Name : .....

Roll No. : .....

Invigilator's Signature : .....

CS/B.Tech(EE)/SEM-5/EE-503/2009-10

2009

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.

Graph sheet(s) & semi-log paper(s) will be provided by the institution.

GROUP – A

(Multiple Choice Type Questions)

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

i) Human system is

a) a multivariable feedback control system

b) an open loop control system

c) a single variable control system

d) a complex control system.

ii) The tansfer function of the network given below is

a) $\frac{1}{1 + sRC}$ b) $\frac{sRC}{1 + sRC}$

c) $\frac{RC}{1 + sRC}$ d) $\frac{1 + sRC}{1 - sRC}$.

iii) Single flow graph is

a) topological representation of a set of differential equations

b) Bode plot

c) polar plot

d) locus of roots.

iv) The unit impulse response of a linear time invariant second order system is

$$g(t) = 100\, e^{-8t} \sin 6t \quad (t \geq 0)$$

The natural frequency and damping fraction of the system are respectively

a) 10 rad/sec & 0·6 b) 10 rad/sec & 0·8

c) 6 rad/sec & 0·6 d) 6 rad/sec & 0·8

v) The characteristic equation of a unity feedback system is given by $s^3 + s^2 + 4s + 4 = 0$. The system

a) has one pole in the RH s plane

b) has no poles in the RH s plane

c) exhibits oscillatory nature

d) both (b) and (c).

vi) If the gain (k) of a system becomes zero, the roots will

a) move away from zero b) move away from poles

c) coincide with the zero d) coincide with poles.

vii) For $\zeta = 0$, w_r is equal to

a) 0 b) w_n

c) $\frac{w_n}{\sqrt{1 - 2\zeta^2}}$ d) $w_n \sqrt{1 - 3\zeta^2}$.

viii) For a type-3 system, the asymptote at a lower frequency will have a slope of

a) – 6 dB / octave b) – 12 dB / octave

c) – 24 dB / octave d) – 40 dB / octave.

ix) Gain margin is the reciprocal of the gain at the frequency at which the phase angle is

a) 90° b) 180°

c) – 180° d) 0°.

x) The transfer function of a lead compensator is

$$G_C(S) = \frac{1 + 0{\cdot}12\,s}{1 + 0{\cdot}04\,s} .$$

The maximum phase shift that can be obtained from this compensator is

a) 60° b) 45°

c) 30° d) 15°.

xi) The disadvantage(s) of polar plot is (are)

a) the calculations are time consuming for exact plot

b) it is very difficult to calculate gain & phase margin

c) plot is crammed at high frequencies

d) all of these.

xii) The characteristic equation of an armature controlled *dc* motor is of

a) first order equation

b) second order equation

c) zero order equation

d) third order equation.

GROUP – B
(Short Answer Type Questions)

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

2. For a rotational system shown in figure below, draw electrical analogous circuit based on *T-i* analogy.

3. Find the simplified block diagram of figure shown.

4. Find the range of *k* of the system shown in figure to be stable.

5. A unity feedback system has

$$G(S) = \frac{180}{s(s+6)} \quad \& \; r(t) = 4t$$

Determine :

a) the steady state error

b) the value of k to reduce the error by 6%.

6. Determine time respone specification for a unit step input to a unit feedback system having $G(S) = \frac{144}{s(s+12)}$.

GROUP – C

(Long Answer Type Questions)

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

7. a) What do you mean by root locus ?

b) Draw the root locus diagram for the control system shown below and calculate gain at break-away points. Comment on the stability of the system. 2 + 13

8. a) Define (i) Bode plot (ii) minimum phase function (iii) all pass function.

   b) Sketch the Bode plot for the system having open loop transfer function.

$$G(S) = \frac{16(1 + 0{\cdot}1s)}{s^2(s+1)(s + 0{\cdot}5s)}$$

From the plot determine (i) phase margin (ii) gain margin (iii) stability of the system. 3 + 12

9. a) What do you mean by Nyquist criterion ?

   b) For the system with open loop transfer function

$$G(S)H(S) = \frac{40}{(s+4)(s^2 + 2s + 1)}$$

obtain gain margin, phase margin and stability of the system using Nyquist plot. 3 + 12

10. a) Obtain mathematical model of armature controlled DC motor and then determine the transfer function of the stystem.

    b) What are (i) synchros (ii) position encoder (iii) resolvers ?

9 + 6

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

    a) PID controller

    b) Lead-lag compensator

    c) Polar plots

    d) AC tacho generator.