Name : .....

Roll No. : .....

Invigilator's Signature : .....

CS / B.TECH (ICE) / SEM-4 / IC-401 / 2011

2011

BASIC CONTROL THEORY

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)

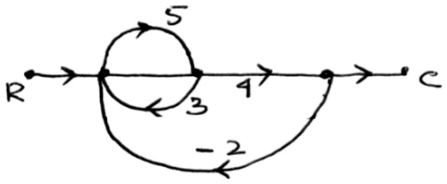
1. Choose the correct alternatives for any *ten* of the following : $10 \times 1 = 10$

i) The impulse response of a system is given by $y(t) = \frac{1}{2} e^{-t/2}$. Which one of the following is its unit step response ?

a) $1 - e^{-t/2}$ b) $1 - e^{-t}$

c) $2e^{-t}$ d) $1 - e^{-2t}$.

ii) In the signal flow graph shown below, the value of ratio $\frac{C}{R}$ is



a) $\frac{28}{57}$ b) $\frac{40}{57}$

c) $\frac{40}{81}$ d) $\frac{28}{81}$.

iii) The settling time for 2% tolerance bond of a system with closed loop transfer function $G(s) = \frac{4}{s^2 + 1 \cdot 6s + 8}$ & unit step input is

a) 1 sec b) 5 sec

c) 3·75 sec d) 4 sec.

iv) The current in a circuit in *s*-domain is $I(s) = \frac{1}{s(s+2)(s+5)}$. What is the steady state value of the current ?

a) 10 b) 1

c) 0·1 d) 0·667.

v) The characteristic equation of a closed loop system is $s^3 + 5s^2 + 5s - 2 = 0$. The no. of roots in the right half of s plane would be

a) 1 b) 2

c) 0 d) 3.

vi) If the Open loop Transfer function of a system is $G(s)\,H(s) = \dfrac{K}{s^2(s+2)(s^2+2s+45)}$, the centroid of asymptotes will be

a) – 1, 0 b) 1, 0

c) 0, – 1 d) 0, 1.

vii) The root of the characteristic equation of a system represented by $\dot{X} = AX + BU$, when $A = \begin{bmatrix} -9 & 1 & 0 \\ -26 & 0 & 1 \\ -24 & 0 & 0 \end{bmatrix}$, are located at

a) – 9, – 26, – 24 b) – 2, – 3, – 4

c) – 2, – 3, – 9 d) – 9, – 3, – 4.

viii) Analogous system is concerned with

a) non-linear systems only

b) linear systems only

c) both linear & non-linear systems

d) only linear time varying systems.

ix) For a system with $G(s) = \dfrac{k}{(s^3 + 3s^2 + 2s)(s+2)}$. The type & order can be given by

a) 0 & 3 b) 0 & 4

c) 4 & 1 d) 1 & 4.

x) The step response of system with $G(s) = \dfrac{1}{1+sT}$ attains more than 98% of its final value in time equal to

a) T b) $4T$

c) $2T$ d) $4T$.

xi) A single pole at the origin, represents

a) a unit step response

b) an oscillatority response

c) an exponentially decay response

d) an unstable system.

xii) If any of the states cannot be observed at an output, the state is said to be

a) controllable b) observable

c) unobservable d) uncontrollable.

GROUP – B

(Short Answer Type Questions)

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

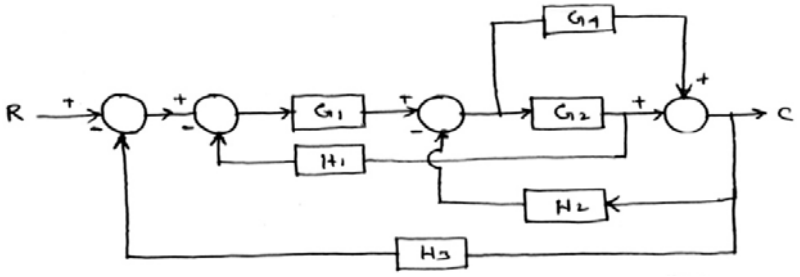
2. Develop block diagram of a field controlled dc motor using governing mathematical equations.

3. Obtain state variable representation of the system having system dyamics is

$$\frac{d^3y(t)}{dt^3} + 5\frac{d^2y(t)}{dt^2} + 2\frac{dy(t)}{dt} + y(t) = 2\frac{du(t)}{dt} + u(t).$$

4. Find the impulse response of the system represented by transfer function $G(s) = \dfrac{100}{s^2 + 10s + 100}$.

5. Draw signal flow graph and find $\dfrac{C}{R}$ for the block diagram shown below :



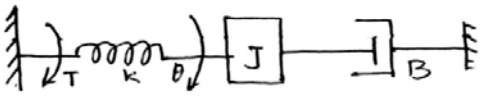
6. A system is described by $\dot{X} = AX + BU$; $Y = CX$ when $A = \begin{bmatrix} -4 & 1 \\ 2 & -1 \end{bmatrix}$; $B = \begin{bmatrix} 2 \\ 1 \end{bmatrix}$ and $C = \begin{bmatrix} 1 & 1 \end{bmatrix}$. Obtain transfer function of the system.

GROUP – C

(Long Answer Type Questions)

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

7. a) For the mechanical system shown below :



Determine *J*, *B*, *K*, if on application of 10 N-m step input, the result found are 6% maximum overshoot, 1 second peak overshoot time & 0·5 radian steady state output.

b) Investigate stability of a closed loop system whose characteristic equation is

$$s^4 + Ks^3 + s^2 + s + 1 = 0 \qquad 7 + 8$$

8. a) Open loop transfer function of a system is given by $G(s)H(s) = \frac{K(s+1)}{s^2(s+9)}$. Comment on stability of the system.

b) For a system whose open loop transfer function is given by $G(s)H(s) = \frac{s(s+3)}{s(s+2)(s+5)(s+10)}$. Sketch Bodo plot & calculate phase margin & gain margin. Comment on stability of the system. 7 + 8

9. a) Explain the following terms related to control system analysis.

   i) Encirclement & Enclosement

   ii) Nyquist contour

   iii) Nyquist stability criterion.

   b) Open loop transfer function of a system is given by $G(s)H(s) = \frac{500}{s(s+6)(s+9)}$. Investigate stability of the closed loop system using Nyquist plot. Find phase margin & gain margin of the system. 6 + 9

10. a) How the performance of a control system is affected by adding P, PD & PID controllers ?

    b) A PI controller is introduced to a unity feedback control system having $G(s)H(s) = \frac{1}{(s-1)^2}$ will be system be stable ? Justify your answer with analysis. 6 + 9

11. Write notes on any *three* of the following : 3×5

    i) Analogous circuits

    ii) Dynamic error coefficients

    iii) Time domain specifications of control system.

    iv) Effects of adding poles & errors on system stability.

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