

SE | Sem. IV | INST | C-2019 | Dec-2023

Duration: 3 Hours

Max. Marks: 80

- (1) Question No. 1 is COMPULSORY.  
 (2) Answer ANY THREE questions from Q.2 to Q.6.  
 (3) Use of Statistical Tables permitted.  
 (4) Figures to right indicate full marks.

Que. 1 a. Evaluate the integral  $\int_C \frac{1}{(z^2+1)(z^2+4)} dz$ , where **5**

C is the circle  $|z-i|=1$ .

b. A random variable X has the distribution **5**

X: 0 1 2 3 4 5 6

p(x): k 3k 5k 7k 9k 11k 13k

Find i) k ii)  $P(3 < X \leq 6)$

c. Show that the vectors  $V_1 = (1, 2, 4)$ ,  $V_2 = (2, -1, 3)$  **5**  
 and  $V_3 = (0, 1, 2)$  are linearly independent.

d. Find Rank correlation coefficient for the **5**  
 following data

x:	12	17	22	27	32
y:	113	119	117	115	121

Que. 2 a. Find usual inner product between two vectors **6**  
 $(2, -3, 1)$  and  $(3, 4, -5)$ . Find norm of each  
 vectors and verify Cauchy Schwarz inequality.

b. Find the Extremal of  $\int_{x_1}^{x_2} \sqrt{1+(y')^2} dx$ . **6**

c. The following table gives data concerning the savings bank **8**  
 deposits (X) in lakhs and number of strikes and lockouts(Y)  
 over a period of 7 years. Calculate the correlation  
 coefficient and the regression lines.

X	51	54	55	59	65	60	70
Y	38	44	33	36	33	23	10

**Que. 3 a.** Show that the  $V = \{(x, y) | x = 7y\}$  is a subspace of  $R^2$ . 6

The weekly wages of 1000 workmen are normally distributed around a mean of Rs 70 and standard deviation Rs 5. 6

**b.** Estimate the number of workers whose weekly wages will be

(i) between 69 and 72 (ii) more than 75

**c.** Obtain all possible Taylor and Laurent series expansions about  $z=0$  for the function  $\frac{z}{z^2+3z+2}$  indicating the region of convergence 8

**Que. 4 a.** By using Cauchy residue theorem, evaluate 6

$$\oint_C \frac{\sin^3 z}{(z-\frac{\pi}{6})^2} dz \text{ where } C \text{ is a circle } |z|=2$$

**b.** A continuous random variable  $X$  has a 6  
 $f(x) = kx^2 e^{-x}$ ,  $x \geq 0$  probability density function.

Find  $k$ , mean and variance.

**c.** Using Rayleigh-Ritz method, find approximate solution for the extremal of 8

$$\int_0^1 (y'^2 - 4y^2 + 2x^2 y) dx, y(0)=1, y(1)=0$$

**Que. 5 a.** Ten students got the following percentage of marks in mathematics and statistics 6

	78	36	98	25	75	82	90	62	65	39
Maths										
Stats	84	51	91	60	68	62	86	58	53	47

Calculate the coefficient of correlation.

**b.** Using Gram-Schmidt process, construct an orthonormal basis of  $R^3$  for 6

$$S = \{(3, 0, 4) \ (-1, 0, 7) \ (2, 9, 11)\}$$

**c.** Reduce quadratic form 8



by congruent transformation. Obtain transformation applied in the reduction and Find the rank, index and class value.

Que. 6 a. Find the curve on which the functional  $\int_0^1 \{y'^2 + 12xy\} dx$  with  $y(0)=0$ ,  $y(1)=1$  is extremal.

b. A car hire firm has two cars, which they hires out day by day. The number of demands for a car on each day is distributed as a Poisson variate with mean 1.5. Calculate the proportion of days on which (i) neither car is used (ii) some demands are refused.

c. Find a singular value decomposition of the matrix  $\begin{bmatrix} 4 & 0 \\ 3 & -5 \end{bmatrix}$

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[Time: Three Hours]

[Marks: 80]

Note:

1) Question 1 is compulsory.

2) Solve any three from remaining &amp; assume suitable data wherever necessary.

Q1: Attempt any four.

20

- State & explain various Engineering Units and its significance.
- Explain the construction & working of bourdon tube pressure gauge.
- What is pH electrode? With suitable sketch explain pH measurement circuit.
- What is cold junction compensation in thermocouples? Explain.
- Compare between variable head and variable area flow meter.

Q2:

- State Hydrostatic law. Elaborate major & minor losses in fluid flow measurement. 10
- Explain different arrangements of strain gauges for better sensitivity. List the materials used for strain gauges. 10

Q3:

- Explain construction and working of Coriolis flow meter. 10
- What is piezoelectric transducer? State its working principle. List the advantages, limitations and applications. 10

Q4:

- What is density measurement? List various techniques of density measurement and explain any one in detail. 10
- An orifice meter with orifice diameter 10 cm is inserted in a pipe of 20 cm diameter. The pressure gauges fitted upstream and downstream of the orifice meter gives readings of 19.62 N/cm<sup>2</sup> and 9.81 N/cm<sup>2</sup> respectively. Co-efficient of discharge for the meter is given as 0.6. Find the discharge of water through pipe. 10

Q5:

- State and explain the construction and working of Bulk modulus cell. 10
- Explain with a neat diagram a force measurement using LVDT. 10

Q6: Write short note of any two.

20

- Types of Orifice plates & its applications
- Bernoulli's Equation and its significance for flow measurement
- Viscosity measurement



(3 Hours)

Total Marks: 80

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

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|----|---|----|
| Q1 | Solve any four  | 20 |
|    | (a) Draw and explain window detector.   |    |
|    | (b) Draw and explain block diagram of Data Acquisition System.  |    |
|    | (c) The resistors in a bridge are given by $R_1=R_2=R_3=240\ \Omega$ and $R_4 = 242\ \Omega$ . If the supply voltage is 5V. Find the offset voltage |    |
|    | (d) Compare the characteristics of ideal and practical OPAMP.   |    |
|    | (e) Explain the characteristics of digital data.  |    |
| Q2 | (a) Draw and explain circuit diagram of Integrator using op-amp with waveforms.   | 10 |
|    | (b) Draw and explain RC phase shift Oscillator using op-amp. Design RC phase shift Oscillator for frequency 1KHz.                                   | 10 |
| Q3 | (a) What is a RTD? Explain its construction and signal conditioning circuitry associated with it.   | 10 |
|    | (b) What is a multivibrator? Explain astable multivibrator using IC 555 and also design astable multivibrator for 65% duty cycle.                   | 10 |
| Q4 | (a) Draw and explain the principle and construction of metal strain gauges. What is the signal conditioning associated with it.                     | 10 |
|    | (b) A sensor outputs a range of 20mV to 250mV as a variable varies over its range. Develop signal conditioning so that this becomes 0V to 5V.       | 10 |
| Q5 | (a) Explain successive approximation analog to digital converter. Find ADC output for a 4-bit converter to a 5V input if the reference is 10V.      | 10 |
|    | (c) Discuss the applications of Instrumentation amplifier. Explain one in Detail.   | 10 |
| Q6 | (a) Draw and explain circuit diagram of absolute value circuit using op-amp. Discuss its advantages over traditional diode rectifier.               | 10 |
|    | (b) With suitable diagram explain summing amplifier in inverting mode configuration with waveform.  | 10 |

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[Time: 3 Hours]

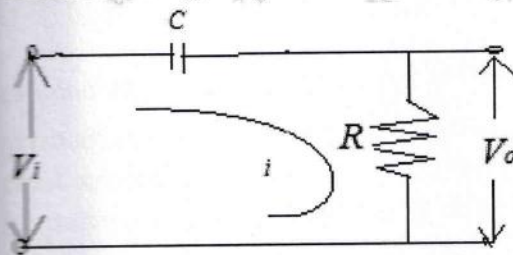
Total Marks: 80

**Instructions:**

- Q1 is compulsory
- Answer any **Three** out of the remaining **Five** questions
- Assumptions made should be clearly stated
- Assume any suitable data wherever required but justify the same
- The figure to the right indicate gets full marks

**Q1. Solve any Five of the following** (20)

- Find the transfer function of the series RLC electrical network.
- For the feedback system open-loop transfer function is  $G(s) = \frac{10}{s(s+1)}$  and feedback path  $H(s) = 5$ , then find the sensitivity of closed-loop system transfer function with respect to G and H at  $\omega = 1$  rad/sec.
- For the following electrical network if input  $V_i(t) = 10$  then find the output voltage  $V_o(t)$ .



Assume  $C = 2$  F and  $R = 5$  ohm

- Determine the Position, Velocity and acceleration constants of the following system –

$$G(s) = \frac{20}{(0.5s + 1)(s + 10)}$$

- Consider a unity feedback system with open-loop transfer function –

$$G(s) = \frac{5}{s(s+5)}$$

Find the steady-state error for  $r(t) = t$

- Determine the range of  $K$  for the system represented by the following characteristic equation  $s^4 + 20Ks^3 + 5s^2 + 10s + 15 = 0$  is stable.

**(20)**

- Give a classification of the control system. Differentiate between open-loop and closed-loop systems.

- A system has the transfer function  $C(s)/R(s) = 10/(s + 5)$ . Determine its unit step, unit ramp response with zero initial conditions.

**(20)**

- Give definition of stability of a control system and necessary and sufficient conditions for stability.

- Explain rules of Root Locus.

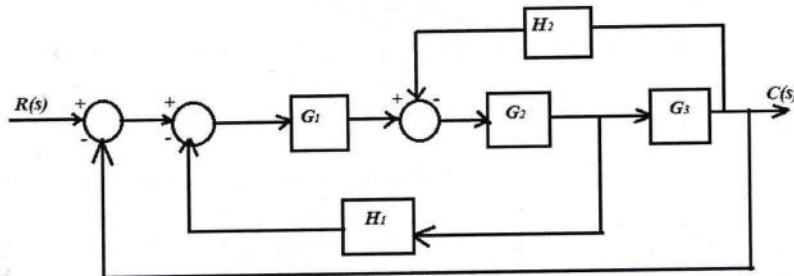


(20)

A feedback system has,  $G(s)H(s) = \frac{50(s+4)}{s(s+0.5)(s+10)}$

Draw the Bode plot and comment on stability of the system.

Convert the block diagram given in the following figure to a signal-flow-graph and determine the closed loop transfer function  $C(s)/R(s)$  by using Mason's gain formula.



(20)

A second order system is given by  $\frac{C}{R} = \frac{25}{s^2 + 6s + 25}$ . Find its Rise time, Peak time, Peak overshoot and settling time if subjected to unit step input. Also calculate expression for its output response.

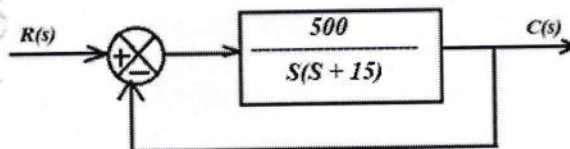
Determine the stability of system by using Routh Criterion of the following system whose characteristic equation is –

i)  $s^4 + 4s^3 + 7s^2 + 16s + 12 = 0$

ii)  $s^5 + s^4 + 2s^3 + 2s^2 + 3s + 15 = 0$

(20)

For the system shown in the following figure, obtain the closed-loop transfer function, damping ratio, natural frequency, settling time and steady-state error if  $R(s) = 0.5/s^2$ .



Draw polar plot for,  $\frac{C}{R} = \frac{1}{s(s+2)}$

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Note: 1) Q.N.1 is Compulsory

2) Q.N. 2 to 6 solve any three questions

**Q1** Solve any four Questions out of five **20 Marks**

- a Explain Single acting and double acting linear actuator.
- b Draw a neat diagram of the Gate valve and state its application.
- c Explain the different hydraulic valves used for hydraulic applications
- d Compare pneumatic and Electrical system
- e Explain the function of Thermostat

**Q2** Solve any two Questions out of Three **20 Marks**

- a Explain the function of Hydraulic actuators
- b Explain with sketch working of a SMART transmitter
- c Compare conventional Transmitter and smart transmitter

**Q3** Solve any Two Questions out of Three **20 Marks**

- a Give classification of relay and Draw a diagram for Electromagnetic Relay.
- b Explain Air to open control valve with diagram
- c What is Valve positioner and explain its applications

**Q4** Solve any two Questions out of Three **20 Marks**

- a Explain control valve terminology and also give classification of control valve
- b Draw a neat diagram of the butterfly valve in detail.
- c Explain the control valve characteristics

**Q5** Solve any Two Questions out of Three **20 Marks**

- a Classify Switches and explain any one of them
- b Explain the function of alarm annunciator
- c Explain the function of Dampers

**Q6** Solve any Two Questions out of Three **20 Marks**

- a Explain the function of flow regulators
- b Explain the function of relief valves
- c Explain the function of stepper motor

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