2013
CONTROL SYSTEM

ime Allotted : 3 Hours | *Full Marks* : 70

The figures in the margin indicate full marks.

Candidates are required to give their answers in their own words as far as practicable.

GROUP – A

(Multiple Choice Type Questions)

1. Choose the correct alternatives for any *ten* of the following : 10 × 1 = 10

i) A phase lead compensator is responsible for

a) fast vanish of transient

b) improvement of steady state error

c) both (a) & (b)

d) neither (a) nor (b).

ii) For a stable liner control system

a) gain crossover frequency is greater than phase crossover frequency

b) gain crossover frequency is less than phase crossover frequency

c) gain crossover frequency is equal to phase crossover frequency

d) both (a) & (b) are possible.

iii) Root locus is the variation of open loop as open loop gain, K is varied from zero to infinity.

a) poles to zeros b) zeros to poles

c) origin to zeros d) poles to origin

iv) A PD controller is inserted in a system to

a) fasten the response

b) decrease steady state error

c) slow down the response

d) increase steady state error.

v) If the polar plot does not intersect the negative real axis it can be inferred that

a) the system is inherently stable

b) the system is inherently unstable

c) the system is marginally stable

d) cannot be determined.

vi) What happens to the time constant of a system if a negative feedback is inserted ?

a) Time constant is increased

b) Time constant is decreased

c) Time constant is unaffected

d) Time constant is increased 10 times.

vii) The concept of analogous system is applicable for

a) linear system only

b) non-linear system only

c) both linear & non-linear systems

d) non-linear system but can be extended to linear system too.

viii) By increasing the gain k of the system, the steady state error of the system

a) increases b) decreases

c) remains unaltered d) none of these.

ix) For $\xi = 0$, resonant frequency (ω_r) is equal to

a) 0 b) ω_n

c) $\frac{\omega_n}{\sqrt{1 - 2\xi^2}}$ d) $\omega_n \sqrt{1 - 3\xi^2}$

x) The initial slope of Bode plot for a transfer function having single pole at origin is

a) 20 dB/decade b) – 40 dB/decade

c) 40 dB/decade d) – 20 dB/decade.

xi) If the system has multiple poles of imaginary axis the system is

a) stable b) unstable

c) marginally stable d) none of these.

xii) A feedback control system has transfer function given by $G(s) = \frac{6(s + 1)(s + 6)}{s^3 (s + 2)(s + 4)}$. It is a

a) Type-5 system b) Type-3 system

c) Type-2 system d) Type-0 system.

xiii) A system described by the state equation $\dot{x} = Ax + Bu$, & $y = Cx$ where $A = \begin{bmatrix} 4 & -1 \\ 3 & 1 \end{bmatrix}$, $B = \begin{bmatrix} 1 \\ 1 \end{bmatrix}$ $C = \begin{bmatrix} 1 & 0 \end{bmatrix}$. The transfer function $G(s)$ of the system is

a) $\frac{s}{s^2 + 5s + 7}$ b) $\frac{1}{s^2 + 5s + 7}$

c) $\frac{s}{s^2 + 3s + 2}$ d) $\frac{1}{s^2 + 3s + 2}$

GROUP – B

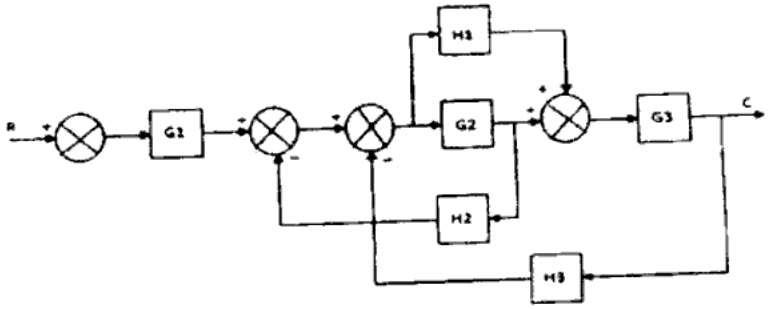
(Short Answer Type Questions)

Answer any *three* of the following. $3 \times 5 = 15$

2. a) What are the advantages & disadvantages of closed loop control system ?

   b) What is the difference between transient response & steady state response of a system ? $3 + 2$

3. Construct the equivalent signal flow graph for the block diagram show below & evaluate the transfer function.



4. The characteristics equation of a feedback system is $S^4 + 4S^3 + 16S^2 + 16S + 48 = 0$. Check whether the system is oscillatory. If so, determine the frequency of oscillations.

5. What do you mean by principle of argument ? State and explain Nyquist Criterion.

6. Derive the transfer function of a PID controller. What is the advantage of PID control over other control actions ?

GROUP – C

(Long Answer Type Questions)

Answer any *three* of the following. $3 \times 15 = 45$

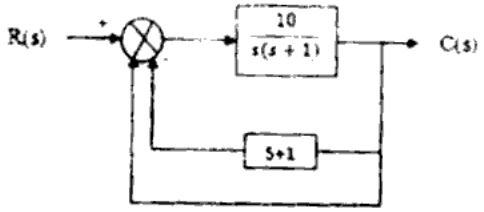
7. a) What are the angle & magnitude conditions for root locus ?

   b) Draw the root locus for the control system having the open loop transfer function with unity feedback.

   $G(s) = k/s(s + 1)\left(s^2 + 2s + 2\right)$.

   c) Determine the value of K at the point on root locus where the damping factor $\xi = 0.5$. $3 + 9 + 3$

8. a) For the given system



i) Determine k_p, k_v & k_a.

ii) Find the steady state error for input $5t^2\,u(t)$.

iii) State the 'type' number of the system.

b) Consider the closed loop system given by $\frac{C(s)}{R(s)} = \frac{\omega_n^2}{s^2 + 2\zeta\omega_n s + \omega_n^2}$. Determine the value of ζ & ω_n so that the system response to a step input with approximate 5% overshoot & with a settling time of 2 sec.

c) Mention the difficulties that may arise in applying Routh stability criterion. What do you mean by relative stability ? (3 + 3 + 1) + 4 + (2 + 2)

9. Check for controllability and observability of a system having following coefficient matrices. 7 + 8

$$A = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ -6 & -11 & -6 \end{bmatrix},\ B = \begin{bmatrix} 1 \\ 0 \\ 1 \end{bmatrix} \text{ and } C^T = \begin{bmatrix} 10 \\ 5 \\ 1 \end{bmatrix}$$

10. a) Write down the advantages & disadvantages of state space techniques

b) Obtain the state transition matrix from non-homogeneous state equation of a LTI control system & list the properties of it.

c) Determine the transfer matrix for a system whose A, B, C matrices are

$$A = \begin{bmatrix} 1 & -2 \\ 4 & -5 \end{bmatrix},\ B = \begin{bmatrix} 1 \\ 1 \end{bmatrix} \text{ and } C = \begin{bmatrix} 1 & 0 \end{bmatrix}.$$ 5 + 5 + 5

11. Write short notes on any *three* of the following : 3 × 5

a) Routh array

b) Mason's Gain formula

c) Relative stability & Routh's stability criterion

d) Gain margin and Phase margin

e) Force-voltage & force-current analogy.