Name : .....

Roll No. : .....

Invigilator's Signature : .....

CS/B.TECH/EE(N)/SEM-5/EE-503/2012-13

2012

CONTROL SYSTEM – I

Time Allotted : 3 Hours *Full Marks* : 70

The figures in the margin indicate full marks.

Candidates are required to give their answers in their own words as far as practicable.

GROUP – A

(Multiple Choice Type Questions)

1. Choose the correct alternatives for any *ten* of the following :

$10 \times 1 = 10$

i) Feedback control system is basically

a) high pass filter b) band pass filter

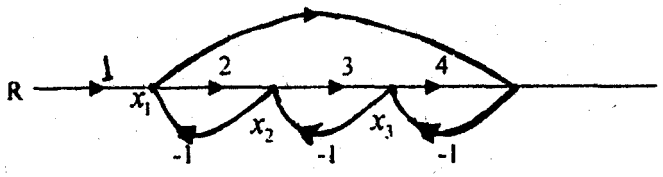
c) low pass filter d) band stop filter.

ii) Given that $G(s) = \dfrac{k}{s^2(s+2)(s+3)}$, the type and order of the system is

a) 3 & 3 b) 2 & 4

c) 3 & 1 d) 3 & 0.

iii) In the signal flow graph of figure the gain C/R will be



a) 11/9 b) 22/15

c) 24/23 d) 44/23.

iv) If the system has multiple poles on the $j\omega$-axis, the system is

a) stable b) unstable

c) marginally stable d) conditionally stable.

v) The steady state error of unit ramp input in the type-2 system is

a) ∞ b) 0

c) 1 d) 5.

vi) The damping ratio of characteristics equation $s^2 + 2s + 8 = 0$ is

a) 0·353 b) 0·350

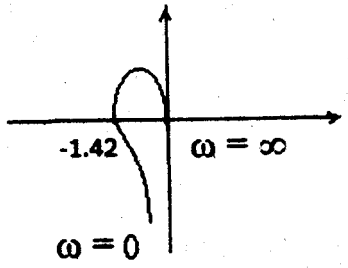
c) 0·30 d) 0·333.

vii) A lag network for compensation normally consists of

a) R only b) R & C elements

c) R & L elements d) R, L & C elements.

viii) The polar plot of a type-1, 3-pole, open loop system is shown in the figure given below. The closed loop system is



a) always stable

b) marginally stable

c) unstable with one RHS pole

d) unstable with two RHS pole.

ix) The settling time for a second order system responding to a step input with 5% overshoot is

a) $\frac{4}{\xi\omega_n}$ b) $\frac{2}{\xi\omega_n}$

c) $\frac{3}{\xi\omega_n}$ d) $\frac{5}{\xi\omega_n}$.

x) A system has 14 poles and 2 zeros. The slope of its highest frequency asymptote in its magnitude plot is

a) – 40 dB/decade b) – 240 dB/decade

c) – 280 dB/decade d) – 320 dB/decade.

xi) If the maximum overshoot is 100%, the damping ratio is

a) 1 b) 0

c) 0·5 d) infinite.

xii) By the use of PD controller to a second order system, the rise time

a) decreases b) increases

c) remains same d) has no effect.

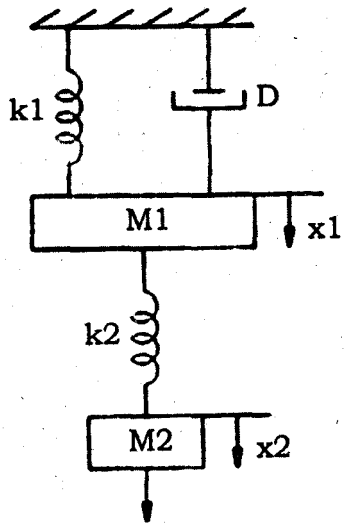
GROUP – B

(Short Answer Type Questions)

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

2. The forward path transfer function of a unity feedback system is given by $G(s) = \frac{5(s^2 + 2s + 100)}{s^2(s+5)(s^2+3s+10)}$. Determine the steady state error for the input $r(t) = 2 + 3t$.

3. Draw the electrical analogous circuit using force-voltage analogy for the mechanical system shown in the figure.



4. How many roots of the given polynomial area on the RHP, LHP and on the $j\omega$-axis ?

$s^7 + 3s^6 + 7s^5 + 10s^4 + 11s^3 + 11s^2 + 2s + 6 = 0$

Hence, comment on the stability of the system.

5. A system has $G(s) = \frac{20}{s^2 + 5s + 5}$ and unity feedback. Find

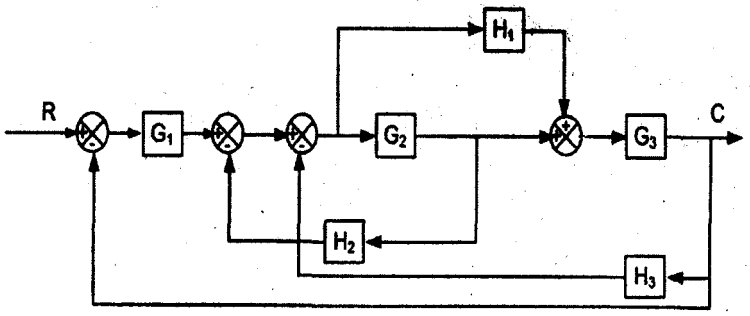
i) ω_n ii) ξ

iii) ω_d iv) M_P

v) T_s.

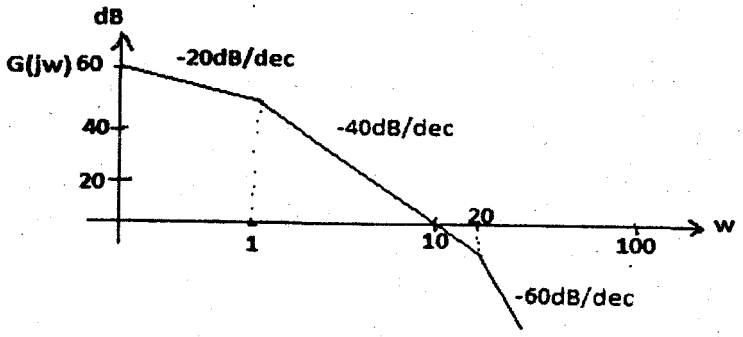
6. The characteristic equation of a system is given by $s^3 + 3ks^2 + (k+2)s + 4 = 0$. Find the range of k for which the system is stable.

7. Construct the equivalent signal flow graph for the block diagram shown in figure and evaluate the transfer function.



2 + 3

8. The asymptotic Bode Plot of a transfer function is as shown in the figure. Determine the transfer function $G(s)$ corresponding to this Bode Plot.



GROUP – C

(Long Answer Type Questions)

Answer any *three* of the following. 3 × 15 = 45

9. A feedback control system has an open-loop transfer function

$$G(s)H(s)=\frac{k}{s(s+3)(s^2+2s+2)}$$

a) Find the root loci as k is varied from 0 to α.

b) Determine the value of k where damping coefficient $\xi = 0 \cdot 5$ and gain margin at this point. 8 + 4 + 3

10. a) Write the advantages of frequency response. Define Cut-off frequency (ω_c) & Cut-off rate.

b) Draw the bode plot of the open loop transfer function of a unity feedback system is given by $G(s) = \frac{k}{s(1+0 \cdot 02s)(1+0 \cdot 04s)}$. Find the gain margin and phase margin. Hence find the value of open loop gain so that the closed loop system has a phase margin of 45°. 2 + 2 + 11

11. a) State Nyquist stability criterion.

b) Using Nyquist stability criterion determine whether the unity feedback close loop system having open loop transfer function $G(s) = \frac{120}{s(s+4)(s+6)}$ is stable or not.

4 + 11

12. a) Draw the schematic diagram of an armature controlled *dc* servo portion control system showing all its components. Use potentiometers as the position error sensor. Draw the block diagram.

b) Find the overall transfer function of the system. Assume all relevant parameters and variables of the system.

8 + 7