2018-2019
M.Tech (1 Semester) Examination
ELECTRICAL ENGINEERING
ADVANCE MATHEMATICS
(AM-621N)

Max.Marks:60. Duration: Two Hours

Attempt all questions

Q1(a) A die is tossed, and independently a card is chosen at random from a regular desk. What is the probability that

(i) the die shows an even number and the card is from a red suit?

(ii) The die shows an even number or the card is from a red suit?

(b) For what value of \( K \) is \( f(x,y) = Ke^{-xy} \), a joint pdf of \( (X,Y) \) over region \( 0<x<1, 0<y<1 \)?

OR

(b') Suppose that \( A \) and \( B \) are independent events associated with an experiment. If the probability that \( A \) or \( B \) occurs equals 0.6, while the probability that \( A \) occurs equals 0.4, determine the probability that \( B \) occurs.

Q2(a) Let \( (X,Y) \) be a two dimensional random variable with a joint probability distribution. Let \( Z=H_1(X,Y) \) and \( W=H_2(X,Y) \) be function of random variable \( (X,Y) \). Then show that
\[
\]

(b) If \( (X,Y) \) is a two dimensional random variable, and if \( X \) and \( Y \) are independent then show that

(i) \( V(X+Y)=V(X)+V(Y) \)

(ii) \( V(CX)=C^2V(X) \), where \( C \) is a constant.

OR
(b') Suppose that the two dimensional random variable \((X,Y)\) is uniformly distributed over the triangle region 
\[ R = \{(x,y) : 0 < x < y < 1\} \]. Find

(i) the marginal pdf's of \(X\) and \(Y\) (ii) \(E(X^2)\) and \(E(XY)\) \(\quad (7,8)\)

Q3(a) Define the following wavelets

(i) Haar wavelet (ii) Gaussian wavelet (iii) Morlet wavelet.

(b) Define the triangular scaling function. Prove that any scaling function in an orthogonal Wavelet system satisfies the relation \( \sum \phi(t-n) = 1 \) \(\quad (7,8)\)

Q4(a) Derive Daubechies wavelets system with two vanishing moments

and show that \(|H(w)|^2 + |H(w+r)|^2 = 1\)

(b) Define Wavelet packet analysis. Consider the data set \(t = (1,0,-3,2,1,0,1,2)\). Assuming these as coefficients when signal is expressed in terms of the normalized Haar bases in \(V_3\), show that the actual signal is

\[ f(t) = 2\sqrt{2}\phi(2t) - 6\sqrt{2}\phi(8t-2) + 4\sqrt{2}\phi(8t-3) + 2\sqrt{2}\phi(8t-4) + 2\sqrt{2}\phi(8t-6) + 4\sqrt{2}\phi(8t-7). \]

OR

(b') Solve the boundary-value problem \(u_{tt} = 4u_{xx}\) subject to the conditions:

\[ u(0,t) = u(4,t), \quad u_t(x,0) = 0 \text{ and } u(x,0) = 4x - x^2. \] \(\quad (7,8)\)
Maximum Marks: 60  Duration: 02 Hours

Answer any four questions.
Assume suitable data if missing.

<table>
<thead>
<tr>
<th>Q.1(a)</th>
<th>Explain the four quadrant operation of a chopper based control of a dc motor drive.</th>
<th>12</th>
</tr>
</thead>
<tbody>
<tr>
<td>(b)</td>
<td>A 220 V, 970 rpm, 100 A dc separately excited motor has an armature resistance of 0.05 Ω. It is braked by plugging from an initial speed of 1000 rpm. Calculate (i) resistance to be placed in armature circuit to limit braking current to twice the full load value, (ii) braking torque and (iii) torque when the speed has fallen to zero.</td>
<td>3</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Q.2(a)</th>
<th>Draw the block diagram of a current limiting closed loop speed control of a dc motor with low pass filter. Explain its operation.</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>(b)</td>
<td>Write a short note on the following controller: hysteresis current control, negative feedback control, on-off control, proportional control, integral control, derivative control, continuous PID control.</td>
<td>10</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Q.3 (a)</th>
<th>Draw and explain single phase thyristor based dual converter for four quadrant closed loop control of variable speed dc drive.</th>
<th>10</th>
</tr>
</thead>
<tbody>
<tr>
<td>(b)</td>
<td>Give an example of an open loop and closed loop system and explain its operation.</td>
<td>5</td>
</tr>
</tbody>
</table>

| Q.4 (a) | Compare SRM and SyRM for their relative advantages and disadvantages. | 5 |

(contd...2)
<table>
<thead>
<tr>
<th>Q.5 (a)</th>
<th>A 4-phase, 1.5kW, 500 rpm switched reluctance motor (SRM) with 8 stator and 6 rotor poles has a stator pole arc of 30° and rotor pole arc of 22.5°. The aligned inductance is 25 mH and the unaligned inductance is 2.5 mH. The resistance per phase is 0.25 Ω. Saturation can be neglected. An eight device converter is fed from a battery of 48 V used to supply 4-phase stator winding of the motor. The motor is used in an industry as pallet truck. Calculate (a) average battery current, peak and rms winding current to obtain the instantaneous torque eight times the rated torque at starting when two phases are excited simultaneously, (b) average battery current, and peak and rms winding current at the rated torque at 50% of the rated speed when only one phase is excited.</th>
<th>7</th>
</tr>
</thead>
<tbody>
<tr>
<td>(b)</td>
<td>Explain different control strategies used for PM Synchronous Motor drive system.</td>
<td>5</td>
</tr>
<tr>
<td>(c)</td>
<td>What is sliding mode controller?</td>
<td>3</td>
</tr>
<tr>
<td>Q.6 (a)</td>
<td>State the advantages of PMBLDC motor against PMSM and PMDC motor.</td>
<td>5</td>
</tr>
<tr>
<td>(b)</td>
<td>Draw a complete block diagram of a PMBLDC motor drive system and explain its operation.</td>
<td>3</td>
</tr>
<tr>
<td>(c)</td>
<td>Do the modelling of a PMBLDC motor drive system.</td>
<td>7</td>
</tr>
</tbody>
</table>
Maximum Marks: 60  
Credits: 04  
Duration: Two Hours

Answer all questions.
Assume suitable data if missing.
Notations and symbols used have their usual meaning.

<table>
<thead>
<tr>
<th>Q.No.</th>
<th>Question</th>
<th>CO</th>
<th>M.M.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1(a)</td>
<td>Write the expression for the rms value of fundamental component in the line to line output voltage of a 6 step 3 phase inverter. Draw the harmonic spectrum for this inverter. What are the order of harmonics present in the output voltage?</td>
<td>(CO2)</td>
<td>[10]</td>
</tr>
<tr>
<td>1(b)</td>
<td>What are the advantages of choosing the value of frequency modulation ( m_f ) to be integer, in a PWM inverter?</td>
<td>(CO3)</td>
<td>[05]</td>
</tr>
</tbody>
</table>

OR

| 1'(a) | With the help of waveforms as well as mathematical analysis, explain the selective harmonic elimination technique as applied to 1 phase half bridge inverter. | (CO1) | [10] |
| 1'(b) | What are the advantages and disadvantages of over-modulation? | (CO2) | [05] |

| 2(a)  | With the help of closed loop schematic diagram, explain the operation of space vector controlled speed control of ac motor. Compare it with that of PWM control scheme. | (CO1) | [10] |
| 2(b)  | Show that a system of 3 phase quantities, \( x_a(t) \), \( x_b(t) \) and \( x_c(t) \), distributed in space by 120°, can be represented by a single vector, known as space vector. Also specify the conditions under which this representation is possible. | (CO2) | [05] |

| 3(a)  | What are phase-shifted and level-shifted modulation schemes for carrier-based modulation schemes for multilevel inverters? Explain their relative merits. | (CO3) | (10) |

OR...
3 (a) (i) Give the circuit diagrams of a five-level inverter with Cascaded H-Bridge, Diode Clamped, and Flying-Capacitor configurations.
(ii) With the help of relevant circuit diagram explain the principle of working of Resonant-dc-Link Inverters With Zero-Voltage Switching.

3(b) With the help of neat circuit diagram and relevant switching states, explain the operation of three-level NPC inverter. Explain the commutation of the switching devices in an NPC inverter for one of the transitions possible.

4(a) With the help of neat circuit diagram, relevant waveforms and switching diagrams, explain the operation of Parallel-Loaded Resonant dc-dc Converter when it is operating with discontinuous conduction.

OR

4 (a) Give the circuit diagrams of ZCS and ZVS topologies for a dc-dc step down converter. Compare the operations of the two topologies.

4(b) What challenges one will face when computer simulation of converters is attempted?

4(c) Compare circuit-oriented simulators with equation solvers in reference with simulation of converter. Give examples of the two.
Maximum Marks: 60  
Credits: 04  
Duration: Two Hours

Answer any FOUR questions.
Assume suitable data if missing.
Notations and symbols used have their usual meaning.

<table>
<thead>
<tr>
<th>Q.No.</th>
<th>Question</th>
<th>CO</th>
<th>M.M.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Derive the expressions for self and mutual inductance of a 2 pole synchronous generator model 2.2 in terms of rotor angle $\theta_s$, where $\theta_s$ is the position of the direct axis of the rotor with respect to the axis of phase a.</td>
<td>(CO1)</td>
<td>[15]</td>
</tr>
<tr>
<td>2(a)</td>
<td>Find the relation between the complex power in terms of abc components and $d\theta q\theta$ by choosing constant of Park's transformation matrix $k_1 = \sqrt{2/3}$ and $k_2 = \sqrt{1/2}$. Also comment whether power is invariant or not.</td>
<td>(CO1)</td>
<td>[05]</td>
</tr>
</tbody>
</table>
| 2(b)  | A three-phase 300 MVA, 20 kV, 0.9 pf, 50 Hz, 2 pole synchronous generator has the following parameters.  
$t_{aa} = 4.67 + 0.0534 \cos(2\theta) \ mH,$  
$t_{ab} = -2.3375 - 0.0534 \cos(2\theta + \frac{\pi}{3}) \ mH$  
$t_{bb} = 0.5792 \ mH,$  
$t_{abf} = 67.2 \cos(2\theta) \ mH,$  
$t_{bf} = 1084.08 \ mH$  
$r_s = 0.0014\Omega,$  
r_{fp} = 0.0635\Omega$  
(i) Determine d-axis and q-axis inductances $l_d, l_{md}, l_q$ and $l_{mq}$  
(ii) Define and find all the base quantities and express all the generator parameters in per unit in $dq0$ reference frame. | (CO1) | [10] |
| 3.    | Derive the dynamic equations and corresponding IEEE control block diagrams of a rotating amplifier type dc excitation system (DC Type 1). | (CO2) | [15] |
| 4(a)  | Derive the transfer function that relates the per unit change in gate position to per unit change in power of an ideal hydraulic turbine model. | (CO3) | [07] |
4(b) The data related to the turbine, penstock, and generator of a hydraulic power plant are as follows:

- Generator rating = 140 MVA,
- Penstock length = 300 m
- Rated hydraulic head = 165 m

Turbine rating = 127.4 MW,
Pipe Area = 11.15 m²
Water flow rate at rated load = 85 m³/s
Gate opening at rated load = 0.94 pu
Gate opening at no load = 0.06 pu

(a) Calculate (i) the velocity of water in penstock, and (ii) water starting time, at full load.

(b) Determine the classical transfer function of the turbine relating the change in power output to change in gate position at rated load.

(c) Draw the nonlinear model of the turbine, assuming an inelastic water column. Identify the values of the parameters and variables of the model at rated output. The turbine mechanical power/torque is to be expressed on a common base of 100 MVA.

5 Give the turbine configuration and block diagram of a single reheat tandem-compounded steam turbine model and derive its simplified transfer function. State assumptions made in approximation.

6(a) Explain the voltage dependency and frequency dependency static load characteristics representation by (i) exponential model (ii) polynomial model.

6(b) Develop equivalent π (pie) model of a long transmission line.
2018-19
M.TECH. (ELECTRICAL) AUTUMN (I SEMESTER) EXAMINATION
(Power System and Drives) & (High Voltage Engineering)
POWER SYSTEM ANALYSIS (EE-632)

Maximum Marks-60
Credit-04
Time- 2 Hours

NOTE: (i) Answer any four questions.
(ii) Notations used have their usual meaning.
(iii) Assume suitable data, wherever necessary.

1. (a) Prove \( Y_{BR} \, Z_{LOOP} = U \), where \( Y_{BR} \) and \( Z_{LOOP} \) are branch admittance and loop impedance matrices respectively of the augmented network.

   CO1 12

(b) Write performance equation of a primitive network in impedance and admittance form.

   CO1 03

2. (a) What are usual assumptions made in the short circuit studies? Give significance of each assumption.

   CO2 05

(b) Find the fault admittance matrix in phase and symmetrical components for single-line-to-ground fault.

   CO2 10

3. Assuming that the Bus Impedance Matrix \( Z_{BUS} \) is known for a partial network, derive the necessary relations to calculate the elements of modified Bus impedance matrix when a link is added to the partial network.

   CO4 15

4. Derive expressions for the fault current and voltages (during fault) for a three phase-to-ground fault at bus ‘p’ in a large power system using Thevenin’s equivalent of the system.

   CO2 15

5. (a) Show that the symmetrical component transformation diagonalizes the impedance matrix in phase components for both stationary and rotating elements.

   CO4 07

(b) What is meant by power system security? What are various modes of power system operation?

   CO3 08

6. (a) Discuss Fast-Decoupled Load Flow (FDLF) method of load flow analysis, explaining the assumptions made.

   CO3 09

(b) Discuss the problem of “optimal power flow”. In what way it is different from usual load-flow study?

   CO3 06
2018-19  
M. TECH. (AUTUMN SEMESTER) EXAMINATION  
ELECTRICAL ENGINEERING (INSTRUMENTATION & CONTROL)  
OPTIMAL CONTROL  
EE-641  

Maximum Marks: 60  
Credits: 04  
Duration: Two Hours

*Question Number 1 is compulsory. Answer any three questions from Questions 2 to 6.*  
Assume suitable data if missing.  
Notations and symbols used have their usual meaning.

<table>
<thead>
<tr>
<th>Q.No.</th>
<th>Question</th>
<th>CO</th>
<th>M.M.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1(a)</td>
<td>Why the Linear Quadratic Regulator is one of the most common performance measures used in optimal control?</td>
<td>(CO:1,3)</td>
<td>[03]</td>
</tr>
<tr>
<td>1(b)</td>
<td>What is the utility of Lagrange multiplier in solving the optimal control problem?</td>
<td>(CO1)</td>
<td>[03]</td>
</tr>
<tr>
<td>1(c)</td>
<td>What is the Bolza type problem of optimal control? Write the equation for performance measure for a Bolza problem. How is it different from the Lagrange problem of optimal control?</td>
<td>(CO1)</td>
<td>[03]</td>
</tr>
<tr>
<td>1(d)</td>
<td>How the solution of an optimal control problem is simplified by the introduction of the Hamiltonian?</td>
<td>(CO1)</td>
<td>[03]</td>
</tr>
<tr>
<td>1(e)</td>
<td>With the help of suitable examples distinguish state regulator and output regulator problems.</td>
<td>(CO:1,3)</td>
<td>[03]</td>
</tr>
<tr>
<td>2</td>
<td>Derive the Euler-Lagrange equation. Also comment on the nature of this equation.</td>
<td>(CO2)</td>
<td>[15]</td>
</tr>
<tr>
<td>3</td>
<td>For a Finite Time Linear Quadratic Regulator derive the Matrix Differential Riccati Equation.</td>
<td>(CO3)</td>
<td>[15]</td>
</tr>
<tr>
<td>4</td>
<td>Find the equation of optimal curve for the functional $f(x) = \int_0^2 [(x^2 - 1)^2] dt$ The initial condition is given as $x(0) = 1$ and $x(2) = 1$.</td>
<td>(CO2)</td>
<td>[15]</td>
</tr>
<tr>
<td>5(a)</td>
<td>What is the significance of Pontryagin’s principle in optimal control? Provide a summary of the steps and equations involved in solving an optimal control problem by using Pontryagin’s principle.</td>
<td>(CO:3,4)</td>
<td>[10]</td>
</tr>
<tr>
<td>5(b)</td>
<td>What is the principle of optimality? Explain the salient features of Dynamic programming approach for solving an optimal control problem.</td>
<td>(CO4)</td>
<td>[5]</td>
</tr>
<tr>
<td>6</td>
<td>Derive Hamilton-Jacobi-Bellman equation and discuss its applications in solving an optimal control problem.</td>
<td>(CO4)</td>
<td>[15]</td>
</tr>
</tbody>
</table>
M.TECH. IN ELECTRICAL ENGG. (AUTUMN SEMESTER) EXAMINATION
(INSTRUMENTATION AND CONTROL)
ADVANCED INSTRUMENTATION
EE-651

Maximum Marks: 60
Credits: 04
Duration: Two Hours

Answer the following questions.
Assume suitable data if missing.
Notations used have their usual meaning.

Q. No.  Question                                                                 M.M.  
1 (a).  Briefly explain the following “in terms of an instrument error”. [06]  
   i.  Probability Density Function CO-1  
   ii. Probability Distribution Function  
1 (b).  Draw single ended and differential ended bus configurations. Which configuration [06]  
   is more prone to noise? CO-3  
2 (a).  Briefly explain how thermistors can be used for temperature compensation of a [06]  
   copper conductor. CO-2  
2 (b).  Show that the output voltage of a differential capacitor transducer depends linearly [06]  
   on the displacement. CO-2

OR

2'(a).  Write down the steps to design temperature measurement circuit using LM335 [06]  
   sensor. CO-2  
2'(b).  If the same oscillator is used as the clock, compare the speeds of the following [04]  
   Analogue to Digital converter. CO-2  
   i.  Sigma- Delta Converter type  
   ii. Successive approximation type  
   iii. Dual slope integrating type ADC  
2'(c).  If an ADC is to be interfaced with a microcontroller, what will be the roles of a [02]  
   microcontroller in the conversion process? CO-3  
3 (a).  i.  For data 11110010, draw NRZ and Manchester code. [05]  
   ii. Draw transmission waveform for an 8-QAM for the data 001010011100. CO-3
   Assume 2 amplitude levels and 4 phase levels.

contd...
3 (b). Draw the bus layout for IEEE-488 (General Purpose Interface) Bus showing various group of lines and the connection to different instruments. 

OR

3'(a). Derive the expression for Discrete Time Fourier Transform (DTFT)

3'(b). Show that while Discrete Fourier Transform (DFT) requires Analogue computers, Fast Fourier Transform (FFT) can be implemented on a Digital Computer.

3'(c). Draw block diagram of Frequency Division Multiplexing process.

4. a. Explain the working of any ONE of the following techniques:
   i. Fourier Transform Infrared (FTIR) Spectroscopy
   ii. Scanning Electron Microscopy (SEM)

b. What are other techniques of material characterisation?
Maximum Marks: 60

Answer all questions.
Assume suitable data if missing.
Notations and symbols used have their usual meaning.

Q.No. | Question                                                                                                                                                                                                 | CO | M.M.
--- | ---                                                                                                                                                                                                     | --- | ---
1(a) | Discuss features of fractional order controller with the help of suitable example.                                                                                                                       | (CO1) | [07]
1(b) | Design a Proportional derivative controller to improve the performance of a unity feedback second order system represented by, \[ G(s) = \frac{\omega_n^2}{s(s+2\zeta \omega_n)} \]  

Draw the block diagram of the closed loop system with PD controller, and determine its overall transfer function and new damping ratio.  
OR  
1'(a) | What does tuning a control system mean? What are different tuning methods for feedback control system? Explain Frequency response method.                                                                 | (CO1) | [07]
1'(b) | A transient disturbance test was run on a process loop. The results of 10% controlling variable change gives process reaction graph as shown in figure below. Find the settings of PID controller. | (CO1) | [08]

![Error vs Time Graph](image-url)
2(a) Explain computer supervisory control and data acquisition in a process and write its advantages and limitations. (CO4) [07]

2(b) Differentiate between
   (i) Regulatory and servomechanism feedback control system.
   (ii) Feedback and feed forward control system. (CO1) [08]

3(a) What is actuator, explain hydraulic actuators with help of suitable diagram. (CO3) [07]

3(b) With neat sketch, explain pneumatic PID controller. (CO3) [08]

OR

3'(a) Design an Electronic PID controller with the help of three OPAMP and derive its transfer function (CO3) [07]

3'(b) Explain various valve plug designs. An equal percentage control valve has rangeability of 32. If the maximum flow rate is 100 m³/hr; find the flow rate at 2/3 and 4/5 open settings. (CO3) [4+4]

4(a) What is Programmable Logic controller? With neat sketch discuss the architecture of PLC. Explain the function of each part. (CO4) [07]

4(b) Write technical notes on process Identification and drawing (P & ID). (CO4) [08]
2018-19
M. TECH. (AUTUMN SEMESTER) EXAMINATION
ELECTRICAL ENGINEERING
BIO INSTRUMENTATION
EE-655

Maximum Marks: 60
Credits: 04
Duration: Two Hours

Answer all questions.
Assume suitable data if missing.
Notations and symbols used have their usual meaning.

<table>
<thead>
<tr>
<th>Q.No.</th>
<th>Question</th>
<th>CO</th>
<th>M.M.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1(a)</td>
<td>a) _______ refers to the degree of repeatability of a measurand.</td>
<td>(CO1)</td>
<td>[10]</td>
</tr>
<tr>
<td></td>
<td>b) _______ is considered to be the primary pacemaker of the heart?</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>c) Source of Bioelectric potential is _______ in nature.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>d) According to the international 10/20 system to measure EEG, even number denotes _______ of the brain?</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>e) _______ cells secrete their products directly into the bloodstream.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>f) _______ is a genetic disorder that results in a mutated chloride ion channel.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>g) The total operating range of the transducer is called _______</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>h) MRI stands for _______</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>i) Expression for Doppler shift is _______</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>j) _______ is used for ambulatory ECG monitoring.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1(b)</td>
<td>Explain various sources of electrode potential, discussing the NERNST equation.</td>
<td>(CO1)</td>
<td>[05]</td>
</tr>
<tr>
<td>2(a)</td>
<td>What are resting and action potentials? Explain Na+/K+ pump.</td>
<td>(CO2)</td>
<td>[7]</td>
</tr>
<tr>
<td>OR</td>
<td>2(a') What are the different lead arrangements in ECG recording? Explain the bipolar leads in brief with proper sketches.</td>
<td>(CO2)</td>
<td>[7]</td>
</tr>
</tbody>
</table>

Moderated:
1. 
2. 
3. 

Total No. of Sheets used: 2
Total No. of Questions: 4

Signature of Paper Setter(s)
1. 
2. 

[Signature]

[Challan]
Department of Elect. Engg.
A.M.U., Aligarh
2(b) What is the 10 – 20 electrodes placement system? Explain with figure marking all the important regions. (CO2) [8]

3(a) Explain the generalized architecture of Biotelemetry system. (CO3) [07]

OR

3(a') Discuss the methods for measurement of respiration rate. (CO3) [07]
3(b) Explain various methods for pulse measurement. (CO3) [08]

OR

3(b') Discuss the classification and selection criteria for sensors and transducers in biomedical applications. (CO3) [08]

4(a) Explain Architecture, Evolution and application of intelligent sensors. (CO4) [07]
4(b) Explain X-ray machine principle? Mention some applications of X-ray examination. (CO4) [08]

OR

4(b') Explain Ultrasound and its applications in medical instrumentation. (CO4) [08]
Answer all questions.
Assume suitable data if missing.
Notations and symbols used have their usual meaning.

Q.No. Question
1(a) Discuss the characteristics of the sensors in intelligent instrumentation. CO1 08
Moreover, emphasise the benefits of incorporating microcontroller-based signal processing in such instruments.
1(b) Explain the features of intelligent temperature transducer and intelligent flowmeter which distinguish them from traditional one.
2(a) With the help of few examples explain Polymorphism in virtual instrumentation. Further explain indexing in while and for loops.
2(b) What are bundle and unbundle functions, draw the iconic symbols of each used in LabVIEW. Also, discuss tunnelling.

OR
2(b') Draw block representation of different stages involved in virtual instrumentation. Also, discuss the approaches to processing signals in it.
3(a) With the help of relevant diagram, discuss the time and frequency responses of second order sensors.
3(b) Mention the three characteristics that make sensors intelligent. Moreover, discuss their functions.

OR
3’ Explain the steps involved in calibrating a sensor. Furthermore, explain with proper formulation the bias, imprecision and inaccuracy of a sensor.
4(a) Sketch and discuss detailed organization of delta-sigma converter. CO3 08
Furthermore, using a first order representation of delta-sigma modulator, prove that the noise overlays substantially at higher frequency side.

OR
4(a’) With the help of relevant sketch of quantization noise model, in a ADC CO4 08
prove that quantization noise = V_LSB/√12 and therefrom obtain the signal to noise ratio of the output signal.
4(b) Explain the digital to analog conversion using pulse width modulation technique.
M.Tech. (Autumn Semester) Examination
Electrical Engineering (High Voltage & Insulation Engineering)
Insulation System
EE-661

Maximum Marks: 60  Credits: 04  Duration: Two Hour

Answer any four of the following six questions. Assume suitable data if missing.
Notations used have their usual meaning.

Questions

1. (a) Explain the following:
   i) Elastic collisions
   ii) Inelastic collisions
   iii) Treeing
   iv) Tracking

   (b) Explain the different test performed on the transformer oil.

   (c) In an experiment for determining the breakdown strength of transformer oil, the following observations were made. Determine the power law equation.

   | Gap spacing (mm): | 4   | 6   | 8   | 10  |
   | Voltage at breakdown (kV): | 88  | 135 | 165 | 212 |

2. (a) Using Paschen’s relationship between breakdown voltage (V) and ‘pd’, find out the breakdown voltage of a spark gap in a gas at pressure = 760 torr at 25°C if
   A = 15/cm, B = 360/cm, d = 1mm and γ = 1.5 x 10⁻⁴.

   (b) Explain the Townsend’s primary and secondary processes for breakdown of gaseous dielectrics. Also define α and γ for the above said processes.

3. (a) Define attachment coefficient. Explain the criterion for breakdown of
electronegative gases.
(b) Describe how vacuum breakdown is different from normal breakdown of a gas. Explain clump mechanism of vacuum breakdown. Draw suitable figure.

4. (a) Give the temperature classification for solid insulating materials. Also write two examples of each class.

(b) Write short notes on the applications of insulating materials in
   (i) Power Transformers
   (ii) Rotating Machines
   (iii) Circuit Breakers

5. (a) What is Nano-dielectric? Explain its impact on electrical insulation.

(b) Write short notes on SF₆ gas application in power industry. Write advantages and disadvantages of GIS over the conventional open-air substation.

6. (a) Explain how breakdown occurs in solid dielectrics due to internal discharges. Derive the expression for breakdown due to the presence of void in the solid dielectric. Also, discuss the recurrence of partial discharge in an air-filled cavity with a suitable figure.

(b) A solid dielectric specimen of dielectric constant of 4.0 has an internal void of thickness 1 mm. The specimen is 1 cm thick and is subjected to a voltage of 80 kV (rms). If the void is filled with air and if the breakdown strength of air can be taken as 30 kV (Peak)/cm, find the voltage at which an internal discharge can occur.
Answer any FOUR questions.
All questions carry equal marks.
Notations used have their usual meaning.

1(a) How does ‘time constant’ and ‘dielectric dissipation factor’ give an indication of health of insulating material? [7.5]

1(b) How do the working environment, physical layout and mechanical requirements affect the insulation system design? [7.5]

2(a) How does ageing affect life of an insulation system? Discuss the electric and thermal stress ageing. [7.5]

2(b) What are the various effects of presence of conducting particles in GIS? Discuss the various diagnostic tests for GIS. [7.5]

3(a) How can relationship between pC and dB be helpful for online testing of power apparatus? Discuss the transformer grading based on acoustic PD testing. [7.5]

3(b) Discuss the use of temperature labels and online DGA for diagnosis of high voltage equipment. [7.5]

4(a) What are the recommended tests for HV rotating machines? Briefly discuss the AC hipot test and DC hipot test. [7.5]

4(b) Discuss the various breakdown modes for failure of high voltage current transformer. [7.5]

5(a) What are the limitations of conventional electrical PD detection techniques? What are the advantages of acoustic PD detection technique? State the accepted AE signal parameters. [7.5]

5(b) Discuss the use of optical fibre sensors for insulation condition monitoring. What are its major advantages and disadvantages? [7.5]

6(a) What are the various factors that lead to the failure of high voltage surge arresters? [7.5]

6(b) What is meant by inspection time slot? Discuss the concept of ‘failure’ and ‘subjective failure’ of insulation. [7.5]
**M.TECH. (AUTUMN SEMESTER) EXAMINATION**
**ELECTRICAL ENGINEERING**
**HIGH VOLTAGE GENERATION AND MEASUREMENT**
EE-664

Maximum Marks: 60  
Credits: 04  
Duration: Two Hours

*Answer any four questions.*
*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>
</thead>
<tbody>
<tr>
<td>1(a)</td>
<td>With the help of a neat sketch, explain the working of 3-stage cascaded transformer connection for generation of high A.C. voltages. Derive an expression for equivalent reactance of such a cascaded connection.</td>
<td>[08]</td>
</tr>
<tr>
<td>1(b)</td>
<td>With suitable diagrams, explain the principle of operation of Resonant transformers for generating high ac voltages. What are its limitations?</td>
<td>[07]</td>
</tr>
<tr>
<td>2</td>
<td>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.</td>
<td>[15]</td>
</tr>
<tr>
<td>3</td>
<td>Explain the working of basic Marx circuit for generation of impulse voltages. Develop expression to show that the output voltage waveform is a double exponential function. Also develop expressions for wave-front and wave-tail time using approximate analysis.</td>
<td>[15]</td>
</tr>
<tr>
<td>4</td>
<td>With the help of a neat sketch explain the working of a multi-stage Marx circuit for generation of impulse voltages and hence explain the need and working of trigatron gap for triggering the generator.</td>
<td>[15]</td>
</tr>
<tr>
<td>5</td>
<td>What are the requirements of a sphere gap for measurement of high voltages? Compare the use of uniform field electrode spark gap and sphere gap for measuring peak values of voltages. What are the parameters and factors that influence such voltage measurement?</td>
<td>[15]</td>
</tr>
<tr>
<td>6</td>
<td>With suitable sketches, explain the principle of operation of the following for high voltages measurements: (a) Peak voltmeter. (b) Generating voltmeter.</td>
<td>[15]</td>
</tr>
</tbody>
</table>
Maximum Marks: 60  
Credits: 04  
Duration: Two Hours

Answer any Two questions from each section.  
Assume suitable data if missing.  
Notations and symbols used have their usual meaning.

<table>
<thead>
<tr>
<th>Q.No</th>
<th>Question</th>
<th>CO</th>
<th>M.M.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Section A</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1(a)</td>
<td>With the help of a labelled diagram of an artificial neuron, describe its components in brief. Also draw the corresponding labelled artificial neural network.</td>
<td>(CO1)</td>
<td>[10]</td>
</tr>
<tr>
<td>1(b)</td>
<td>What is an activation function? Explain the sigmoid function.</td>
<td>(CO1)</td>
<td>[05]</td>
</tr>
<tr>
<td>2(a)</td>
<td>Explain Hebbian method of learning in brief. Discuss its mathematical model. What is the shortcoming of this model, and how can it be improved?</td>
<td>(CO2)</td>
<td>[10]</td>
</tr>
<tr>
<td>2(b)</td>
<td>Discuss the constraints and conditions for a perfect recall from an associative memory.</td>
<td>(CO2)</td>
<td>[05]</td>
</tr>
<tr>
<td>3(a)</td>
<td>Discuss Cover’s theorem? Use Gaussian function to solve the XOR gate problem.</td>
<td>(CO2)</td>
<td>[09]</td>
</tr>
<tr>
<td>3(b)</td>
<td>Draw the flowchart for Genetic Algorithm based solution. Describe crossover and mutation steps in brief.</td>
<td>(CO4)</td>
<td>[06]</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Section B</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
| 4(a) | Define the following with respect to fuzzy sets:  
   i) Universe of Discourse (UOD)  
   ii) Support and Nucleus  
   iii) Interval of confidence  
   iv) Convexity. | (CO1) | (07) |
| 4(b) | The two-sided $\pi$-MF is defined with four parameters $a$, $b$, $c$, and $d$:  
   \[
   \text{ts}_\pi(x: [a, b, c, d]) = \begin{cases} 
   0, & \text{for } x \leq a. \\
   S(x: [a, b]), & \text{for } a < x < b. \\
   1, & \text{for } b \leq x \leq c. \\
   Z(x: [c, d]), & \text{for } c < x < d. \\
   0, & \text{for } x \leq d. 
   \end{cases}
   \]
   where | (CO3) | (08) |
\[
S(x; [l, r]) = \begin{cases} 
0, & \text{for } x \leq l, \\
2 \left( \frac{x - l}{r - l} \right)^2, & \text{for } l < x < \frac{l + r}{2}, \\
1 - 2 \left( \frac{x - l}{r - l} \right)^2, & \text{for } \frac{l + r}{2} < x < r, \\
1, & \text{for } r < x.
\end{cases}
\]

and

\[
Z(x; [l, r]) = 1 - S(x; [l, r])
\]

Find the crossover points and width of \( ts_\pi(x; [a, b, c, d]) \).

5(a) For the Implication

"If \( x \) is A Then \( y \) is B"

where

\[
A = \frac{0.1}{x_1} + \frac{0.5}{x_2} + \frac{0.8}{x_3} + \frac{1}{x_4}
\]

and,

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

Find the Rule Matrix defined by: (i) Godel Implication, (ii) Lukasiewicz Implication, (iii) Kleen's – Dienes Implication, and (iv) Mamdani Implication.

5(b) Describe briefly the difuzzification methods generally used in Mamdani's model of FIS? Give their mathematical expressions also. Using the expressions find the representative values of a fuzzy set \( A \) defined by

\[
\mu_A(x) = \text{trapezoidal}(x; [10, 30, 50, 90]).
\]

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

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

\[
\mu_{\text{old}}(x) = \text{gaussian}(x; 100, 30) = e^{-\frac{x - 100^2}{20}}
\]

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

6(b) What are Mamdani's fuzzy inference system (FIS) and Takagi-Sugeno's FIS. Differentiate these FISs.