model of speed governing system for turbo-generators. [8]
6.(b) Draw the zero sequence equivalent circuit of a three winding Delta- Star- Delta transformer with the star neutral grounded through $Z_n$. [4]
7.(a) Describe the working of a brushless excitation system for an alternator. [7]
7.(b) State different methods of modelling the loads in a power system. [5]
1(a). Draw the oriented connected graph of figure 1. Choose the tree whose branches are (1, 3, 5). Find the basic loop and basic cutest matrices using bus incidence matrix. Take bus 1 as reference bus.

![Figure 1](image)

1(b). Prove that $Y_{BUS} = A^t y A$

2. Form the bus impedance matrix by $Z_{BUS}$ building algorithm of the network as shown in figure 2.

![Figure 2](image)

The data for the two bus system is given in Table 2.

**Table 2: Impedance for two bus system (all are in p.u.)**

<table>
<thead>
<tr>
<th>Element number</th>
<th>Bus code $p - q$</th>
<th>Impedance $z_{pq,pa}$</th>
<th>Bus code $r - s$</th>
<th>Impedance $z_{pq,rs}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1-2(1)</td>
<td>0.6</td>
<td>1-2(1)</td>
<td>0.2</td>
</tr>
<tr>
<td>2</td>
<td>1-2(2)</td>
<td>0.4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>1-2(3)</td>
<td>0.5</td>
<td>1-2(1)</td>
<td>0.1</td>
</tr>
</tbody>
</table>

3. Using symmetrical components, calculate the following for a three phase fault at bus 4 for the sample system as shown in figure 3.

(i) Total fault current
(ii) Bus voltages during fault
(iii) Short circuit currents in lines connected to the faulted bus

The data (in p.u.) for the sample network are:

$Z_{44}^{(1)} = j0.2928$, $Z_{24}^{(1)} = j0.0586$, $Z_{34}^{(1)} = j0.0439$, $Z_{43,43}^{(1)} = j0.6$, $Z_{24,24}^{(1)} = j0.4$. Conclusion...
For the network shown in figure 4. With bus 1 as the slack bus, use Fast Decoupled Load Flow method to obtain one iteration for the load flow solution. The line and bus data is given in Tables 4.1 and 4.2 respectively. The transformer impedance is referred to the unity side of the tap. Use a flat start.

**Table 4.1 Line data (all are in p.u.)**

<table>
<thead>
<tr>
<th>Line no.</th>
<th>Between Buses</th>
<th>Line Impedance</th>
<th>Half Line Charging Admittance</th>
<th>Off-nominal turns ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1-2</td>
<td>0+j0.1</td>
<td>0</td>
<td>-</td>
</tr>
<tr>
<td>2</td>
<td>2-3</td>
<td>0+j0.2</td>
<td>0</td>
<td>-</td>
</tr>
<tr>
<td>3</td>
<td>3-1</td>
<td>0+j0.2</td>
<td>0</td>
<td>1.1</td>
</tr>
</tbody>
</table>

A static shunt capacitor at bus 3 is present with admittance=j0.005

**Table 4.2 Bus data (all are in p.u.)**

<table>
<thead>
<tr>
<th>Bus No.</th>
<th>Type</th>
<th>Generator</th>
<th>Load</th>
<th>Voltage magnitude [V]</th>
<th>Reactive Power Limit</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Slack</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>2</td>
<td>P-V</td>
<td>5.3217</td>
<td>-</td>
<td>1.1</td>
<td>0</td>
</tr>
<tr>
<td>3</td>
<td>P-Q</td>
<td>-</td>
<td>-</td>
<td>0.5339</td>
<td>5.3217</td>
</tr>
</tbody>
</table>

Formulate Optimal Power Flow Problem without inequality constraints, inequality constraints on control variables and inequality constraints on dependent variables. Also describe the computational procedure by steepest descent technique for equality constraints.

6(a). What is primitive network? Represent three-phase power system for short circuit studies and also explain the assumptions made for the short circuit representation.

6(b). Derive the equations for the fault current and bus voltages during fault at faulted bus p and at the buses other than P for line to line fault in terms of symmetrical components and phase quantities.

7. Derive the algorithm for the formulation of three phase bus impedance matrix $Z_{BUS}$ by the addition of branch and link.
M.TECH. AUTUMN (I SEMESTER) EXAMINATION
ELECTRICAL ENGINEERING (INSTRUMENTATION & CONTROL)
OPTIMAL CONTROL
EE-641

Maximum Marks: 60  Credits: 04  Duration: Three Hours

Answer any five questions.
Assume suitable data if missing.
Notations used have their usual meaning.

Q.No.  Question  M.M.
1. Define and explain:
   i) Admissible control  ii) Tracking problem  iii) Bang-bang control  iv) $H_\infty$ control  [12]
2(a) Define and explain the significance of Lagrange and Hamiltonian functions.  [04]
2(b) Derive Euler-Lagrange equation for optimal control.  [08]
3(a) Define and explain the principle of Optimality.  [03]
3(b) Use dynamic programming to find $u(0)$ and $u(1)$ that minimize

$$J = (x(2) - 2)^2 + \sum_{k=0}^{1} u^2(k)$$

Subject to $x(k+1) = x(k) + u(k), \ x(0)=1$  [09]
4 Find the equation of extremal for the performance measure  [12]

$$J(x) = \int_{t_1}^{t_2} [1 + x^2(t)]^\frac{1}{2} dt$$

The initial state is given as $x(t_1) = 2$, the final state is required to lie on the curve $c(t) = -4t+5$. Given $t_1 = 0$ and $t_2$ is free.  [12]
5 Derive an expression for co-state equations of Pontryagin’s principle.  [12]
6 Derive Hamilton-Jacobi-Bellman equation and discuss its applications in solving an optimal control problem.  [12]
7 Derive the equations involved in finding optimal state feedback for a Linear Quadratic Regulator problem and explain the role of Riccati equation in it.  [12]
### Question 1
(a) Briefly describe the relative frequency and axiomatic approach to probability. What is the limitation of the relative-frequency approach?

(b) Define the uniform probability density and distribution functions. Show that the mean and variance of the random variable with uniform density function in the interval \([a, b]\) are:

\[
\bar{X} = \frac{(a + b)}{2} \quad \text{and} \quad \sigma_X^2 = \frac{(b - a)^2}{12}
\]

### Question 2
In a game show contestants choose one of three doors to determine what prize they win. History shows that the three doors, 1, 2, and 3, are chosen with probabilities 0.30, 0.45 and 0.25 respectively. It is also known that given door 1 is chosen, the probabilities of winning prizes of $0, $100, and $1000 are 0.10, 0.20, and 0.70. For door 2 the respective probabilities are 0.50, 0.35, and 0.15 and for door 3 they are 0.80, 0.15, and 0.05. If \(X\) is a random variable describing dollars won, and \(D\) describes the door selected (values of \(D\) are \(D_1 = 1, D_2 = 2, \) and \(D_3 = 3\)), find:

(i) \(F_X(x|D = D_1)\) and \(f_X(x|D = D_1)\)

(ii) \(f_X(x|D = D_2)\)  (iii) \(f_X(x|D = D_3)\)  (iv) \(f_X(x)\)

### Question 3
(a) A certain typist sometimes makes mistakes by hitting a key to the right or left of the intended key, each with a probability of 0.02. The letters E, R, and T are adjacent to one another on the standard QWERTY keyboard, and in English they occur with probabilities of \(\Pr(E) = 0.1031, \Pr(R) = 0.0484, \) and \(\Pr(T) = 0.0796.\)

(i) What is the probability with which the letter R appears in text typed
(ii) What is the probability that a letter R appearing in text typed by this typist is in error?

(b) Sample functions from a deterministic random process are described by:

\[ X(t) = \begin{cases} \alpha t + B & t \geq 0 \\ 0 & t < 0 \end{cases} \]

where \( A \) is a Gaussian random variable with zero mean and a variance of 9 and \( B \) is a random variable that is uniformly distributed between 0 and 6. \( A \) and \( B \) are statistically independent.

(i) Find the mean and variance of this process.

(ii) If a particular sample function is found to have a value of 10 at \( t = 2 \) and a value of 20 at \( t = 4 \), find the value of the sample function at \( t = 10 \).  

4 (a) List the properties of power density spectrum.

(b) Three zero mean, unit variance random variables \( X, Y \) and \( Z \) are added to form a new random variable \( W = X + Y + Z \). Random variables \( X \) and \( Y \) are uncorrelated, \( X \) and \( Z \) have a correlation coefficient of \( 1/2 \) and \( Y \) and \( Z \) have a correlation coefficient of \( -1/2 \).

(i) Find the variance of \( W \).

(ii) Find the correlation coefficient for \( W \) and \( X \).

(iii) Find the correlation coefficient between \( W \) and the sum of \( Y \) and \( Z \).

5 (a) A random process is defined by \( Y(t) = X(t) - X(t-a) \), where \( X(t) \) is a wide-sense stationary process and \( a > 0 \) is a constant. Find the autocorrelation function and power density spectrum of \( Y(t) \) in terms of the corresponding quantities for \( X(t) \).

(b) Specify the properties of the Correlation matrix for a stationary discrete-time stochastic process.

6 (a) Write a short note on Stochastic models. Identify three popular types of linear stochastic models.

(b) Consider an MA process \( x[n] \) of order 2 described by the difference equation:

\[ x[n] = v[n] + 0.75 v[n-1] + 0.25 v[n-2] \]

where \( v[n] \) is a zero-mean white noise process of unit variance. The requirement is to approximate this process by an AR process \( u[n] \) of order \( M = 2 \) and \( 5 \) respectively.
7 (a) Consider a linear discrete-time filter with input as a time series \( u(0), u(1), \ldots \) and the filter characterised by the impulse response \( w(0), w(1), \ldots \) At some discrete time 'n' the filter produces an estimate \( y(n) \) of the desired output \( d(n) \). Let the estimation error be denoted by \( e(n) \). Using the principle of orthogonality, prove that
\[
E[y_0(n)e_0(n)] = 0
\]
where, \( y_0(n) \) is the filter output optimised in the mean-square sense and \( e_0(n) \) is the corresponding estimation error.

(b) Consider the Wiener Filtering problem with:
\[
R = \begin{bmatrix} 1 & 0.5 \\ 0.5 & 1 \end{bmatrix} \quad \text{and} \quad p = \begin{bmatrix} 0.5 \\ 0.25 \end{bmatrix}
\]
where \( R \) is the correlation matrix of the input vector \( u(n) \) and \( p \) is the cross correlation vector between \( u(n) \) and the desired response \( d(n) \). The variance of the desired response is 0.5.

(i) Evaluate the tap weights of the filter.

(ii) Find the minimum mean squared error produced by this filter.
1(a) A voltage, $V = (200 \pm 2)$ volt is applied across two resistances $R_1 = (60 \pm 3)$ ohm and $R_2 = (30 \pm 2)$ ohm are connected in parallel. Find the resulting power consumed by combination and the error associated in the measurement of power.

1(b) A resistance strain gauge with gauge factor 2.4 is wound on steel beam whose Young's modulus of elasticity $Y = 2 \times 10^6$ kg/m$^2$. The strain gauge has an unstrained resistance of 120 ohm which increases to 120.1 ohm, when the beam is subjected to a stress. Calculate the stress at the point where the strain gauge is wounded.

2(a) What are the different types of input in any system? Explain them with the help of examples and generalized block diagram of input-output configuration.

2(b) Define the following terms:
   (i) Accuracy
   (ii) Resolution
   (iii) Noise
   (iv) Limiting error

3(a) What are the different types of inductive transducers? Explain the measurement of displacement using inductive transducer.
3(b) What are the commonly known ionizing radiations? With the help of schematic diagram explain the working of Geiger Muller counter.

4(a) What are the different methods of correction for interfering and modifying inputs?

4(b) What is the data acquisition system? With the help of block diagram explain the microcontroller based data acquisition system.

5(a) What is the purpose of signal conditioning of inputs? How it can be performed.

5(b) Explain the resistive and capacitive transducers with the help of examples.

6(a) Explain the data transmission system and its method. Also explain the AC and DC telemetry system.

6(b) Explain the different types of errors with the help of practical examples.

7(a) What is modulation? Explain the time division multiplexing and frequency division multiplexing.

7(b) Differentiate between single data acquisition system and multichannel data acquisition system.
2014 – 2015
M. TECH. AUTUMN (I SEMESTER) EXAMINATION
ELECTRICAL ENGINEERING
(Instrumentation & Control Engg.)
Process Instrumentation
EE – 652

Maximum Marks: 60
Duration: Three Hours

Attempt any five questions.

Q.1 (a) Define the following terms with the help of example.
   a) Process load  b) Self regulation  c) Control lag

(b) A 5-m- diameter cylindrical tank is emptied by a constant outflow of 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
    setpoint is 12 m.
    (i) Calculate the cycling period
    (ii) Plot the level verses time.

Q.2 (a) What is an actuator? Explain the Electrical actuators commonly used in
        process industry.

(b) Fig. 1 shows the error applied to PID controller with $K_p = 5$, $K_i = 0.7 \text{ s}^{-1}$,
    $K_d = 0.5 \text{ s}$ and $p_i(0) = 25\%$. Plot the controller output.

Q.3 (a) With neat sketch, explain various control valves used in process industry.

(b) Draw a neat sketch of Pneumatic PID Controller and explain its operation.

Q.4 (a) What are the advantages of using a Programmable Logic Controllers?
        Mention the different transducers that may be used to convert analog data
        into digital data for PLC.

(b) What is a ladder diagram. Make a ladder diagram, for the following sequence:
    When SW$_1$ is closed, CR$_1$ goes on
    After CR$_1$ goes on, SW$_2$ can turn CR$_2$ on
    When CR$_2$ goes on, PL$_1$ goes off

Q.5 (a) Fig. 2 shows some of the process control symbols. Indicate what they
        represent.

(b) What is meant by cascade control? Explain the features of cascade process
    control with the help of block diagram.
(b) Explain the Zeigler Nichole's method for tuning a controller.

Q.7 (a) With the help of block diagram describe the important elements of a computer aided process control system.

(b) Explain direct digital control and computer supervisory control in a process and mention their advantages and limitations.
Q.No.

1(a) Distinguish between:
   i) Statistical and formative time lag.
   ii) Primary and secondary ionization process.
   iii) Treeing and Tracking.

(b) Define Townsend's primary and secondary ionization coefficients and hence derive Townsend's breakdown equation of a gas under uniform fields. Also write the Townsend's breakdown criteria.

2(a) Give reasons for the following:
   i) Use of SF₆ and its mixtures
   ii) IEC classification of insulating materials.
   iii) Puffer type SF₆ circuit breakers are most preferred.

(b) Define attaching coefficient and discuss the change in the Townsend's breakdown equation where an electron attaching gas is involved. Why electron attaching gases are more useful as insulators when compared to non attaching gases?

3(a) Compare Streamer and Townsend's breakdown mechanisms in gases under uniform field conditions. Also state the conditions under which they are applicable.

(b) Explain Bubble and Stressed oil volume theory that explain breakdown in commercial liquid dielectrics.

(c) Explain Electromechanical breakdown in solid dielectrics. Also draw the curve showing the variation of breakdown strength with time depicting the mechanism of breakdown in solid dielectrics.

4(a) What are the advantages and limitations of Gas insulated substations?

(b) Discuss the main components of Gas insulated substations and its field of applications. Why thermostatically controlled heaters are employed at high pressures?

(c) Identify the components to be insulated and discuss its insulation in power...
5(a) What is vacuum? How is it characterized? What is the normal range of vacuum used in high voltage apparatus?

(b) Discuss various mechanisms of vacuum breakdown. How it is different from normal breakdown of a gas?

6(a) With the help of a neat sketch explain the recurrence of partial discharges in solid insulation when subjected to ac voltages. What are the adverse effects of partial discharges on solid insulation?

(b) Draw an analogue circuit and hence determine the expression for partial discharge inception voltage for discharge in voids.

7. Explain the different theories of charge formation in clouds. What are the mechanisms by which lightning strokes develop and induce overvoltages on overhead power lines?
2014-15
M.TECH. 1st SEMESTER EXAMINATION
M.Tech (Electrical)
High Voltage & Insulation Engineering
Condition Monitoring of Power System Apparatus
EE-661N

Maximum Marks: 60
Credits: 04
Duration: Three Hours

Answer any FIVE questions.
Notations used have their usual meaning.

1(a) Differentiate between predictive, preventive and proactive maintenance. [06]
1(b) Discuss, in brief, the various sources, forms and effects of partial discharges. [06]

2(a) What are the various factors that affect the reliability of insulation structures? [06]
2(b) What are the various factors that lead to the failure of high voltage surge arresters? [06]

3(a) What are the various factors that lead to failure of string insulators and post insulators? [06]
3(b) What are the various insulation problems associated with power transformers and reactors? [06]

4(a) With the help of a schematic diagram discuss the various components of straight detection technique of partial discharges. [06]
4(b) Why is calibration of partial discharge measurement circuit necessary? With help of a diagram explain a PD calibration circuit. [06]

5(a) Discuss the evolution of acoustic technique of PD measurement. How is it useful for condition monitoring of power system apparatus? [06]
5(b) What are the various effects of presence of conducting particles in GIS? Discuss the various diagnostic tests for GIS. [06]

6(a) What are the recommended tests for rotating machines? Briefly discuss the AC hipot test and DC hipot test. [06]
6(b) Discuss the acoustic PD testing of power capacitors. [06]

7(a) Discuss the very low frequency testing method as applied to cables. [06]
7(b) What are the various tasks that a capable acoustic emission should be able to perform? Explain with help of a block diagram, a four channel acoustic emission system. [06]
Maximum Marks: 60
Credits: 04
Duration: Three Hours

Answer any five questions.
Assume suitable data if missing.
Notations used have their usual meaning.

Q.No. | Question | M.M.
--- | --- | ---
1 | Explain the principle of operation of a n-stage Cockcroft-Walton type voltage multiplier circuit for generation of high D.C. voltages under no load conditions. Deduce expression for ripple in the output voltage and voltage regulation when such a generator is loaded. | [12]
2 | Discuss the limitations of Cockcroft-Walton type voltage multiplier circuit for generation of high D.C. voltages. How are they overcome in improved Allibone’s voltage multiplier circuits with cascaded transformers. | [12]
3 | With the help of a neat sketch, explain the construction and working of testing transformers. Explain its working when connected in a cascade connection for generation of high A.C. voltages. | [12]
4 | Discuss equivalent circuit of an impulse voltage generator for calculating wave shaping components and hence determine the limiting equations for the circuit components which can generate the required wave shape and efficiency. Find suitable values for generator capacitance \( C_g \) and the resistances \( R_f \) and \( R_t \) for generating a 1.2/50 μs lightning impulse across a load \( C_L = 2000 \) pF. The values of \( \alpha \) and \( \beta \) are \( \alpha = 14.5 \times 10^5 \) and \( \beta = 2.45 \times 10^6 \). | [12]
5 | Explain:
   (a) Oscillation free recording of impulse voltages
   (b) Tripping of impulse generators using Trigatron gap | [12]
6 | With suitable sketches, explain the principle of operation and application of impulse current generators. Deduce expressions for time to crest and time to tail assuming critical damping of the circuit. | [12]
7 | Enumerate and explain different methods for measurement of high d.c. voltages in a high voltage laboratory | [12]
2014-15
M.TECH. (AUTUMN SEMESTER) EXAMINATION
ELECTRICAL ENGINEERING
BIO-SIGNAL PROCESSING
EE-671N

Maximum Marks: 60 Credits: 04 Duration: Three Hours

Answer any five questions.
Assume suitable data if missing.
Notations used have their usual meaning.

Q.No. Question M.M.
--- ---- --------
1(a) Explain the rationale and goals of bio-signal processing. [06]
1(b) Classify the bio-medical signal according to its source. Explain each class [06]
2(a) What is Unit Impulse function $\delta(t)$? Explain its properties and some intuitive [05]
     imagination for $\delta(t)$.
2(b) State and prove the Parseval's Theorem for periodic and aperiodic signal. [07]
3(a) Obtain the Fourier integrals, synthesis and analysis form, starting from Fourier [06]
     series.
3(b) Obtain the Fourier transform of $x(t)$ as shown in Figure 1. [06]

![Graph of the signal](image)

Figure 1.

4(a) Differentiate between single random variable and random process [03]
4(b) What are IIR Filters? Give a cascade realization, illustrating each step, of the [09]
     following.

$$H(z) = \left(\frac{0.44 + 0.362z^{-1} + 0.02z^{-2}}{1 + 0.8z^{-1} + 0.5z^{-2}}\right) \left(\frac{z^{-1}}{1 - 0.4z^{-1}}\right)$$

5(a) What are the usages of ECG? Explain clinically relevant parameters of ECG. [06]
5(b) Explain linear filtering method for removal of power line interface from ECG. [06]
6(a) Describe the origin of EEG and MEG signals. [06]
6(b) Differentiate between Grandmal and Petitmal epilepsy pattern on EEG [06]
7(a) Classify the electrographic seizure pattern in scalp recorded EEG. [08]
7(b) What are the artifacts associated with ECG? Explain [04]
M.TECH. (AUTUMN SEMESTER) EXAMINATION
ELECTRICAL ENGINEERING
SOFT COMPUTING
EE 679

Maximum Marks: 60          Credits: 04          Duration: Three Hours

Answer five questions. Question number 1 is compulsory. Choose any two questions from each section (A & B).
Assume suitable data if missing.
Notations used have their usual meaning.

<table>
<thead>
<tr>
<th>Q.No.</th>
<th>Question</th>
<th>M.M.</th>
</tr>
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<tbody>
<tr>
<td>1.(a)</td>
<td>Describe the least-mean square (LMS) algorithm. What are its convergence considerations?</td>
<td>[06]</td>
</tr>
<tr>
<td>1.(b)</td>
<td>What is defuzzification? Briefly describe different defuzzification methods.</td>
<td>[06]</td>
</tr>
</tbody>
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Section A

2. (a) Compare the biological neuron with its mathematical model. Support your answer with relevant figures and explain the terms in brief. | [06] |
2. (b) A neuron ‘j’ receives inputs from four other neurons whose activity levels are 10, -20, 4, and -2. The respective synaptic weights of neuron ‘j’ are 0.8, 0.2, -1.0, and -0.9. Calculate the output of the neuron ‘j’ if the neuron is represented by a McCulloch-Pitts model. Also, find the output if the neuron is based on a sigmoidal function. | [06] |
3. Explain the following: | [12] |
   (i) Use of momentum term in back-propagations learning. |
   (ii) Role of validation set during training. |
   (iii) Sequential and batch modes of learning. |
4. (a) Describe K-mean clustering algorithm. What is the difference between the batch and adaptive K-mean algorithms? | [06] |
4.(b) How is the optimal number value of the number of cluster for a data set is decided? | [06] |

Section B

5. Define the following and give their mathematical as well as graphical description (if possible): | [12] |
   (i) Universe of Discourse (UOD) |
   (ii) Support and Nucleus of a Fuzzy set |
   (iii) Interval of confidence and α-cut set |
   (iv) Convexity and normality of a Fuzzy set. |
   (v) Fuzzy complements, Intersection and Union. |

Contd....2.
6. (a) For the rule "If x is A then y is B", the meaning of "x is A" and "y is B" are given as:

\[ A = \frac{0.1}{x_1} + \frac{0.5}{x_2} + \frac{0.8}{x_3} + \frac{1.0}{x_4} \]

and

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

Obtain the Fuzzy relation matrix using any five of the following Implications.

(i) Luckasiewicz (ii) Stochastic

(iii) Zadeh (iv) Sharp

(v) Goguen and (vi) Mamdani

Comment upon the results.

6. (b) For the definition of age being young and old as given below:

\[ \mu_{\text{young}}(x) = \text{gaussian}(x; 0, 20) = e^{- \left(\frac{x}{20}\right)^2} \]

and

\[ \mu_{\text{old}}(x) = \text{gaussian}(x; 100, 30) = e^{- \left(\frac{x - 100}{30}\right)^2} \]

Find the definition of: (i) very young or very old, and (ii) not young and not old.

7. What do you understand by Fuzzy Inference System (FIS)? With the help of appropriate schematic diagram explain the operation of the FIS which has ‘n’ inputs, ‘m’ rules and single output. Differentiate between Mamdani’s FIS and Sugeno’s FIS.