

**Control and Instrumentation (EE-406)**

Time : 3 hours

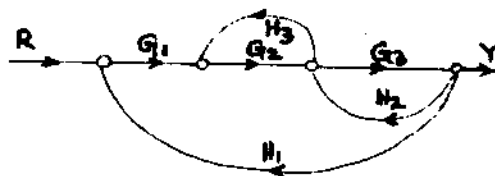
Full Marks : 70

*Use separate answer script for each half.  
Answer SIX questions, taking any THREE from each half.  
Two marks are reserved for neatness in each half.*

**FIRST HALF**

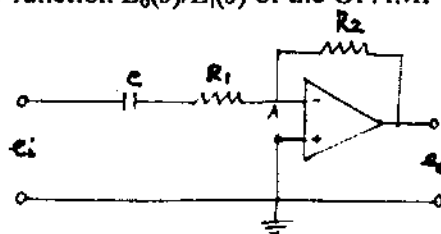
(ANS - Received on 18/04/2012)

1. a) What is the difference between a continuous time and a discrete time system?
  - b) For a given step input  $u(t) = 5$ , find the expression for the response of a system defined by  $G(s) = \frac{1}{(s^2 + 3s + 2)}$
  - c) A closed loop system is described by the transfer function  $\frac{C(s)}{R(s)} = \frac{36}{(s^2 + 2s + 36)}$ . Find the rise time, peak time, maximum overshoot and settling time in the unit step response of the above system.
  - d) A system is described by the equation  $\ddot{y}(t) + 5\dot{y}(t) + 3y(t) = 6r(t)$ ;  $y(0) = \dot{y}(0) = 0$  find the steady state error of the system to an input  $r(t) = \sin 2t$ . [2+3+3+3]
2. a) The characteristic equation of a system is  $s^4 + 2s^3 + (4+k)s^2 + 9s + 25 = 0$ . Using Routh stability criterion, determine the range of  $k$  for stability.
  - b) Find the closed loop transfer function of system shown in Fig. 1 using Mason's gain rule.



**Fig.1**

- c) Deduce the transfer function of a series RC circuit with  $e_i(t)$  as input and  $e_o(t)$  as output. [3+4+4]
3. a) For a standard servo system, find out the closed loop transfer function. Find the response of the same if  $0 < \zeta < 1$ . Explain the term damping ratio ( $\zeta$ ).
  - b) Find the transfer function  $E_o(s)/E_i(s)$  of the OPAMP circuit shown in Fig. 2.



**Fig. 2**

[6+5]

(2)

4. For the open loop transfer function as given below sketch the general shape of the root locus plot of the characteristic equation  $1+F(s) = 0$ , where the gain  $k$  is varied from 0 to  $\infty$ .

$$F(s) = \frac{k}{s(s+3)(s^2+2s+2)} \quad [11]$$

5. a) What is Bode diagram? Sketch Bode diagram of the following closed loop system

$$\frac{C(s)}{R(s)} = \frac{K}{s(s+1)+K}$$

- b) Consider a unity feedback control system with the closed loop transfer function

$$\frac{C(s)}{R(s)} = \frac{Ks+b}{s^2+as+b}; \text{ determine the open loop transfer function } G(s).$$

Show that the steady state error in the unit ramp response of the system is given by

$$e_{ss} = \frac{a-k}{b} \quad [6+5]$$

### **SECOND HALF**

(PBC -Received on 24/04/2012)

6. a) Draw the major blocks of an instrumentation System. Explain their functions briefly.  
b) Define "Active" and "passive transducers with suitable examples. Discuss the advantages of electrical transducers. [5 + (3 + 3)]
7. a) Distinguish between resistive and semiconductor strain gauges in terms of the accuracy, sensitivity and temperature dependence.  
b) A resistance strain gauge with a gauge factor 2.0 is fastened to a steel member subjected to a stress of  $1050 \text{ kg/cm}^2$ . The modulus of elasticity of steel is approximately  $2.1 \times 10^6 \text{ kg/cm}^2$ . Calculate the percentage change in resistance of the strain gauge element due to the applied stress. [5+6]
8. a) A displacement capacitive transducer uses a differential arrangement with two outer plates which are fixed and a central plate which is movable. The distance between fixed and movable plates is 5mm when no displacement is applied. A voltage of 1000V (rms) is applied across the fixed plates. Find the differential output voltage, if a displacement of 0.01mm is applied to the central plate.  
b) A thermistor has a resistance of  $3980\Omega$  at  $0^\circ\text{C}$  and  $794\Omega$  at  $50^\circ\text{C}$ . The resistance temperature relationship is given by  $R_T = aR_0 e^{b/T}$ . Find the parameters 'a' and 'b'. [6+5]
9. a) Find the digital output of the 6 bit successive approximation type ADC to a 4.25V analog input. Consider the reference voltage = 10V.  
b) An 8-bit D/A converter has a reference voltage of 12Volt. It uses weighted resistive network. If the maximum output current does not exceed 10mA, find the value of the output current for a digital input of 01010101. [5 + 6]
10. Write short notes on **any two** of the following: [2 × 5½]
- Capacitive transducers
  - LVDT
  - DAC