Name : .....

Roll No. : .....

Invigilator's Signature : .....

CS/B.TECH/EE(O)/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) In an open-loop control system

a) system variables affect the output signal

b) output signal has no control on the input signal

c) none of the variables have any effect on the input signal

d) none of these.

ii) A position control is

a) an automatic regulating system

b) a servomechanism

c) a process control system

d) a stochastic control system.

iii) The damping frequency of oscillation is given by

a) $\omega_d = \omega_n \sqrt{1-\xi^2}$ b) $\omega_d = \omega_n \sqrt{1+\xi^2}$

c) $\omega_d = \omega_r \sqrt{1+\xi^2}$ d) $\omega_d = \dfrac{\omega_n}{\sqrt{1-\xi^2}}$.

iv) The term 'reset control' refers to

a) integral control b) proportional control

c) derivative control d) none of these.

v) If a closed loop control system operates at a point on $j\omega$ axis the system is

a) overdamped b) underdamped

c) marginary stable d) stable.

vi) In terms of Bode plot the system is stable if

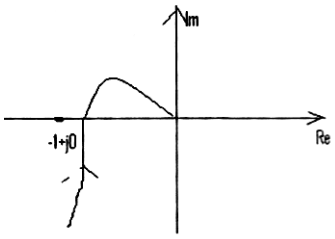
a) G.M. = P.M.

b) P.M. & G.M. both are positive

c) P.M. & G.M. both are negative

d) P.M. is negative, but G.M. is positive.

vii) The Nyquist plot shown in figure indicates



a) marginally stable system

b) unstable system

c) stable system

d) none of these.

viii) The Routh Hurwitz criterion gives

a) relative stability b) absolute stability

c) gain margin d) phase margin.

ix) The frequency at which the magnitude of the Bode plot crosses 0 dB axis is termed as

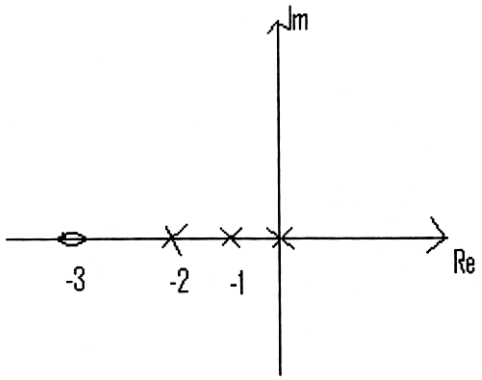
a) natural frequency

b) phase crossover frequency

c) gain crossover frequency

d) corner frequency.

x) The forward path gain of a control system is 2·5 and the pole-zero configuration of the overall transfer function is shown in figure. The overall transfer function is



a) $\frac{2\cdot 5(s+1)}{s(s+2)(s+3)}$ b) $\frac{2\cdot 5(s+2)}{s(s+1)(s+3)}$

c) $\frac{2\cdot 5(s+3)}{s(s+1)(s+3)}$ d) $\frac{(s+3)}{2\cdot 5(s+1)(s+3)}$.

xi) The characteristic equation of a feedback control system is $s^3 + ks^2 + 5s + 10 + 0$. For the system to be critically stable the value of k should be

a) 1 b) 2

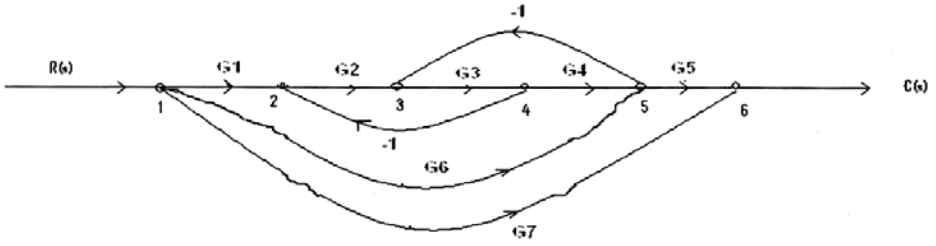
c) 3 d) 4.

GROUP – B

(Short Answer Type Questions)

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

2. Obtain the transfer function for $\frac{C(S)}{R(S)}$, given figure by the use of Block Diagram Reduction method.



3. System, given $C(S) = \frac{600}{(s+10)(s+60)}$ when subjected to a unit step input.

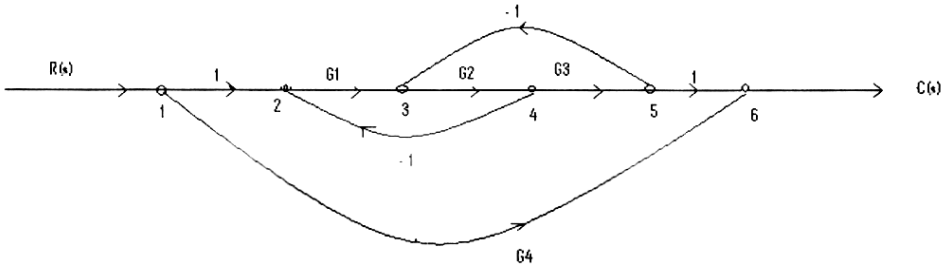
   a) Obtain the expression for the closed loop transfer function (considering unity feedback).

   b) Determine the undamped neutral frequency and damping ratio of the system. 3 + 2

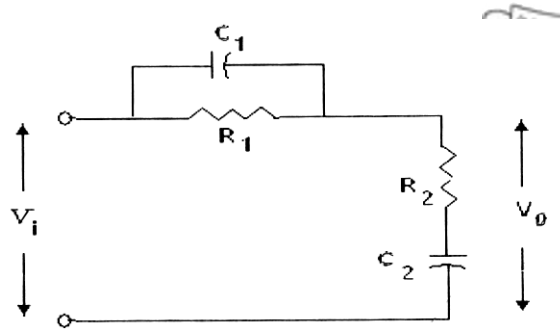
4. a) Write short note on $P + I$ control action.

   b) Why derivative controller cannot be used alone ? 3 + 2

5. Obtain the transfer function for $\frac{C(S)}{R(S)}$, given figure by the use of signal flow graph (Using Mason's gain formula).



6. Derive the transfer function of the network shown in figure.



GROUP – C

(Long Answer Type Questions)

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

7. By means of Routh criterion determine the

   a) Stability of the system represented by the following characteristic equation

   $$s^6 + 3s^5 + 5s^4 + 9s^3 + 8s^2 + 6s + 4 = 0$$

   For system found to be stable or not, determine the number of roots of the characteristic equation in right half of *s*-plane.

   b) For a unity feedback system the open loop transfer function is

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

   Sketch the root locus as *k* varies from zero to infinity.

5 + 10

8. a) Define the term Absolute and relative stability of a system.

   b) The open loop transfer function of a control system is given by $G(s)=\frac{k}{s(s+2)(s+10)}$. Determine the value of k so that the system may be stable with

      i) Gain margin equal to 6 dB

      ii) Phase margin equal to 45°

   c) Explain why derivative cannot be used alone. 4 + 8 + 3

9. Construct the Bode plot for a unity feedback control system having $G(s)=\frac{10(s+10)}{s(s+2)(s+5)}$

   a) From the plot obtain the gain margin, phase margin and gain crossover frequency, phase crossover frequency.

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

10. a) What do you mean by servomechanism ?

    b) Discuss about the effect of feedback on control system.

    c) Prove the expression for the transfer function of armature controlled DC motor and field controlled DC motor. 3 + 3 + 9

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

    a) Effect of addition of poles and zeros in closed loop transfer function

    b) Potentiometer

    c) Tachometer

    d) Lead-lag compensation.

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