Name : .....

Roll No. : .....

Invigilator's Signature : .....

CS/B.Tech(ECE)/SEM-5/EC-513/2009-10

2009

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.

Semi log paper and Graph Sheet/(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) A system having transfer function $G(s) = \frac{1}{2(s + 0{\cdot}5)}$ is subjected to a unit step input, the steady value of the output is

a) 1 b) 2

c) $\frac{1}{2}$ d) $\frac{1}{10}$.

ii) The natural frequency of oscillations of the output for the equation $\frac{d^2x}{dt^2} + 1{\cdot}5\frac{dx}{dt} + 4x = 1$ is

a) 0 rad/sec b) 1·5 rad/sec

c) 2 rad/sec d) 4 rad/sec.

iii) The type number of a transfer function denote the number of

a) zeros at the origin b) poles at infinity

c) poles at origin d) zeros at infinity.

iv) The stready state error for a unity feedback system having open loop transfer function as

$G(S) = \frac{9}{S(0{\cdot}2\,S + 1)}$ when subjected to a unit step input will be

a) 0·1 b) 1/9

c) 0·2 d) 0.

v) The settling time of a second order system on 2% basis is given by

a) $t_s = \frac{4}{\zeta \omega_n}$ b) $t_s = \frac{\zeta \omega_n}{4}$

c) $t_s = \frac{4\zeta}{\omega_n}$ d) $t_s = 4\zeta \omega_n$.

vi) Integral error control

a) increases the order of the system

b) decreases the order of the system

c) increases the steady state error

d) does not affect the steady state error.

vii) The initial slope of the Bode plot gives an indication of

a) type of the system

b) nature of the system time response

c) system stability

d) gain margin.

viii) If the root locus branches cross the emaginary axis, the system becomes

a) overdamped b) underdamped

c) oscillatory d) sustained oscillations.

ix) The transfer function of an integral compensator is given by

a) $\frac{1}{s}$ b) $\frac{1}{s^2}$

c) $\frac{k}{s}$ d) ks.

x) The state transition matrix $\phi(t)$ is given by

a) $[SI] - [A]$

b) $\{[SI]\} - [A]\}^{-1}$

c) $h^{-1}\{[SI]\} - [A]\}^{-1}$

d) $h^{-1}\{[SI]\} - [A]\}$.

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

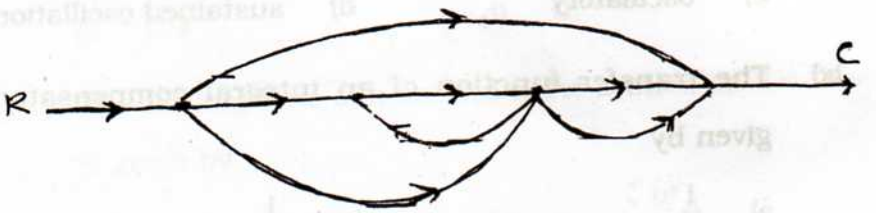
a) *n* 2nd order differential equations

b) 2 differential equations

c) *n* 1st order differential equations

d) a low order system.

xii) The number of forward paths in the signal flow graph shown below is



a) 1 b) 2

c) 3 d) 5.

GROUP – B

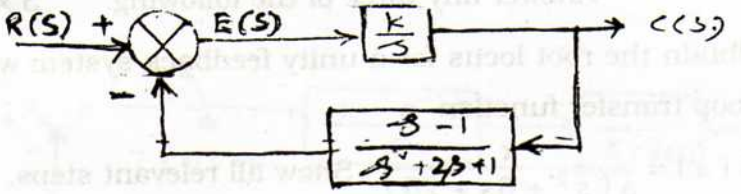
(Short Answer Type Questions)

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

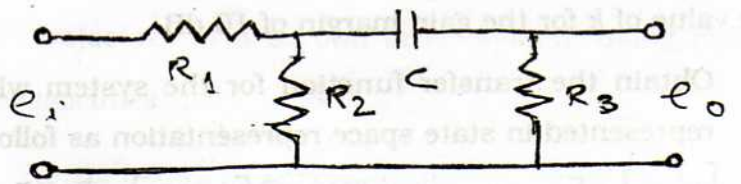
2. A unity feedback heat treatment system has open loop transfer function

$$G(s) = \frac{10000}{(1+s)(1+0{\cdot}5s)(1+0{\cdot}02s)}$$. The output set point is 500°C. What is the steady state temperature ?

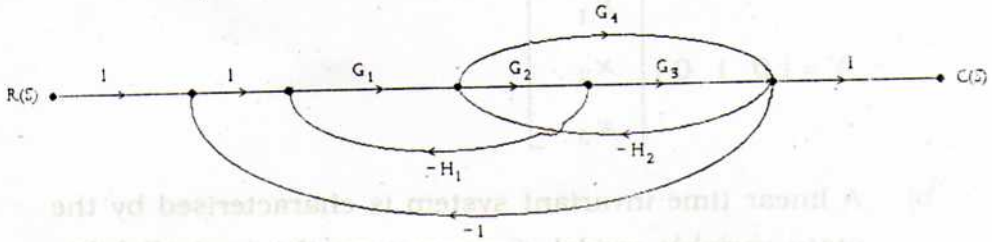
3. Find the range of k to keep the system shown in figure to be stable.



4. Determine the transfer function of the network shown in figure relating $E_o(s)$ & $E_i(s)$



5. Find the transfer function from the following signal flow graph using Mason's gain farmula.



6. Construct the state model for a system characterized by the differential equation

$$\ddot{Y} + 5\dot{y} + 6y = 4.$$

GROUP – C

(Long Answer Type Questions)

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

7. Obtain the root locus for a unity feedback system with open loop transfer function

$G(s) = \dfrac{k}{s(s^2 + 6s + 25)}$. Show all relevant steps.

8. Draw the Bode plot of the system whos open loop transfer function is given by

$GH(s) = \dfrac{k}{s(1 + s)(1 + 0{\cdot}1s)(1 + 0{\cdot}02s)}$. Determine the value of k for the gain margin of 10 dB.

9. a) Obtain the transfer function for the system which is represented in state space representation as follows :

$$\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \\ \dot{x}_3 \end{bmatrix} = \begin{bmatrix} -2 & 1 & 0 \\ 0 & -3 & 1 \\ -3 & -4 & -5 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix} + \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix} u.$$

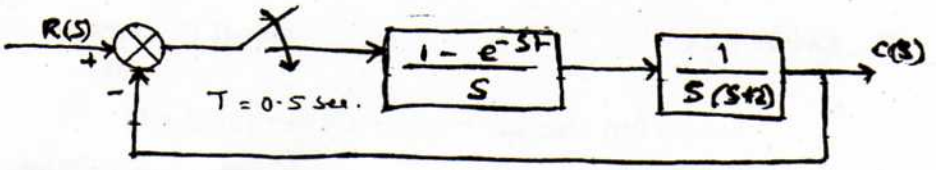
$$Y = [0 \;\; 1 \;\; 0] \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix}$$

b) A linear time invariant system is characterised by the state variable model. Comment on the controllability and observability of the system : $10 + 5$

$$\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \end{bmatrix} = \begin{bmatrix} -1 & 0 \\ 0 & -2 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} + \begin{bmatrix} 0 \\ 1 \end{bmatrix} u.$$

10. a) Find Z transform of cos wt.

b) Obtian Z tranfer function for the block diagram shown in the figure.



5 + 10

11. a) Explain with an example the steps to find the phase trajectory of a second order system using method of isoclines.

b) Write a note on PID controller. 10 + 5