Q.P. Code : 37609

(3 Hours) **Total Marks: 80**

Note:- 1) Question number **1** is **compulsory**.
2) Attempt any **three** questions from the remaining **five** questions.
3) **Figures** to the **right** indicates **full** marks.

Q.1 a) Verify Cauchy's Schwartz inequality for the vectors $u = (-4,2,1)$ and $v = (8,-4,-2)$ 05

b) Show that the matrix $A = \begin{bmatrix} 2 & -2 & 3 \\ 1 & 1 & 1 \\ 1 & 3 & -1 \end{bmatrix}$ is non derogatory. 05

c) Let X be a continuous variable with probability density function $f(x) = kx(1-x),\ 0 \le x \le 1$. Find k and determine a number b such that $P(X \le b) = P(X \ge b)$. 05

d) Evaluate $\int_C (\bar{z} + 2z)dz$, where C is 05
i) The upper half of the circle $|z| = 2$.
ii) The lower half of the circle $|z| = 2$.

Q.2 a) Find the eigen values and eigen vectors of the matrix 06
$\begin{bmatrix} 6 & -2 & 2 \\ -2 & 3 & -1 \\ 2 & -1 & 3 \end{bmatrix}$

b) If $f(a) = \int_C \frac{4z^2+z+5}{z-a}dz$, where C is $|z| = 2$, find the values of 06
$f(1), f(i)\ f'(-1), f''(-i)$

c) A random variable X has the following Probability function 08

X	:	1	2	3	4	5	6	7
$P(X=x)$	:	k	$2k$	$3k$	k^2	k^2+k	$2k^2$	$4k^2$

$Find\quad i)\ k\quad ii)\ P(X<5)\quad iii)\ P(X>5)\quad iv)\ P\left(\frac{X<5}{2<X\le 6}\right)$

Q.3 a) The equation of the two regression lines are $3x + 2y = 26$ and $6x + y = 31$. Find i) mean of x and y ii) coefficient of correlation between x and y iii) σ_y if $\sigma_x = 3$ 06

b) Fit a Binomial distribution to the following data 06

X:	0	1	2	3	4	5	6
Y:	5	18	28	12	7	6	4

c) Examine whether the set of real numbers with operations of addition and multiplication defined as $(x_1, y_1) + (x_2, y_2) = (x_1 + x_2, y_1 + y_2)$; $k(x_1, y_1) = (3kx_1, 3ky_1)$ is a vector space 08

Q.4 a) Construct an orthonormal basis of R^3 using Gram-Schmidt process to $S = \{(3,0,4), (-1,0,7), (2,9,1)\}$ 06

b) A continuous random variable has probability density function $f(x) = kx^2(1 - x^3)$ $0 < x < 1$. Find i) k ii) mean iii) variance 06

c) Show that the matrix $\begin{bmatrix} 2 & 2 & 1 \\ 1 & 3 & 1 \\ 1 & 2 & 2 \end{bmatrix}$ is diagonalizable. Also find the transforming matrix and diagonal matrix. 08

Q.5 a) Verify Caley-Hamilton theorem for $A = \begin{bmatrix} 2 & 0 & -1 \\ 0 & 2 & 0 \\ -1 & 0 & 2 \end{bmatrix}$ Hence find A^{-1} 06

b) Find Karl Pearson's coefficient of correlation and also, the spearman's rank coefficient of correlation for the following data. 06

X:	12	17	22	27	32
Y:	113	119	117	115	121

c) Obtain Taylor's and Laurent's series for $f(z) = \frac{z^2-1}{z^2+5z+6}$ around z=0. 08

Q.6 a) Evaluate $\int_0^{2\pi} \frac{cos2\theta}{5+4cos\theta} d\theta$, using Cauchy's residue theorem 06

b) A random variable X has the following probability density function $f(x) = \begin{cases} ke^{-kx}, & x > 0, k > 0 \\ 0, & elsewhere \end{cases}$ 06

Find m.g.f. and hence find mean and variance

c) For the normal variate with mean 2.5 and standard derivation 3.5, find the probability that i) $2 \leq X \leq 4.5$ ii) $-1.5 \leq X \leq 5.3$ 08

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Q.P. Code : 38553

[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 Answer the following 20
a Compare variable head meter with variable area meter for flow measurement.
b Explain vena contracta with pressure and velocity profile.
c Explain need of temperature compensation for strain gauge sensor.
d Define gauge pressure, vacuum and absolute pressure.

2 a State and derive Bernoulli's equation. 10
b Explain vacuum measurement using Pirani Gauge. 10

3 a Draw and explain pH measurement set up. 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 specific gravity 0.9 when the Cd is 0.64. 10

4 a Explain the working of instrument used for calibration of pressure gauges. 10
b A Wheatstone bridge has R1=120.4 ohm, R2 = 119.0 ohm and R3= 119.7 ohm. What resistance must R4 have for bridge balance? If R4 has a value of 121.2 ohm and if the input voltage is 12 V d.c. what is the output voltage of the bridge assuming it to be voltage sensitive bridge? 10

5 a List various techniques of density measurement and explain any two in detail. 10
b Explain pressure measurement using LVDT. 10

6 Write short note on any two 20
a Mass flow meter
b Dynamometer
c Smart sensors

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Duration: 3 Hours **Max. Marks 80**

N.B.

1. **Q.1** is compulsory. Attempt **any three** from the remaining questions.
2. All questions carry equal marks.
3. Figures to the Right indicate full marks.
3. Assume suitable data if necessary

Q.1 Attempt **any four** **20**

a. For a feedback control system with forward path transfer function $G(s)$ and feedback transfer function $H(s)$, define 'Order' and 'Type' of the system.

b. Define root locus of a system? What is root locus for a system, $G(s) = \frac{K(s+1)}{s+3}$.

c. For a system $\frac{Y(s)}{R(s)} = \frac{1}{(3s+1)}$, obtain unit step response $y(t)$.

d. Determine steady state error in unit step response for the system $\frac{Y(s)}{R(s)} = \frac{2(s+0.1)}{(s^2+0.8s+1)}$.

e. Write difference between open-loop and closed-loop systems.

f. Obtain the poles of the system $G(s) = \frac{1}{s^4+81}$ and comment on stability from locations of poles.

Q.2 A. For the following system, compute risetime (t_r), peak time (t_p), peak overshoot ($\%M_p$) and settling time (t_s) for 2% tolerable error in response. **10**

$$G(s) = \frac{1}{s^2 + 1.2s + 1}$$

B. Construct the signal flow graph for system in **Fig.1** and obtain the transfer function using Mason's gain formula. **10**

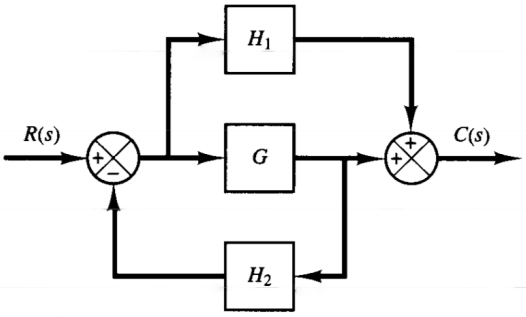

Fig.1

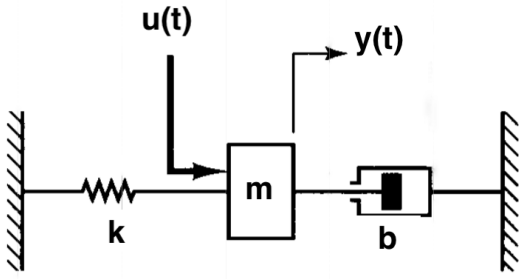

Fig.2

Q.3 A. Obtain the mathematical model of the system in **Fig.2**. What will be the transfer function of this system if $k = 2$ N/m and $b = 2.4$ N-sec/m and $m = 2$Kg? **10**

B. Determine the range of K for stability of the system having a characteristic equation **10**

$$P(s) = s^4 + 2s^3 + 2s^2 + s + K = 0$$

using Routh's criterion.

Turn Over

Q.4 A. Determine the position, velocity and acceleration error constants for unity feedback systems with open loop transfer functions **10**

(i) $G(s) = \dfrac{k}{(T_1 s + 1)(T_2 s + 1)}$ **(ii)** $G(s) = \dfrac{1}{s(s + \alpha)}$

Where T_1, T_2 and α are positive constants.

B. Construct the root locus for the system **10**

$$G(s) = \frac{K}{s^3 + 6s^2 + 11s + 6}$$

with feedback $H(s) = 1$.

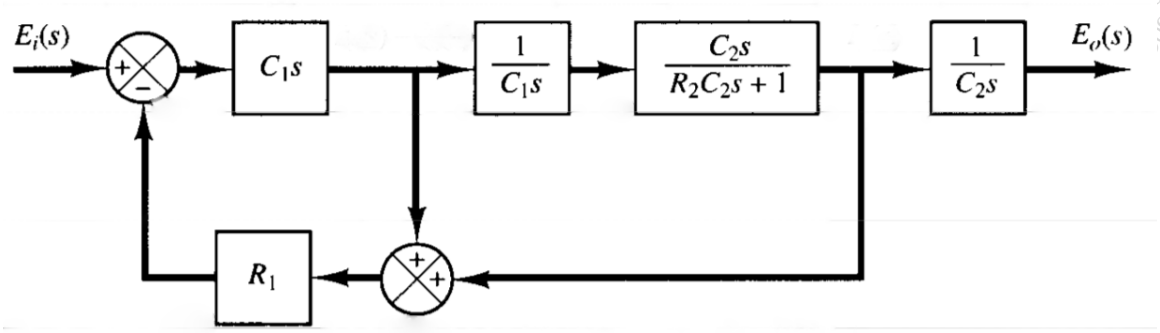

Fig.3

Q.5 A. Obtain $E_o(s)/E_i(s)$ for the system in **Fig.3** using block diagram reduction technique. **10**

B. Define stability of the system. Determine the stability of the system using Hurwitz criteria, if characteristic equation of the system is given by, **10**

$$P(s) = s^4 + 12s^3 + 49s^2 + 78s + 40 = 0$$

Q.6 A. Draw Nyquist plot for the system, **10**

$$G(s) = \frac{1}{s(0.4s + 1)(0.5s + 1)}$$

What frequency does the response will cross the real axis and what will be the magnitude at that frequency?

B. Draw Bode plot for the system, **10**

$$G(s) = \frac{15(s + 15)}{(s + 1.5)(s + 150)}$$

and obtain gain and phase margins from plot.

Q.P.Code:37876

[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.
4. Figures to the right indicate full marks.

1		Answer the following	20
	a	State Beer- Lambert's Law and explain the causes for deviation from Beer's law.	
	b	Determine resonance frequency of proton in Ho=23,000 G, I= ±1/2, μ= 2.797, and h= 6.626 x 10^{-34} J sec.	
	c	Explain in brief the principle of operation of mass spectrometry.	
	d	Explain Time decay of radioactive isotopes.	
	e	Calculate the energy of i) 5.3 Å photon, ii) 530 nm photon of visible radiation.	
2	a	Explain the working of a double beam UV spectrometer with neat diagram.	10
	b	With neat diagram, explain Raman effect. Draw and explain the construction of Raman spectrometer.	10
3	a	Draw and 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	Explain the concept of Fluorescence and Phosphorescence. Also explain the working of single beam filter fluorimeter with neat diagram.	10
	b	Explain the working of Photomultiplier tube.	10
5	a	Explain with a neat diagram, the working of Ionization Chamber.	10
	b	Explain Paramagnetic Oxygen analyzer with a neat diagram.	10
6		Write short notes on (any two)	20
	a	Gas density analyzer	
	b	Flame ionization detector	
	c	Monochromators	

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(Time: 3 Hours) **Total Marks: 80**

N. B. 1) Question No. **1** is **compulsory**.
2) Answer any **3** questions from the remaining **5** questions.
3) Assume suitable data wherever necessary.

Q1 Solve any four **20**
(a) Explain the significance of all pass filter
(b) With suitable diagram discuss the concept of loading and how to avoid it.
(c) Explain the characteristics of digital data
(d) Explain V to F converter
(e) What are the four characteristics of 3 terminal IC regulator

Q2 (a) Draw and explain circuit diagram of differentiator using op-amp. Discuss its advantages over practical differentiator. **20**

(b) Explain the optical encoder signal conditioning for linear displacement and linear velocity application with suitable diagram.

Q3 (a) Draw and explain the principle and construction of metal strain gauges. What is the signal conditioning associated with it. **20**

(b) Temperature is to be measured in the range of 0 to 100°C with an accuracy of ±2°C. The sensor is a resistance that varies linearly from 100Ω to 139.2Ω for this temperature. Develop analog signal conditioning that provides a voltage varying linearly 0V to 5V for this temperature range.

Q4 (a) Mention the types of analog to digital converters and explain any one of them **20**

(b) Discuss the applications of Instrumentation amplifier. Explain one in detail.

Q5 (a) What is a multivibrator? Explain astable multivibrator using IC 555 and also design astable multivibrator for 35% and 65% duty cycle. **20**

(b) A CdS cell has a dark resistance of 100kΩ and a resistance in a light beam of 30kΩ. The cell time constant is 72ms. Devise a system to trigger a 3V comparator within 10ms of the beam interruption.

Q6 Write a short note on . (Any Four) **20**
(a) Impedance matching and concept of loading
(b) Sample and hold circuit
(c) Data Acquisition System
(d) Phase lock loop
(e) Peak detector