**ENGINEERING & MANAGEMENT EXAMINATIONS, DECEMBER – 2007**

# CONTROL SYSTEM

**SEMESTER – 5**

Time : 3 Hours ] [ Full Marks : 70

Semi-log and graph sheets are printed at the end of this booklet.

## GROUP – A

**( Multiple Choice Type Questions )**

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

i) The characteristic equation of a second order system is $s^2 + 6s + 25 = 0$. The system is

a) underdamped b) overdamped

c) undamped d) critically damped.

ii) The type number of a transfer function denotes the number of

a) poles at origin b) zeros at origin

c) poles at infinity d) none of these.

iii) Presence of non-linearities in a control system leads to introduce

a) transient error b) instability

c) steay state error d) all of these.

iv) In terms of Bode plot, the system is stable if

a) PM = GM b) PM & GM both are positive

c) PM and GM both are negative d) PM negative but GM positive.

v) By the use of PD control to the second order system, the rise time

a) decreases b) increases

c) remains same d) none of these.

vi) The lead-lag compensation will improve

a) transient response

b) transient response and steady state response

c) none of these.

vii) The response of a control system, having damping factor as unity will be

a) oscillatory b) underdamped

c) critically damped d) none of these.

viii) A system has a single pole at origin. Its impulse response will be

a) constant b) ramp

c) decaying exponentially d) oscillatory.

ix) The matrix shown below is

$$\begin{bmatrix} 4 & -4 & 2 \\ -4 & 5 & -2 \\ 2 & -2 & 1 \end{bmatrix}$$

a) positive definite b) positive semi-definite

c) negative definite d) none of these.

x) $A$ is an $n \times n$ matrix. Then the system to be controllable, the rank of the controllability matrix should be

a) $n$ b) $> n$

c) $\geq n$ d) $\leq n$.

xi) The settling tine for a second order system resonding to a step input with 5% overshoot is

a) $4/\xi W_n$ b) $2/\xi W_n$

c) $3/\xi W_n$ d) $5/\xi W_n$.

xii) Area under a unit impulse function is

a) infinity b) zero

c) unity d) none of these.

## GROUP – B

### ( Short Answer Type Questions )

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

2. Obtain state variable model of the system whose transfer function is given by

$$\frac{Y(s)}{U(s)} = \frac{s+1}{s^3 + 3s^2 + 7s + 1}.$$

3. Determine the transfer function of an armature control d.c. motor system.

4. A feedback control system is decribed as

$$G(s) = \frac{50}{s(s+2)(s+5)}, \quad H(s) = \frac{1}{s}$$

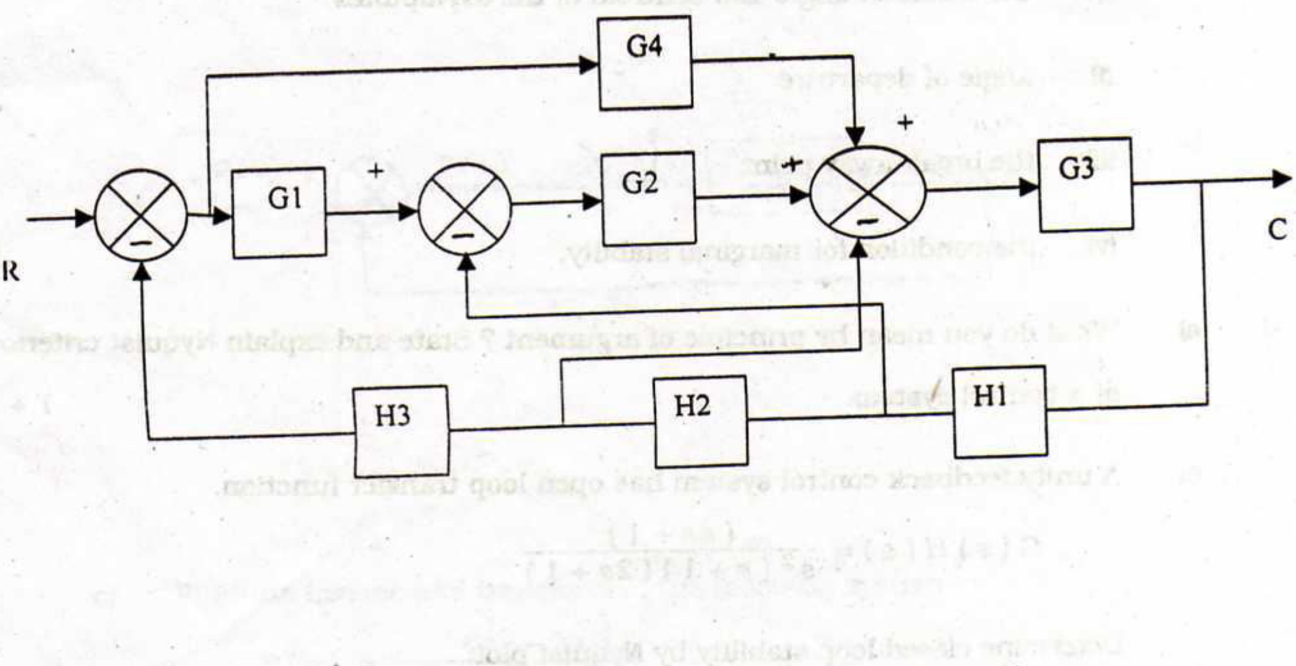
Evaluate the static error constants $K_p$, $K_v$ & $K_a$ for the system.

5. Consider the system

$$\dot{x}_1 = -x_2 + \alpha x_1^3$$
$$\dot{x}_2 = x_1 + \alpha x_2^3.$$

Discuss the stability in the sense of Lyapunov.

6. Find C/R using block diagram reduction method of the following diagram :



## GROUP – C

**( Long Answer Type Questions )**

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

7. a) Mention the difficulties that may arise in applying Routh stability criterion. What do you mean by relative stability ? 2 + 1

b) The open loop transfer function of a unity feedback control system is given by

$$G(s) = \frac{K(s+1)}{2s^3 + as^2 + 2s + 1}$$

The above system oscillates with frequency $\omega$, if it has poles on $s = +j\omega$ and $s = -j\omega$ and no poles in the right half $s$-plane. Determine the values of $K$ and $a$, so that the system oscillates at a frequency of 2 radian/sec. 6

c) The open loop transfer function of a unity feedback control system is given by

$$G(s) = \frac{K}{s(s^2 + 6s + 25)}$$

Find :

i) the number, angle and centroid of the asymptotes

ii) angle of departure

iii) the break-away point

iv) the condition for marginal stabilty. 6

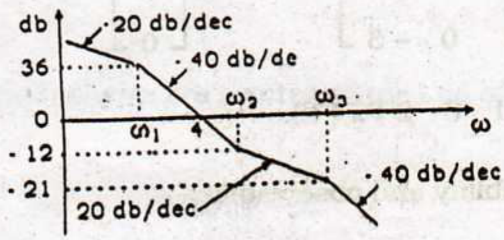
8. a) What do you mean by principle of argument ? State and explain Nyquist criterion of a control system. 1 + 2

b) A unity feedback control system has open loop transfer function,

$$G(s)H(s) = \frac{(4s+1)}{s^2(s+1)(2s+1)}$$

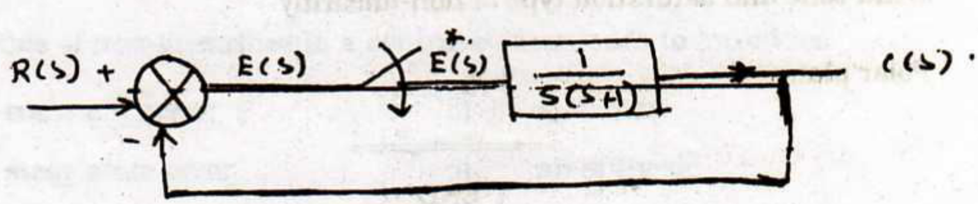
Determine closed loop stability by Nyquist plot. 7

c) Determine the transfer function of the system whose Bode plot is shown below : 5




9. a) Explain sampling and hold. 3

b) Find the pulse transfer function for the error sampled system shown in the following figure. 7




c) Find the inverse and transform of the following system : 5

$$F(z) = \frac{4z^2 - 2z}{z^3 - 5z^2 + 8z - 4}.$$

10. a) State the difference between describing function and transfer function. 5

b) A single input single output system is given by

$$\dot{x} = \begin{bmatrix} -1 & 0 & 0 \\ 0 & -2 & 0 \\ 0 & 0 & -3 \end{bmatrix} x(t) + \begin{bmatrix} 1 \\ 1 \\ 0 \end{bmatrix} u(t)$$

and $y(t) = [1 \quad 0 \quad 2]\, x(t)$.

Test for controllability and observability. 5

c) Obtain the eigenvalues and eigenvectors for a system described by

$$X = \begin{bmatrix} 0 & 1 & 0 \\ 3 & 0 & 2 \\ -12 & -7 & -6 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix} + \begin{bmatrix} 1 \\ 0 \\ 2 \end{bmatrix}, \quad Y = [1 \quad 0 \quad 0]\, X.$$ 5

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

a) PID controller

b) Compensation techniques

c) Phase plane technique of non-linear system analysis

d) Dead zone and saturation type of non-linearitly

e) Polar plot.

END