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.

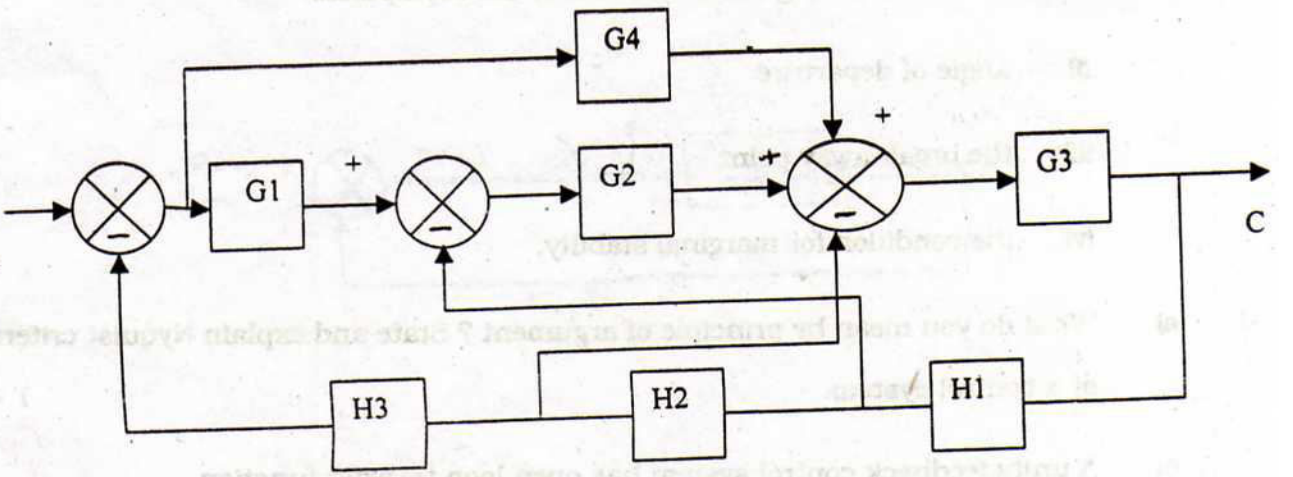
5. Consider the system

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

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

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 × 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 ω, 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 stability. 6

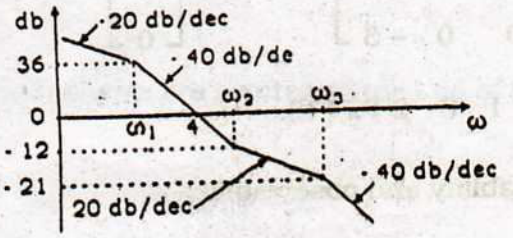
8. a) What do you mean by principle of argument ? State and explain Nyquist criterion of a control system. 1 + 2

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

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

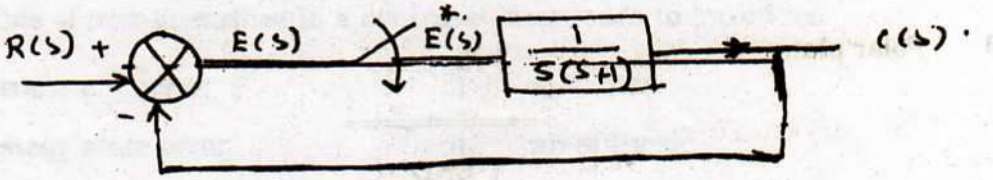
Determine closed loop stability by Nyquist plot. 7

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-linearity

e) Polar plot.

END