Time : 3 Hrs **Marks : 80**

1. Q. No.1 is **compulsory.**
2. Answer any **four** out of remaining six questions.
3. Figures to the right indicate full marks.
4. Use of statistical tables is permitted.
5. Write the sub –questions of main question collectively together.

1. a) Find vector orthogonal to both $(-6, 4, 2), (3, 1, 5)$. 5

b) If $A = \begin{bmatrix} 2 & 3 \\ -3 & -4 \end{bmatrix}$ then find A^{50}. 5

c) A discrete r. v. has the probability density function given below. 5

X	:	-2	-1	0	1	2	3
P(X = x)	:	0.2	k	0.1	2k	0.1	2k

Find k, mean & variance.

d) Integrate the function $f(z) = x^2 + ixy$ from A(1, 1) to B(2, 4) along straight line AB. 5

2. a) Find the eigen values and eigen vectors of $A = \begin{bmatrix} 3 & -1 & 1 \\ -1 & 5 & -1 \\ 1 & -1 & 3 \end{bmatrix}$ 6

b) If X denotes the outcome when a fair die is tossed, find M. G. F. of X & hence, find the mean & variance of X. 6

c) Evaluate $\int_{-\infty}^{\infty} \frac{x^2}{(x^2+4)(x^2+9)} dx$ using contour integration. 8

3. a) Using Cauchy Schwartz inequality show that $\frac{b+c}{a} + \frac{c+a}{b} + \frac{a+b}{c} \geq 6$ 6

b) Caclulate the Correlation coefficient from the following data. 6

X:	23	27	28	29	30	31	33	35	36	39
Y:	18	22	23	34	25	26	28	29	30	32.

c) If the mean of the following distribution is 16 find m, n & variance. 8

X	:	8	12	16	20	24
P(X = x)	:	1/8	m	n	1/4	1/12

4. a) Using Gram – Schmidt process find the orthonormal basis [3, 0, 4], [-1, 0, 7], [2, 9, 11] ,

b) Given $6y = 5x + 90, 15x = 8y + 130, \sigma_x^2 = 16$. Find i) $\bar{x}$ & $\bar{y}$, ii) σ_y^2, iii) r.

c) Is the given matrix diagonalizable $A = \begin{bmatrix} -9 & 4 & 4 \\ -8 & 3 & 4 \\ -16 & 8 & 7 \end{bmatrix}$. Find diagonalising matrix and the diagonal matrix.

5. a) Evaluate $\int_C \frac{(z+4)^2}{z^4+5z^3+6z^2} dz$ where C is a circle $|z| = 1$,.

b) If X is Binomial Distributed with mean 2 & variance 4/3, find probability distribution of X.

c) Fit a Poisson distribution to the following data.

X:	0	1	2	3	4
F:	122	60	15	2	1

6. a) A c. r. v. X has the following probability law

$$f(x) = kx^2(1 - x^3) \qquad 0 \le x \le 1$$
$$= 0 \qquad elsewhere$$

Find i) k, ii) P(0 < x < 1/2), iii) $\bar{x}$, iv) σ^2.

b) **Using** C-H theorem find the matrix represented by $A^8 - 5A^7 + 7A^6 - 3A^5 + A^4 - 5A^3 + 8A^2 - 2A + I$

Where $A = \begin{bmatrix} 2 & 1 & 1 \\ 0 & 1 & 0 \\ 1 & 1 & 2 \end{bmatrix}$.

c) Find all possible Taylor's & Laurent's series expansions of the function, $f(z) = \frac{z-1}{(z+1)(z-3)}$ about z = 0 indicating the region of convergence in each case.

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[Time: Three Hours] **[Marks:80]**

N.B: 1. Question.No.1 is compulsory.
2. Attempt any three questions from remaining five questions.
3. Assume suitable data wherever necessary.

1. Attempt the following **20**
   a. Derive Bernoulli's Equation.
   b. What is Vacuum? Why is it called negative pressure? List the different Vacuum measurement techniques.
   c. Explain Capillary Tube Viscometer.
   d. How pH meter is calibrated?

2. a. Explain with neat diagram working of McLeod Gauge. **10**
   b. An orifice meter with orifice diameter 15 cm is inserted in a pipe of 30 cm diameter. The pressure difference measured by a mercury oil differential manometer on the two sides of the orifice meter gives a reading of 50 cm of mercury. Find the rate of flow of oil of Sp.Gr. 0.9 when the coefficient of discharge of the orifice meter is 0.64. **10**

3. a. List various methods of density measurement and explain any two in detail. **10**
   b. Explain Coriolis Mass Flow Meter in detail. **10**

4. a. A simple U tube manometer containing mercury is connected to a pipe in which a fluid of Sp. Gr. 0.8 and having vacuum pressure is flowing. The other end of the manometer is open to atmosphere. Find the vacuum pressure in pipe, if the difference of mercury level in the two limbs is 40 cm and the height of fluid in the left from the centre of pipe is 15 cm below. **10**
   b. Explain construction and working of Electromagnetic Flow Meter. State the advantages and disadvantages. **10**

5. a. Explain Variable Area type flowmeter. **10**
   b. Derive the expression for Gauge Factor in strain gauge. **10**

6. Write short notes on **20**
   a. Comparison of orifice plate and venturi meter.
   b. Hot Wire Anemometer.
   c. Conductivity Measurement.

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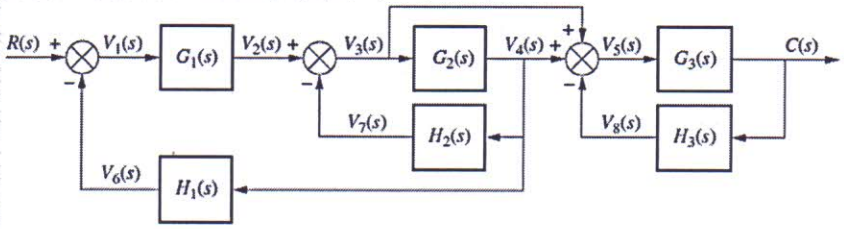
(3 Hours) (Total Marks : 80)

Instructions:

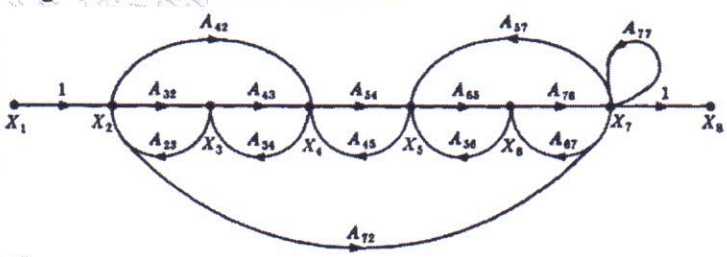
- **Q. No.1** is **compulsory**.
- Answer any **Three** out of remaining **Five** questions.
- Assumptions made should be **clearly stated**.
- Assume any suitable **data** wherever **required** but **justify the same**.
- **Figure** to the **right** indicate gets **full marks**.
- **Illustrate answers** with **sketches** wherever **required**.

1. **Attempt any four.** **(20)**
   - **a.** Explain the development of automatic control systems and classification of the control system with examples.
   - **b.** Derive the transfer function in canonical form of close loop system?
   - **c.** Define Gain and Phase margin of system.
     Also comment on stability of system based on GM and PM.
   - **d.** Describe time domain specifications.
     Define all with their mathematical expression.
   - **e.** Classify the feedback control system based on
     i. Nature
     ii. Time
     iii. Time behavior
     iv. Deterministic and stochastic
     v. Number of inputs and outputs
     vi. Feedback and feed forward system

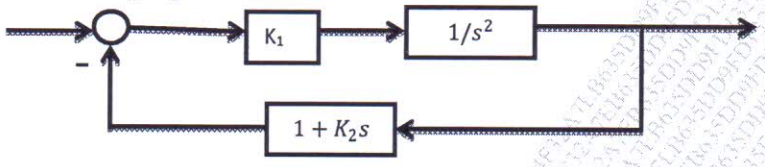
2. **a.** Examine unity feedback system having open loop transfer function **(10)**
   $G(s) = \frac{k(s+1)}{s(s^3+7s^2+12s)}$.
   Find :
   i. Type of system,
   ii. Error coefficients,
   iii. Steady state error when input to the system is $\frac{R}{2}t^2$.
   - **b.** Derive transfer function for following block diagram **(10)**



3. **a.** Solve following SFG and find transfer function. **(10)**



b. For a control system shown below, find the values of K_1 & K_2 so that M_p= 25% and T_p= 4sec. Assume unit step input. **(10)**



4. a. A unity feedback control system has an open loop transfer function. Construct the root locus plot of the system. Find the value of k and frequency at which the root loci cross the $j\omega$ axis. Comment on stability of the system. **(10)**

$$G(s) = \frac{k}{s(s^2 + 10s + 24)}$$

b. The characteristics equations for a certain feedback control system are given below. Evaluate the range of values of k for the system to be stable. **(10)**

i. $s^4 + 23s^3 + 8s^2 + 3s + k = 0$

ii. $s^4 + 7s^3 + 10s^2 + ks + k = 0$

5. a. Construct a bode diagram of an open loop transfer function $G(s)$. Determine GM, PM, ω_{gc}, ω_{pc}. Comment on stability of the system. **(10)**

$$G(s)H(s) = \frac{10(s+2)}{s(s+0.5)(s+10)}.$$

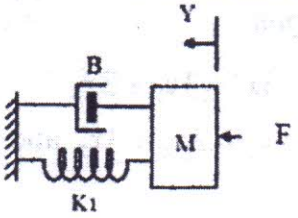
b. A unity feedback system has open-loop transfer function **(10)**

$$G(s) = \frac{1}{s(2s+1)(s+1)}$$

Sketch Nyquist plot for the system and from there obtain the gain margin and the phase margin.

6. a. Explain force voltage and force current analogy. **(10)**

b. Evaluate the differential equation for the mechanical system. **(10)**
Obtain the analogues electrical network based on the force voltage analogy.



[Time: 3 Hours] [Total Marks:80]

N.B: 1. Question.No.1 is compulsory.
2. Attempt any three questions from remaining five questions.
3. Assume suitable data wherever necessary.
4. Figures to the right indicate full marks.

1 Answer the following **(Any 4)** **[20]**
a) Explain Time decay of radioactive isotopes.
b) Explain with a neat diagram, the working of Ionization Chamber.
c) Explain in brief the principle of operation of mass spectrometry.
d) Explain with a neat diagram, the working of Scintillation Counter.
e) Write short note on Plasma Excitation sources.

2 a) State and prove Beer- Lambert's Law. **[10]**
b) With neat diagram, explain Raman effect. Draw and explain the construction of Raman spectrometer. **[10]**

3 a) With a neat diagram, explain the working of Atomic Absorption spectrometer. **[10]**
b) With a neat diagram, explain the working of Gas chromatograph. Also state its applications. **[10]**

4 a) When does Nuclear Magnetic Resonance occur? Explain the working of NMR spectrometer. **[10]**
b) With neat diagram, explain double beam spectrophotometer. **[10]**

5 a) Explain the concept of Fluorescence and Phosphorescence. Also explain the working of single beam filter fluorimeter with neat diagram. **[10]**
b) Explain CO2 analyzer with neat diagram. **[10]**

6 Write short notes on **(Any two)** **[20]**
a) Gas density analyzer
b) Photomultiplier tube
c) Flame Ionization detector

Q.P. Code :

[Time: Three Hours] [Marks:80]

N.B:
1. Question.No.1 is compulsory.
2. Attempt any three questions from remaining five questions.
3. Assume suitable data wherever necessary.

Attempt any four questions. 20

a. Describe the following terms with suitable examples
   i. Signal Level and Bias Changes
   ii. Signal Conversion
b. Explain lead compensation in bridge.
c. Draw and explain circuit for window detector.
d. A current balance bridge is used for potential measurement. The fixed resistors are $R_1=R_2=5K\Omega$, $R_3=1\ K\Omega$, $R_4=990\ \Omega$ and $R_5=10\ \Omega$ with a 10V supply. Find the current necessary to null the bridge if the potential is 12mV.
e. A Sensor output range of 20.0 to 250mV as a variable varies over this range. Develop signal conditioning so that it becomes 0 to 5V. The circuit must have very high input impedance.

a. Discuss the holding time and acquisition time for the sample and hold circuit and write the equations for determining the capacitor size and minimum acquisition time. 10
b. Design the Butterworth second order low pass filter to have 12 KHz cutoff frequency. Use the selected components to calculate the actual cutoff frequency for the circuit. 10

a. Sketch the circuit of 555 Astable multivibrator. Explain how it operates and discuss the determination of component values. 10
b. A control valve has a linear variation of opening as the input voltage varies from 0 to 10V. A microcomputer outputs an 8-bit word to control the valve opening using an 8-bit DAC to generate the valve voltage. 10
   i. Find the reference voltage required to obtain a full open valve.
   ii. Find the percent of valve opening for 1-bit change in the input word.

a. The RTD is used in the bridge circuit. If $R_1=R_2=R_3=100\ \Omega$ and the supply voltage is 10.0 V calculate the voltage the detector must be able to resolvein orderto resolve a1°C change in temperature. 10
b. Draw and explain the principle and construction of metal strain gauges.What is the signal conditioning associated with it. 10

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Q.P. Code :

5 a. A photovoltaic cell is to be used with radiation of intensity from 5 to12 mW/cm^2. Measurementsshow that its unloaded output voltage ranges from 0.22 to 0.41 V over this intensitywhile it delivers current from 0.5 to 1.7 mA into a 100-Ω load.

i Find the range of short-circuit current.

ii Develop signal conditioning to provide a linear voltage from 0.5 to 1.2 V as the intensity varies from 5 to 12 mW/cm^2.

b. Explain Optical encoder signal conditioning for linear displacement and linear velocity applications with suitable diagram.

6 Write short notes on:

a. Phase locked loop
b. Data Acqusition System
c. SMPS

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