ENGINEERING & MANAGEMENT EXAMINATIONS, JUNE – 2008

CONTROL SYSTEM

SEMESTER - 4

Time : 3 Hours] [Full Marks : 70

Semilog Paper and Graph Paper is provided on Pages 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) Given that $G(s) = \dfrac{k}{s^2(s+2)(s+3)}$. The type & order of the system is

a) 3 & 3 b) 2 & 4

c) 3 & 1 d) 3 & 0.

ii) The root loci method of analysis of control system gives us

a) transient response b) frequency response

c) steady state response d) both (a) & (c).

iii) The system represented by its transfer function has some poles lying on imaginary axis of S-plane. The system is

a) Absolute stable b) conditionally stable

c) unstable d) marginally stable.

iv) The concept of analogous system is applicable to

a) linear system only

b) non-linear system only

c) both linear & non-linear systems

d) non-linear systems but can be extented to linear systems too.

v) By increasing the gain, K of the system, the steady state error of the system

a) increases
b) decreases
c) remain unaltered
d) none of these.

vi) The characteristic equation of a closed loop second order system is given as $s^2 + 4s + 16 = 0$. The resonant frequency in radian/sec of the system is

a) 2
b) $2\sqrt{2}$
c) 4
d) $2\sqrt{3}$.

vii) State variable approach converts qn *n*th order system into

a) *n*-number second order differential equations
b) two differential equations
c) *n*-number 1st order differential equations
d) a low order system.

viii) A unity feedback system having an open loop gain $G(s)H(s) = \frac{k(1-s)}{(s+1)}$ becomes stable when

a) mod $(k) > 1$
b) $k > 1$
c) mod $(k) < 1$
d) $k < -1$.

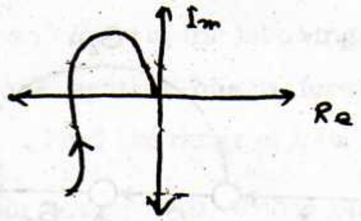
ix) The first derivative control can be used to

a) decrease settling time
b) decrease damping
c) decrease velocity error
d) eigenvalue analysis.

x) The step response of a system with transfer function $G(s) = \frac{1}{\tau s + 1}$ attains more than 98% of its final value in time '*t*' equal to

a) τ
b) 2τ
c) 3τ
d) 4τ.

xi) The Nyquist plot shown in figure indicates



a) marginally stable system b) unstable system
c) stable system d) none of these.

xii) Transfer function is defined for

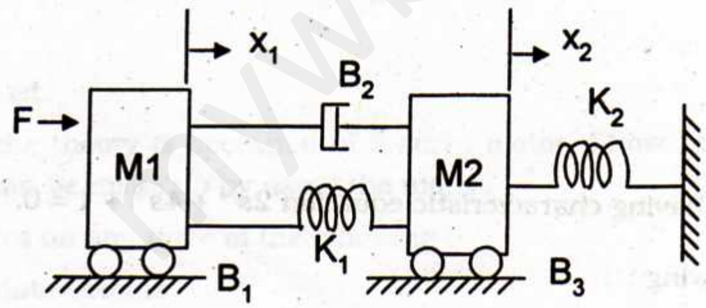
a) linear time invariant system b) linear time variant system
c) non-linear system d) none of these.

GROUP – B

(Short Answer Type Questions)

Write short notes on answer any *three* of the following. 3 × 5 = 15

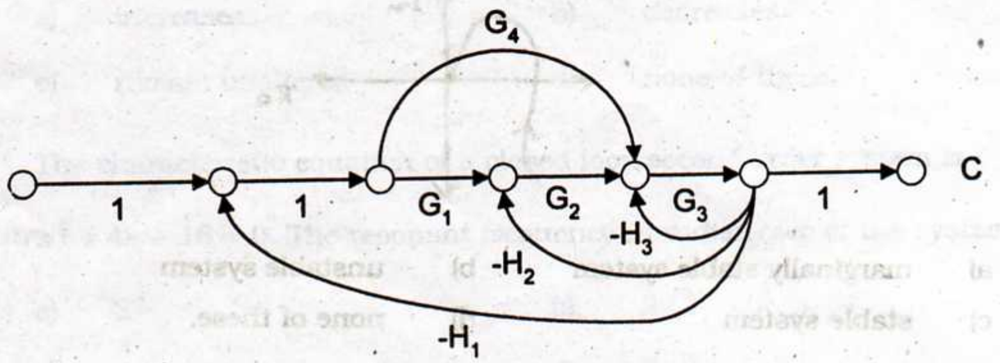
2. Consider the following mechanical translational system. *F* denotes force, *x* denotes displacement, *M* denotes Mass, *B* denotes friction coefficient and *K* denotes spring constant.



i) Write down the differential equations governing the above system.

ii) Draw the corresponding electrical equivalent circuit using force-voltage analogy scheme. 3 + 2

3. Find out the overall transfer function C/R of the following system using the rules of Signal Flow Graph.



4. A system is described by the following differential equation. Represent the system, in state space.

$$\frac{d^3x}{dt^3} + 3\frac{d^2x}{dt^2} + 4\frac{dx}{dt} + 4x = u_1(t) + 3u_2(t) + 4u_3(t).$$

5. For a system having $G(s) = \dfrac{25}{s(s+10)}$ & unity feedback,

Find

i) W_n

ii) ξ

iii) W_d

iv) T_p

v) M_p. 5

6. For a system having characteristic equation $2s^4 + 4s^2 + 1 = 0$.

Find the following :

i) The number of roots in the left half of S plane.

ii) The number of roots in the right half of S plane.

iii) The number of roots on the imaginary axis.

Comment on the stability of the system. Use the Routh-Hurwitz criterion.

GROUP – C

(Long Answer Type Questions)

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

7. a) A unity negative feedback system has a forward path transfer function $G(s) = \frac{ke^{-s}}{s(s^2 + 5s + 9)}$. Find the range of k for which the system is stable.

   b) Sketch the root locus for the system, whose open loop transfer function is $G(s)H(s) = \frac{k}{s(s+5)(s+7)}$, as k is varied from zero to infinity. 6 + 9

8. a) Discuss the Nyquist stability criterion. Predict the stability of the closed-loop system using Nyquist's stability criterion of the following open-loop transfer function :

   $$G(s) = \frac{(s+2)}{(s+1)(s-1)}$$

   b) i) Draw the analog circuit diagram of PID controller.

   ii) Describe the role of integral and derivative action in a PID controller.

   8 + 4 + 3

9. Sketch the Bode plot showing the magnitude in decibels and phase angel is degrees as a function of log frequency for the transfer function given below :

   $$G(s) = \frac{10(s+1)}{s(s+2)(s+10)}$$

   a) Determine Gain Margin, Phase Margin, Gain cross-over frequency and phase cross-over frequency.

   b) Comment on the stability of the system. 8 + 5 + 2

10. a) Find the Z-transform of the following :

   i) a^k

   ii) $\cos \omega t$.

   b) Explain the theory & operation of a servo motor. Show how a position control scheme can be made up by using the motor. 6 + 9

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

   a) Discrete data sptoms

   b) Absolute & relative stability

   c) Effect of poles & zeros on stability

   d) Tachometer.

END