Name : ....

Roll No. : ....

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) ∞ .

ii) If the characteristic equation of a system is $s^2 + 8s + 25 = 0$, the value of ξ_n and ω_n will be

a) 0·8, 5 rad/s b) 0·8, 0·5 rad/s

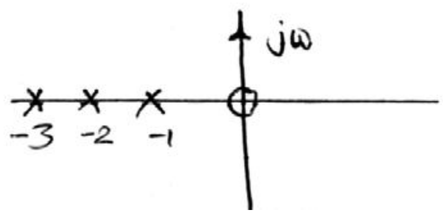
c) 0·5, 8 rad/s d) 5, $\sqrt{8}$ rad/s.

iii) Addition of a pole to the close loop transfer function

a) increases rise time   b) decreases rise time

c) 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



a) $\dfrac{9(s+1)(s+2)(s+3)}{s}$ b) $\dfrac{9(s-1)(s-2)(s-3)}{s}$

c) $\dfrac{9s(s+1)}{(s+2)(s+3)}$ d) $\dfrac{9s}{(s+1)(s+2)(s+3)}$.

v) The TF of a network $\dfrac{1+0\cdot5\,s}{2+s}$ 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.

vii) For a system defined by $G(s) = \dfrac{e^{-0 \cdot 15}}{s}$, the phase crossover frequency is

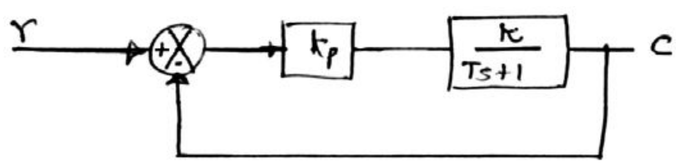
a) $\dfrac{\pi}{2}$ b) $\dfrac{\pi}{10}$

c) $\dfrac{\pi}{0 \cdot 2}$ d) $\dfrac{\pi}{4}$.

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



a) zero b) $\dfrac{1}{1+kk_p}$

c) $\dfrac{kk_p}{1+kk_p}$ d) infinite.

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.

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

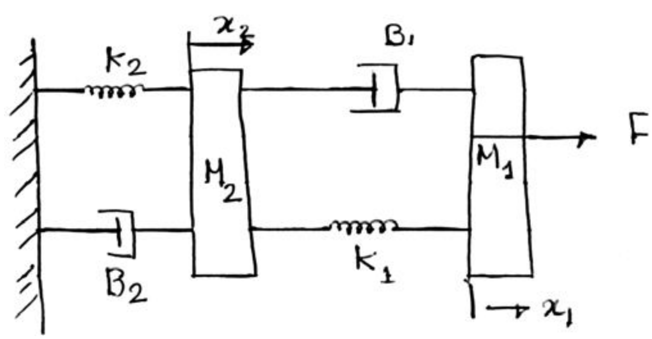
c) low pass filter d) none of these.

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.

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

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

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

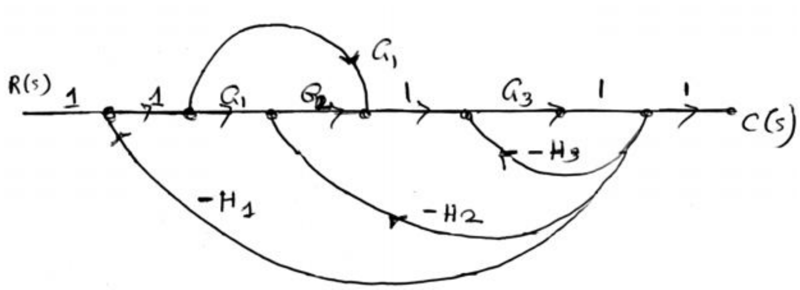
Find the poles of the system. Assume $D = 0$.

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 $G(s) = \dfrac{5(s-1)}{(s+2)(s+5)}$ 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.

GROUP – C

(Long Answer Type Questions)

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

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

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

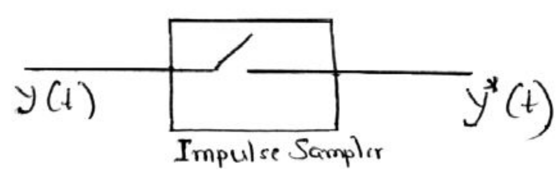
Sketch the root locus of the system and deduce how the peak overshoot varies with increasing k if the loop is closed. 5 + 5

b) What kind of controller would you recommend for this system ? 5

10. Prove that for a standard second order system defined by $G(s) = \dfrac{W_n^2}{s^2 + 2\xi W_n s + W_n^2}$, the peak overshoot due to a step input depends on ξ only. Prove further that the constant ξ 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 $\overset{*}{y}(t)$ 5

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

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

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