ENGINEERING & MANAGEMENT EXAMINATIONS, DECEMBER – 2007

CONTROL SYSTEM

SEMESTER – 5

Time : 3 Hours] [Full Marks : 70

GROUP – A

(Multiple Choice Type Questions)

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

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

a) zeros at origin b) poles at infinity

c) poles at origin d) finite poles. ☐

ii) The characteristic equation of a system is $s^2 + 2s + 2 = 0$. The system is

a) critically damped b) underdamped

c) overdamped d) none of these. ☐

iii) Addition of a pole to the closed loop transfer function

a) increases rise time b) decreases rise time

c) increases overshoot d) has no effect. ☐

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

a) decreases b) increases

c) remains same d) has no effect. ☐

v) When the phase crossover frequency is equal to the gain crossover frequency, the system exhibits

a) sustained oscillations

b) damped oscillatory response

c) oscillations of increasing amplitude

d) overdamped response. ☐

vi) If the gain of the open loop system is doubled, the gain margin

a) is not affected b) gets doubled

c) becomes half d) becomes $\frac{1}{4}$ th. ☐

vii) The function $\frac{1}{1 + sT}$ has slope of

a) – 6 dB/decade b) 6 dB / decade

c) – 20 dB/decade d) 20 dB / decade. ☐

viii) "Synchros" are popularly used as transmitter of

a) digital data b) mathematical data

c) angular data d) all of these. ☐

ix) A 2nd order system exhibits 100% overshoot. Its damping coefficient is

a) equal to 0 b) equal to 1

c) < 1 d) > 1. ☐

x) For the transfer function $G(s)H(s) = \frac{1}{s(s+1)(s+0{\cdot}5)}$,

the phase crossover frequency is

a) 0·5 rad/sec b) 0·707 rad/sec

c) 1·732 rad/sec d) 2 rad/sec. ☐

xi) Transfer function with unit magnitude & antisymmetric pole-zero patterns correspond to

a) all pass system b) minimum phase system

c) non-minimum phase systems d) no-pass systems. ☐

xii) A linear time invariant system obeys

a) the principle of superposition

b) the principle of homogeneity

c) both the principles in (a) & (b)

d) none of these. ☐

GROUP – B

(Short Answer Type Questions)

Answer any *three* of the following. 3 × 5 = 15

2. Determine the transfer function of the network shown below in *fig. 1 :*

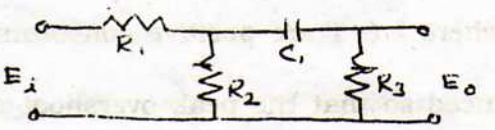

Fig. 1

3. Use block diagram reduction technique to find out the overall transfer function of the system shown below in *fig. 2.*

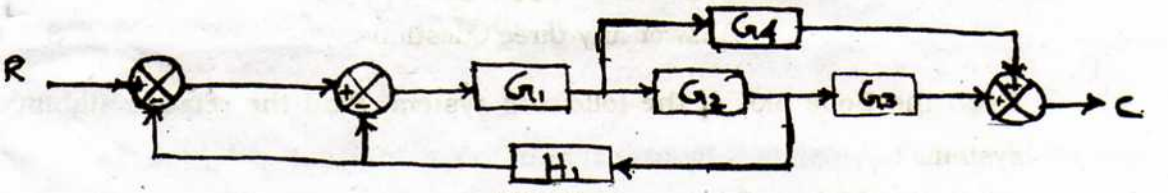

Fig. 2

4. Consider the following mechanical translation system. *F* denotes force, *X* denotes displacement, *M* denotes mass, *B* denotes friction coefficient & *K* denotes spring constant. As shown below in *fig. 3.*

   a) Write down the differential equations governing the system shown below.

   b) Draw the corresponding electrical equivalent circuit using force-voltage analogy.

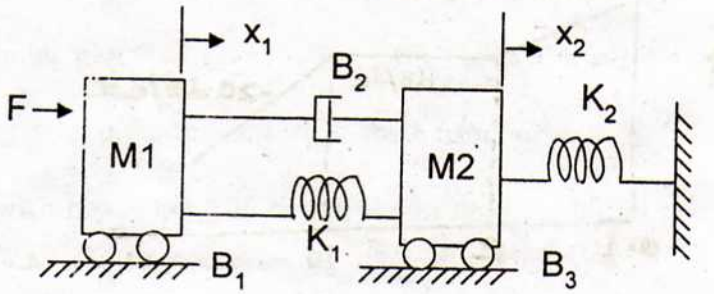

Fig. 3

5. A unity feedback system is characterized by the open loop transfer function

$$G(s) = \frac{1}{s(0{\cdot}5\,s + 1)(0{\cdot}2\,s + 1)}.$$

Determine the steady state errors for unit step, unit ramp & unit acceleration input. Also determine the damping ratio & natural frequency of the dominant roots.

6. The open loop transfer function of a unity feedback system is given by $G(s) = \frac{k}{s(Ts + 1)}$ where k & T are positive constants. By how much should the amplifier gain be reduced so that the peak overshoot of unit step response of the system is reduced from 75% to 25% ?

GROUP – C
(Long Answer Type Questions)

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

7. a) Draw the Bode plot of the following system. Find the relative stability of the system. :

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

b) Derive the transfer function from the following Bode plot shown below in *fig.* 4. 10 + 5

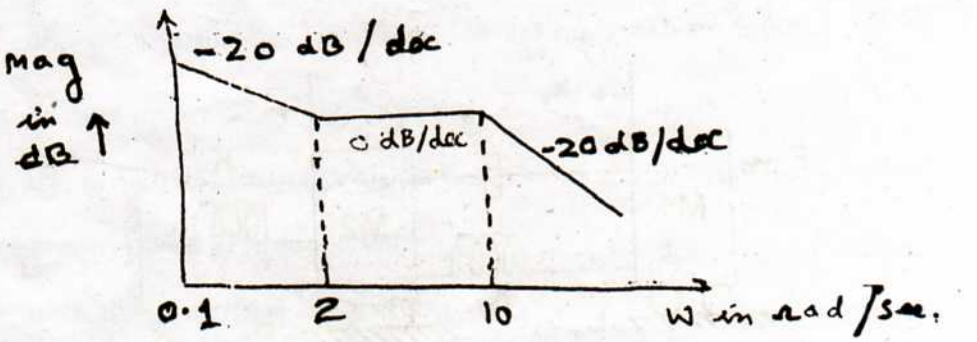

Fig. 4

8. a) Sketch the root locus of a system whose open loop transfer function is given by

$$G(s) = \frac{k}{s(s+2)(s+4)}.$$

b) Evaluate the value of k at a point where the root loci crosses the imaginary axis. Determine the frequency.

c) Calculate the values of k so that the dominant pair of complex poles of the system has a damping ratio of 0·5.

9. a) State Routh's stability criterion.

b) Using Routh's stability criterion, determine the value of K for which the closed loop system with unity feedback system with open loop transfer function

$$G(s) = \frac{K}{(s^2+6s+25)(s+2)(s+4)}$$ exhibits sustained oscillation.

c) Why is the step function used to characterise the dynamic behaviour of a 2nd order system ? State whether the impulse function can be used for this purpose or not. 3 + 7 + 5

10. a) State & explain the Nyquist criterion for studying stability of a control system.

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

$$G(s) = \frac{K}{s(s^2+s+4)}.$$

Draw the Nyquist plot & hence investigate the stability of the system for various values of k.

c) What are the advantages of Nyquist plot ? 4 + 7 + 4

11. a) What is polar plot ? 3

b) Define lag & lead compensators & their functions. 4

c) Discuss with neat sketches two different types of liquid control schemes. 8

END