Name :	Unicidan
Roll No. :	A Against With southing and Cardinal
Invigilator's Signature :	

#### CS/B.TECH(ECE)/SEM-5/EC-513/2011-12

### 2011

# **CONTROL SYSTEM**

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) If the maximum overshoot is 100%, the damping ratio is

- a) 1 b) 0
- c) 0.5 d)  $\infty$ .
- ii) If the characteristic equation of a system is  $s^2 + 8s + 25 = 0$ , the value of  $\xi_n$  and  $\omega_n$  will be
  - a) 0.8, 5 rad/s b) 0.8, 0.5 rad/s
  - c) 0.5, 8 rad/s d)  $5, \sqrt{8} \text{ rad/s}$ .

5403



c)



- iii) Addition of a pole to the close loop transfer function
  - a) increases rise time b)
    - increases overshoot d) has no effect.
- iv) The transfer function of a system having a gain of 9 and a pole zero map as in figure below is



v) The TF of a network 
$$\frac{1+0.5 \text{ s}}{2+\text{s}}$$
 is known as

- a) High pass system
- b) Lead network
- c) Lag network
- d) Proportional controller.
- vi) If the Nyquist plot of a certain feedback system crosses the negative real axis at -0.1 point, the gain margin of the system is given by
  - a) 0·1 b) 10
  - c) 100 d) none of these.

5403

CS/B.TECH(ECE)/SEM-5/EC-513/2011-12 vii) For a system defined by  $G(s) = \frac{e^{-0.15}}{s}$ , the phase crossover frequency is

a) 
$$\frac{\pi}{2}$$
 b)  $\frac{\pi}{10}$   
c)  $\frac{\pi}{0\cdot 2}$  d)  $\frac{\pi}{4}$ .

viii) Integral error control

- a) increases the order of the system
- b) decreases the order of the system
- c) increases steady-state error
- d) decreases steady-state error.
- ix) The steady-state error due to a step input for the system shown below is



x) If the phase margin is negative, it indicates the system is

- a) highly stable
- b) unstable
- c) oscillatory
- d) it has nothing to do with stability.

5403

3

## CS/B.TECH(ECE)/SEM-5/EC-513/2011-12

- xi) The root locus is symmetrical w.r.t.
  - a) negative real axis
  - b) positive real axis
  - c) imaginary axis
  - d) positive & negative real axis.
- xii) A feedback control system is basically
  - a) high pass filter b) band pass filter
  - c) low pass filter d) none of these.

#### GROUP – B

#### (Short Answer Type Questions)

Answer any *three* of the following  $3 \times 5 = 15$ 2. Consider the following mechanical translational system shown in figure below. *F* denotes force, *x* denotes displacement, *M* denotes mass and *B* denotes friction coefficient and *K* denotes spring constant.



- i) Write down the differential equation(s) governing the above system.
- ii) Draw the corresponding electrical equivalent circuit using force-voltage analogy.

5403



3. Using Routh criterion investigate the stability of the unity feedback control system whose open loop transfer function is

$$G(s) = \frac{e^{-sT}}{s(s+2)}$$

For what value of T will the system be stable ?

4. A system is represented by

$$\dot{X} = \begin{bmatrix} -3 & -2\\ -1 & -2 \end{bmatrix} X + \begin{bmatrix} 1\\ 1 \end{bmatrix} U(t)$$

$$Y = \begin{bmatrix} 1 & 2 \end{bmatrix} X$$

Find the poles of the system. Assume D = 0.

5. Find the *Z*-transfer function of the system defined by

 $y(n) - 0 \cdot 5y(n-1) = x(n-2) - 5x(n-2) + 6x(n)$  where y(n)and x(n) denote output and input sequences respectively.

6. For the system defined by  $G(s) = \frac{5(s-1)}{(s+2)(s+5)}$  draw the

approximate root-locus diagram.

7. Using Mason's Gain formula, determine the transfer function of the system.



8. Obtain the *Z*-transform for a unit-step function.

#### 5403

CS/B.TECH(ECE)/SEM-5/EC-513/2011-12



# GROUP – C

( Long Answer Type Questions) Answer any *three* of the following.

9. a) A unity feedback control system has an open loop transfer function

$$G(s) = \frac{k}{(s^2 + 8s + 32)}$$

Sketch the root locus of the system and deduce how the peak overshoot varies with increasing k if the loop is closed. 5+5

- b) What kind of controller would you recommend for this system ? 5
- 10. Prove that for a standard second order system defined by  $G(s) = \frac{W_n^2}{s^2 + 2\xi W_n s + W_n^2}, \text{ the peak overshoot due to a step}$

input depends on  $\xi$  only. Prove further that the constant  $\xi$  lines pass through the origin of the ( $\sigma i j \omega$ ) plane. 10 + 5

#### 11. a) Derive the transfer function for a zero-order hold. 5

b) A continuous function y(t) is sampled by an impulse sampler as shown below :



Obtain the Laplace transform for  $\dot{y}(t)$ 

- 5
- c) Obtain the Z-transform for  $x [n] = |a|^n$  and comment on the ROC. 5

5403

12. The open-loop transfer function of a unity feedback control system is given by

$$G(s) = \frac{s + 0 \cdot 25}{s^2(s+1)(s+0\cdot 5)}$$

Determine the closed-loop stability by applying Nyquist criterion.

13. Sketch the Bode Plot for the transfer function defined by

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

Determine

- a) phase cross-over frequency
- b) gain cross-over frequency
- c) gain margin
- d) phase margin. 7 + 8
- 14. a) Determine the transfer matrix for a system whose *A*, *B*, *C* matrices are :

$$A = \begin{bmatrix} 1 & -2 \\ 4 & -5 \end{bmatrix}, \quad B = \begin{bmatrix} 2 \\ 1 \end{bmatrix}, \quad C = \begin{bmatrix} 1 & 1 \end{bmatrix}$$
6

- b) Is the system stable ? 4
- c) Is the system controllable ? Assume D = 0. 5

#### \_\_\_\_\_

5403