Name : .....

Roll No. : .....

Invigilator's Signature : .....

CS/B.Tech (IT-OLD)/SEM-4/EE-411/2013

2013
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.

GROUP – A

(Multiple Choice Type Questions)

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

   i) The transfer function is defined as

      a) the ratio of Laplace transform of output to Laplace transform of input considering initial condition as zero

      b) the ratio of Laplace transform of input to Laplace transform of output considering initial condition as zero

      c) the ratio of input to output

      d) the ratio of output to input

ii) Unit impulse response of a system in Laplace transform gives

a) transfer function b) system gain

c) unit step function d) unit ramp function.

iii) Signal flow graph is used to obtain the

a) stability of the system

b) transfer function of the system

c) controllability of the system

d) observability of the system.

iv) An increase in damping ratio

a) increases rise time

b) decreases rise time

c) does not affect rise time

d) keeps the time within limits.

v) A second order system has damping ratio $\xi = 0{\cdot}9$. The system is

a) underdamped

b) overdamped

c) critically damped

d) insufficient information for any prediction.

vi) An AC servomotor is basically a

a) universal motor

b) single phase induction motor

c) two phase induction motor

d) three phase induction motor.

vii) The transfer function of a basic PI controller is given by (all k's are real constants)

a) $k_0 + \frac{k_1}{s} + k_2 s$ b) $k_0 + k_2 s$

c) $k_1 s + k_2 s$ d) $k_0 + \frac{k_1}{s}$.

viii) PID controller improves the

a) steady state response only

b) transient response only

c) both steady state response and transient response

d) none of these.

ix) Nyquist criterion for determination of stability of control system is

a) algebraic method

b) graphical method

c) semi-graphical method

d) none of these.

x) 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.

xi) The input-output equation of a system is given by $y = mx + c$, where m and c are constants. The system is

a) Linear b) Non-linear

c) Active d) Passive.

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

a) 1 b) 0

c) infinity d) 0·5.

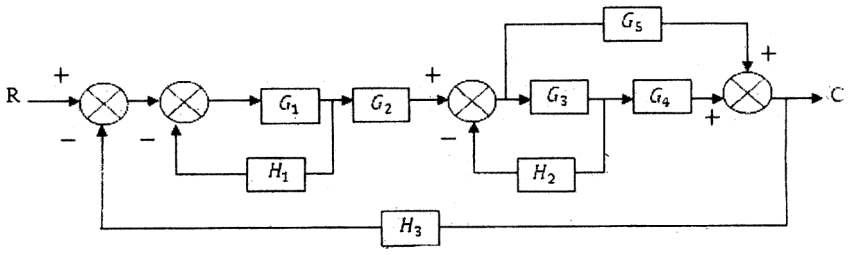
GROUP – B

(Short Answer Type Questions)

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

2. Derive the closed loop transfer function of a field control *d.c.* motor.

3. Determine the transfer function C/R for the system given below :



4. a) Define error co-efficients corresponding to step & ramp inputs.

   b) A unity feedback closed loop second order system has a transfer function $\frac{81}{s^2 + 0{\cdot}6s + 9}$ and it is excited by a step input of 10 units. Find out its steady state error.

5. Find out the stability of the system whose characteristic equation is given by

$$s^5 + 2s^4 + 3s^3 + 6s^2 + 5s + 3 = 0.$$

6. Obtain the state transition matrix of the following system :

$$\dot{x}_1 = x_2$$

$$\dot{x}_2 = -6x_1 - 5x_2.$$

GROUP – C

(Long Answer Type Questions)

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

7. a) Explain the meaning and significance of phase margin & gain margin of a control system. How will you obtain the values of these margins from Bode plots ?

   b) Sketch the Bode plot for the following function & find out the value of gain margin & the phase margin :

$$G(S) = \frac{10\,(S + 2)}{S\,(S + 6)\,(S + 10)}$$

$6 + 7 + 1 + 1$

8. a) State the Nyquist stability criterion.

b) Using Nyquist stability criterion, determine whether the unit feedback close-loop system having open loop transfer function $G(S)\,H(S) = \dfrac{10}{S\,(1+S)\,(1+0{\cdot}05\,S)}$ is stable or not.

c) What is meant by relative stability ? Can you find out relative stability by Routh stability criterion ? 3 + 7 + 5

9. A unity feedback control system has a open loop transfer function $G(s) = \dfrac{k}{s\,(s+3)\left(s^2+2s+2\right)}$. Sketch the root locus of the system by determining the following :

a) Centroid, number & angle of asymptotes

b) Angle of departure of root loci from the poles

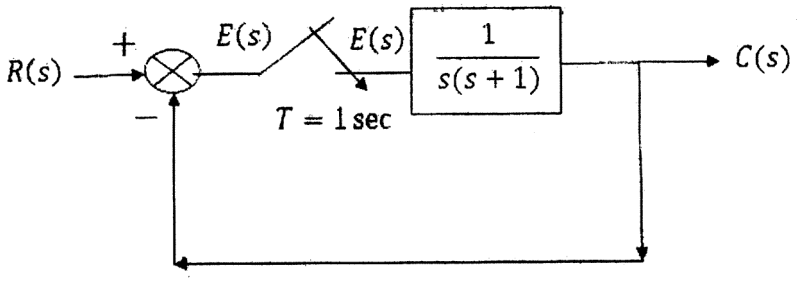
c) Break-away point

d) The value of k & the frequency at which the root locus crosses $j\omega$ axis.

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

$$\dddot{Y}(t) + 6\ddot{Y}(t) + 11\dot{Y}(t) = u(t).$$

b) Find the pulse transfer function for the sampled system shown in the following figure :



7 + 8

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

a) Servo motor

b) Absolute stability and relative stability

c) PID controller

d) Transient response of a 2nd order system.