Name : .....

Roll No. : .....

Invigilator's Signature : .....

CS/B.TECH (ICE)/SEM-4/IC-401/2010

2010

BASIC CONTROL THEORY

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) The transfer function for the state variable representation $\frac{dx}{dt} = AX + BU$, $Y = CX + DU$ is given by

a) $D + C (SI - A)^{-1} B$ b) $B (SI - A)^{-1} C + D$

c) $B (SI - A)^{-1} B + C$ d) $C (SI - A)^{-1} D + B$.

ii) Signal flow graph is used to obtain the

a) stability of the system

b) transfer function of the system

c) controllability of the system

d) observability of the system.

iii) Given that $G(s) = \frac{k}{s^2(s+2)(s+3)}$. The type & order of the system is

a) 3 & 3 b) 2 & 4

c) 3 & 1 d) 3 & 0.

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

a) – 6 db/decade b) 6 db/decade

c) – 20 db/decade d) 20 db/decade.

v) A system having 3 zeroes and 4-poles has root locus branches equal to

a) 3 b) 4

c) 1 d) 7.

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

a) equal to 0 b) equal to 1

c) greater than 1 d) less than 1.

vii) 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.

viii) The electrical resistance is analogous to

a) viscous damper b) spring

c) mass d) torque.

ix) The lead lag compensation will improve

a) transient response

b) steady state response

c) both (a) and (b)

d) none of these.

x) When the gain margin is positive and the phase margin is negative, the system is

a) stable

b) unstable

c) probabilistic

d) undeterministic.

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

a) increases rise time

b) decreases rise time

c) increases over shoot

d) has no effect.

xi) The transfer function of a system is $\frac{10}{1+s}$, when operated as a unity feedback system, the steady state error to a unit step input will be

a) zero b) 1/11

c) 10 d) infinity.

GROUP – B

(Short Answer Type Questions)

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

2. Draw the electrical equivalent circuit diagram for the system shown in figure. Write the system equations.

dia

3. Derive the transfer function of the system shown in figure.

dia

4. A unity feedback system in characterized by an open loop transfer function $G(s) = \frac{k}{s(s+10)}$. Determine the gain k so that the system will have a damping ratio of 0·5. For the values of k, determine rise time, peak time, settling time for a unit step input.

5. Derive the closed loop transfer function of an armature controlled D.C. shunt motor.

6. By means of Routh-Hurwitz's stability criterion, determine the stability of the system represented by the following characteristic equation :

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

GROUP – C

(Long Answer Type Questions)

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

7. a) Derive the transfer function of the network shown below.

dia

b) The open loop transfer function of a serve system with unity feedback is $G(s) = \frac{500}{s(s+15)}$.

Find the static error constants k_p , k_v and k_a for the system. Also evaluate the dynamic error coefficients.

c) Obtain the transfer function of the system from the given state model.

$$\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \end{bmatrix} = \begin{bmatrix} -5 & -1 \\ 3 & -1 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} + \begin{bmatrix} 2 \\ 5 \end{bmatrix} u$$

$$y = \begin{bmatrix} 1 & 2 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} .$$ 5 + 5 + 5

8. Draw the Bode plot of the open loop transfer function

$$G(s) = \frac{10(s+10)}{s(s+2)(s+5)}$$

From the graph determine gain margin, phase margin, gain crossover frequency, phase crossover frequency and the stability of the system.

9. Sketch the root locus for $G(s)H(s) = \frac{k}{s(s+2)(s+4)}$.

Find the value of k at the point when the root loci cross the imaginary axis. Also determine the frequency at this point. Determine the value of k such that the dominant pair of complex poles of the system has a damping ratio of 0·5.

10. State Nyquist stability criterion. For the open loop transfer function given below determine the stability of the closed loop system using Nyquist criteria :

$$G(s)H(s) = \frac{60}{(s+1)(s+2)(s+5)} .$$

11. a) Explain the principle of operation of lead and lag compensators.

b) Discuss the design method of PID controllers by analytical method. 8 + 7