|                           | (U)ech                                 |
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# 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 :

 $10 \propto 1 = 10$ 

- i) A system having transfer function  $G(s) = \frac{1}{2(s+0.5)}$  is subjected to a unit step input, the steady value of the output is
  - a) 1

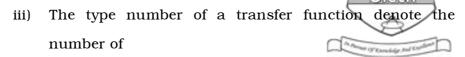
b) 2

c)  $\frac{1}{2}$ 

- d)  $\frac{1}{10}$ .
- ii) The natural frequency of oscillations of the output for the equation  $\frac{d^2x}{dt^2} + 1.5 \frac{dx}{dt} + 4x = 1$  is
  - a) 0 rad/sec
- b) 1.5 rad/sec
- c) 2 rad/sec
- d) 4 rad/sec.

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- 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

 $G \ (\ S\ ) = \frac{9}{S \ (\ 0 \cdot 2 \ S + 1\ )} \ \ \text{when subjected to a unit}$  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) 
$$t_s = \frac{4}{\xi w_n}$$

b) 
$$t_s = \frac{\zeta w_n}{4}$$

c) 
$$t_s = \frac{4 \zeta}{w_n}$$

d) 
$$t_s = 4 \zeta w_n$$
.

- 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.

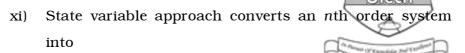
- vii) The initial slope of the Bode plot gives an indication of
  - a) type of the system
  - b) nature of the system time response
  - c) system stability
  - d) gain margin.
- viii) If the root locus branches cross the emaginary axis, the system becomes
  - a) overdamped
- b) underdamped
- c) oscillatory
- 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) *k*s.
- x) The state transition matrix  $\phi$  ( t ) is given by
  - a) [SI] [A]
  - b)  $\{[SI]\}-[A]\}^{-1}$
  - c)  $h^{-1} \{ [SI] \} [A] \}^{-1}$
  - d)  $h^{-1} \{ [SI] \} [A] \}$ .

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- 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

Dia

a) 1

b) 2

c) 3

d) 5.

#### **GROUP - B**

#### (Short Answer Type Questions)

Answer any *three* of the following.

 $3 \propto 5 = 15$ 

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

 $G~(~s~)=\frac{10000}{(~1+s~)~(~1+0\cdot5s~)~(~1+0\cdot02s~)}~.~{\rm The~output}$  set point is 500°C. What is the steady state temperature ?

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

Dia

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

Dia

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

Dia

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.



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

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

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

$$GH\left(s\right)=\frac{k}{s\left(1+s\right)\left(1+0\cdot1s\right)\left(1+0\cdot02s\right)} \ . \ \text{Determine the}$$
 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:

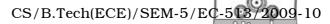
$$\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \\ \dot{x}_3 \end{bmatrix} = \begin{bmatrix} -2 & 1 & 0 \\ 0 & -3 & 1 \\ -3 & -4 & -5 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix} + \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix} u.$$

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

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

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

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- 10. a) Find *Z* transform of cos wt.
  - b) Obtian Z transfer function for the block diagram shown in the figure.

Dai.

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

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