ENGINEERING & MANAGEMENT EXAMINATIONS, DECEMBER – 2008

CONTROL SYSTEM

SEMESTER – 5

Time : 3 Hours] [Full Marks : 70

One Graph sheet and one Semilog sheet are provided on Page 33 and 35.

GROUP – A

(Multiple Choice Type Questions)

1. Choose the correct alternatives for any *ten* of the following : $10 \times 1 = 10$

i) A second order control system with $\xi = 0$ is always

a) marginally stable b) stable

c) unstable d) none of these. ☐

ii) The Routh-Hurwitz criterion gives

a) relative stability b) absolute stability

c) gain margin d) phase margin. ☐

iii) In z plane, the unit circle corresponds to

a) imaginary axis of s-plane

b) positive real axis of s-plane

c) negative real axis of s-plane

d) origin of s-plane. ☐

iv) A speed control system is expressed by the transfer function $\frac{W(S)}{V(S)} = \frac{100}{2 + 10S}$. 1 volt of the input corresponds to an output of

a) 100 rad/sec b) 10 rad/sec

c) $\frac{100}{12}$ rad/sec d) 50 rad/sec. ☐

v) The error detector element in a control system gives

a) the sum of the reference signal and feedback signal

b) the sum of the reference signal and error signal

c) the difference of the reference signal and feedback signal

d) the difference of the reference signal and output signal. ☐

vi) State variable approach converts on n^{th} order system into

a) n second order differential equation

b) two differential equation

c) n first order differential equation

d) a lower order system. ☐

vii) For the system $\frac{C(S)}{R(S)} = \frac{16}{S^2 + 8S + 16}$, the nature of the time response will be

a) overdamped b) underdamped

c) criticallydamped d) undamped. ☐

viii) The type of transfer function denotes the number of

a) zeroes at origin b) poles at infinity

c) poles at origin d) finite poles. ☐

ix) $V(x, y) = (x - y)^2$, this function is

a) positive definite b) negative definite

c) positive semi-definite d) none of these. ☐

x) The lead compensator network is considered to be

a) high-pass filter b) low-pass filter

c) equalizer d) none of these. ☐

xi) For a stable system

a) the gain crossover occurs before phase crossover

b) the gain crossover occurs after phase crossover

c) the gain crossover and phase crossover frequencies are very close to each other

d) the gain crossover and phase crossover frequencies are same. ☐

xii) Without affecting steady state error, the maximum overshoot can be decreased by incorporating

a) derivative error control b) integral error control

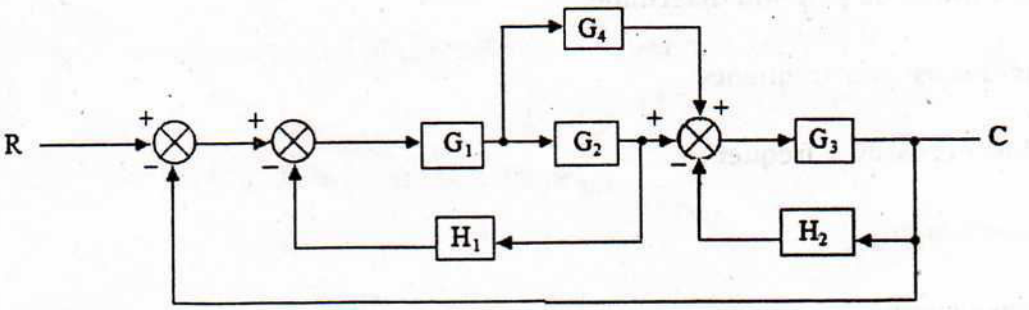
c) gain adjustment d) proportional error control. ☐

GROUP – B

(Short Answer Type Questions)

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

2. Using block diagram reduction technique find C/R.



3. A control system is described by the state equation :

$$\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \end{bmatrix} = \begin{bmatrix} -5 & -1 \\ 3 & -1 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} + \begin{bmatrix} 2 \\ 5 \end{bmatrix} u,$$

$$y = [\,1 \quad 2\,] \begin{bmatrix} x_1 \\ x_2 \end{bmatrix}.$$

Obtain the transfer function of the system.

4. The characteristic equation of a system is given by

$$s^3 + 3ks^2 + (k+2)s + 4 = 0$$

Find the range of k for which the system is stable.

5. For a unity feedback system $G(S)$ given below, find the time domain specification for a unit step input $G(S) = \frac{200}{S(S+2)}$.

6. A feedback control system is described as $G(S) = \frac{50}{S(S+2)(S+5)}$, $H(S) = \frac{1}{5}$. Evaluate static error constants, k_p, k_v and k_q for the system.

GROUP – C

(Long Answer Type Questions)

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

7. The open loop transfer function of a unity feedback system is given by

$$G(S) = \frac{200}{S(S+4)(S+10)}.$$

Construct the Bode plot and determine

a) Gain crossover frequency

b) Phase crossover frequency

c) Gain margin

d) Phase margin

e) Comment on the stability of the system.

8. A unity feedback control system has an open loop transfer function

$$G(S) = \frac{K}{S(S+2)\left(S^2 + 6S + 25\right)}, \quad K \geq 0$$

Sketch the root locus of the system mentioning relevant steps.

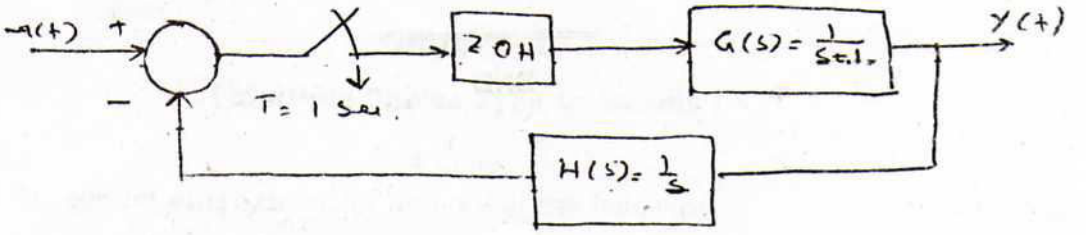
Also find the value of K so that the system has a damping factor of 0·707.

9. a) Find z transform of the following :

i) $f(t) = \left(1 - e^{-5t}\right)$ sampling time $T = 0{\cdot}2$ sec

ii) $f(t) = e^{-dt} \cos \omega t$.

b) For the sampled data system shown in figure, find the output $Y(k)$ for $r(t)$ = unit step.



7 + 8

10. a) Obtain state transition matrix $\phi(t)$ from non-homogeneous state equation of a linear time invariant control system and list the properties of it.

b) The state model of the following system is given below :

$$\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \end{bmatrix} = \begin{bmatrix} 0 & 1 \\ -2 & -3 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} + \begin{bmatrix} 0 \\ 1 \end{bmatrix} u,$$

$$y = \begin{bmatrix} 1 & 0 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix}.$$

Determine the following :

i) The state transition matrix

ii) Test controllability of the system

iii) Test observability of the system. 6 + 9

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

a) Fuzzy logic in control engineering

b) Nyquist plot

c) Phase trajectories using isocline method

d) Common non-linearities in control system

e) Lyapunov stability analysis.

END