*Name* : .....

*Roll No.* : .....

*Invigilator's Signature* : .....

**CS/B.Tech (IT)/SEM-4/EE-411/2010**

**2010**

# CONTROL SYSTEMS

*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 × 1 = 10

i) If a closed loop control system operates at a point on JW axis, the system is

a) overdamped b) underdamped

c) marginally stable d) unstable.

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) 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) The state transition matrix is given by

a) $[SI - A]$ b) $\left\{(SI - A)^{-1}\right\}$

c) $\mathrm{L}\left\{(SI - A)^{-1}\right\}$ d) $\mathrm{L}^{-1}\left\{(SI - A)^{-1}\right\}$.

v) An a.c. servomotor is basically a

a) universal motor

b) single phase induction motor

c) two phase induction motor

d) three phase induction motor.

vi) A potentiometer converts linear/rotational displacement into

a) current b) power

c) voltage d) torque.

vii) State variable approach converts an *n*th order system into

a) *n* second order differential equations

b) two differential equations

c) *n* first order differential equations

d) a higher order system.

viii) In control system, we have the following methods for system analysis :

i) Nyquist criterion

ii) Bode plot

iii) Root locus

iv) Routh-Hurwitz criterion

Which of the above are in time domain ?

a) (i) and (ii) b) (ii) and (iii)

c) (i) and (iii) d) (iii) and (iv).

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

**Fig.**

a) $\frac{2\cdot5(s+1)}{s(s+2)(s+3)}$ b) $\frac{2\cdot5(s+2)}{s(s+1)(s+3)}$

c) $\frac{2\cdot5(s+3)}{s(s+1)(s+3)}$ d) none of these.

x) The close loop gain of the system in the given figure is

**Fig.**

a) 6 b) –6

c) $\frac{3}{2}$ d) none of these.

xi) An increase in damping ratio

a) increases rise time

b) decreases rise time

c) does not affect rise time

d) keeps the time within limits.

xii) A second order system has damping ratio $\xi = 0{\cdot}9$. The system is

a) underdamped

b) overdamped

c) critically damped

d) insufficient information for any prediction.

## GROUP – B
## ( Short Answer Type Questions )

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

2. Derive the closed loop transfer function of an armature controlled DC shunt motor.

3. Determine the transfer function C/R for the system given below.

**Fig.**

4. Find the condition for stability for the system whose characteristic equation is given below :

$$s^3 + (k + 0 \cdot 5)s^2 + 4ks + 50 = 0$$

5. 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 step, ramp & parabolic error co-efficients. Also determine the type of the system.

6. Obtain the state transition matrix of the following system :

$$\frac{dx_1}{dt} = x_1 + u$$

$$\frac{dx_2}{dt} = x_1 + x_2 + u.$$

**GROUP – C**

**( Long Answer Type Questions )**

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

7. A unity feedback control system has a open loop transfer function $G(s)=\frac{k}{s(s+3)(s^2+2s+2)}$. Sketch the root lous of the system by determining the following :

   a) Centroid, number & angle of asymptotes.

   b) Angle of departure of root loci from the poles.

   c) Break-away point.

   d) The value of *k* & the frequency at which the root locus crosses JW axis.

8. Construct the Bode plot for a unity feedback control system having $G(s)=\frac{10(s+10)}{s(s+2)(s+5)}$. From the plot obtain the gain margin, phase margin, gain cross-over frequency & phase cross-over frequency. Comment on the stability of the system.

9. a) State the Nyquist stability criterion. How is Nyquist criterion different from Routh-Hurwitz criterion ?

   b) What do you mean by relative stability ?

   c) The open loop transfer function of a unity feedback control system is given by :

$$G(s)=\frac{s+0\cdot25}{s^2(s+1)(s+0\cdot5)}$$

   Determine the closed loop stability by applying Nyquist criterion. ( 3 + 2 ) + 3 + 7

10. a) Obtain the transfer function of the system from the given state model :

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

$$Y=\begin{bmatrix}1, & 2\end{bmatrix}\begin{bmatrix}x_1\\ x_2\end{bmatrix}.$$

   b) Find z-transform of the following function $F(s)=\frac{1}{s(s+a)}$.

   c) Determine the pulse transfer function of the sampled data control system shown below. The sampling time is $T$ = 0·5 second.

**Fig.**

5 + 3 + 7

11. Write short notes on any *three* of the following : $3 \times 5$

a) PID controller.

b) Sample & Hold circuits.

c) Tachometer.

d) Transient response of a 2nd order system.