Name : .....

Roll No. : .....

Invigilator's Signature : .....

CS/B.Tech(EIE)/SEM-5/EE-511(EI)/2009-10

2009

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) For a unit step input, a system with a closed loop transfer function $\frac{20}{s^2 + 2s + 5}$ has a steady-state output of

a) 10 b) 5

c) 2 d) 4.

ii) For a second order system $2\frac{d^2y}{dt} + 4\frac{dy}{dt} + 8y = 8x$. The damping ratio is

a) 0·1 b) 0·25

c) 0·333 d) 0·5

iii) Which of the following systems is stable ?

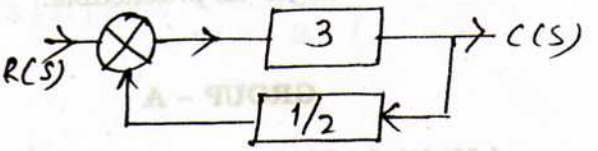
a) $AS^2 + BS + C = 0$

b) $AS^4 + BS^2 + CS + D = 0$

c) $-AS^2 + BS - C = 0$

d) $AS^2 - BS - C = 0$.

iv) The closed loop gain of the system in the given figure is



a) 6 b) – 6

c) $\frac{3}{2}$ d) $-\frac{3}{2}$.

v) By the use of PD control to a 2nd order system, the rise time

a) decreases b) increases

c) remains same d) has no effect.

vi) The unit step response of a particular control system in $C(t) = 1 - 10\, e^{-1}$. Then transfer function is

a) $\frac{10}{S+1}$ b) $\frac{S-9}{S+1}$

c) $\frac{1-9S}{S+1}$ d) $\frac{(1-9S)}{S(S+1)}$.

vii) The steady-state error for a type 2 system subjected to a unit ramp input is

a) 2 b) 1

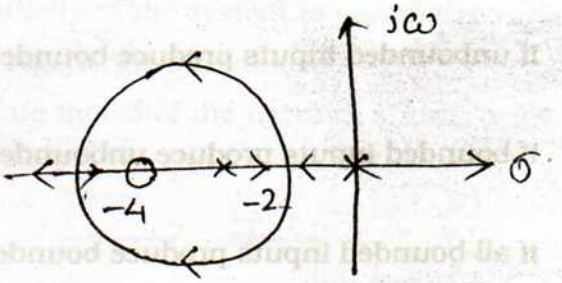
c) 0 d) ∞.

viii) Consider the root locus diagram of a system and the following statements :

I. The open loop system is a second order system

II. The system is overdamped for $k > 1$

III. The system in absolutely stable for all the value of k.



Of the statements :

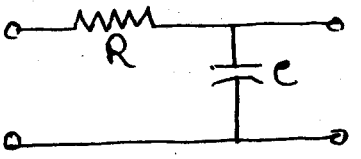
a) I, II and III are correct

b) I and III are correct

c) I and II are correct

d) II and III are correct.

ix) The transfer function of a simple R-C integrator circuit shown in the fig. is



a) $\frac{1}{S-a}$ b) $\frac{1}{S+a}$

c) $\frac{a}{S-a}$ d) $\frac{a}{S+a}\left[a=\frac{1}{RC}\right]$.

x) A system is stable

a) if bounded inputs produce bounded outputs

b) if unbounded inputs produce bounded outputs

c) if bounded inputs produce unbounded outputs

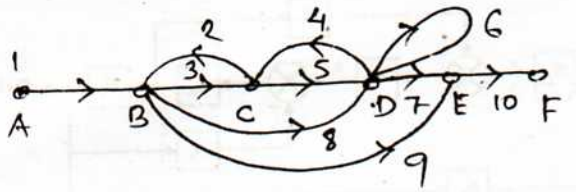
d) if all bounded inputs produce bounded outputs.

xi) The initial slope of Bode plot for a transfer function having simple pole at origin is

a) 20 db/dec b) – 40 db/dec

c) 40 db/dec d) – 20 db/dec.

xii) The signal flow diagram of a system is shown in the given figure. The number of forward paths and the number at pairs of non-touching loops are respectably



a) 3, 1 b) 3, 2

c) 4, 2 d) 2, 4.

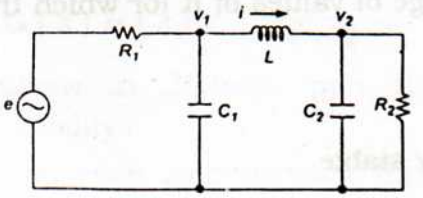
GROUP – B
(Short Answer Type Questions)

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

2. a) Show the use of feedback in control system reduces the sensitivity of the system to parameter variation. 3

b) What is regenerative feedback ? 2

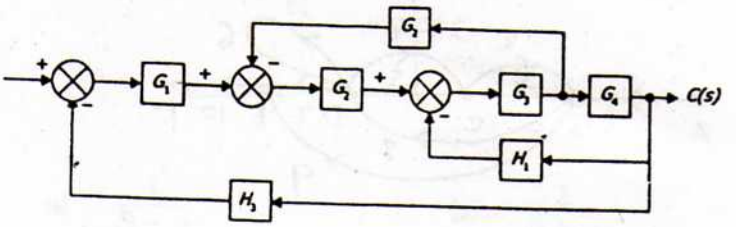
3. Obtain the state model of the network shown below :



4. The characteristics equation for certain feedback control systems are given below. Determine the range of K for which the system is stable.

$S^3 + 2KS^2 + (K + 2)S + 4 = 0.$

5. Construct an equivalent signal flow-graph for the block diagram shown in the following figure and evaluate transfer function. 5



6. Derive an expression for step response of a typical first order system. Sketch the response. What is the steady-state error due to step input to the first order system. 3 + 1 + 1

GROUP – C
(Long Answer Type Questions)

Answer any *three* of the following. 3 × 15 = 45

7. a) The characteristic equation of a system in differential equation form is

$d^2x/dt^2 - (K + 2)\, dx/dt + (2K + 5)\, x = 0.$

i) Find the range of values of K for which the system is

x) stable

y) limitedly stable

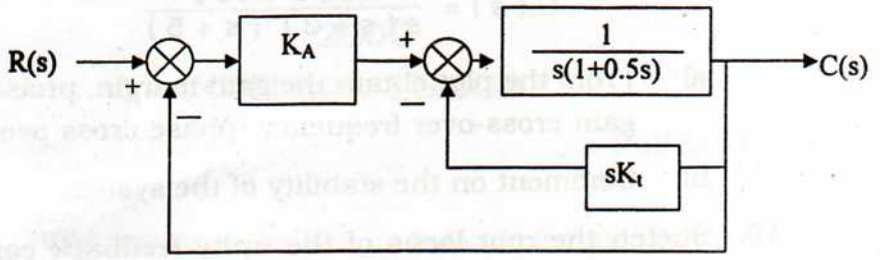
z) unstable. 3 × 1

ii) For the stable case, find the range of values of K for which the system is

x) under damped

y) over damped. 2 × 2

b) A feedback system employing output rate damping is shown in Fig. :



i) In the absence of derivative feedback ($K_t = 0$), determine the damping ratio of the system for amplifier gain $K_A = 5$. Also find the steady state error to unit ramp input.

ii) Find suitable values of the parameters K_A and K_t so that the damping ratio of the system is increased to 0·7 without affecting the steady state error as obtained in part (i). 3 + 5

8. a) State and explain Nyquist criterion.

b) A unity feedback control system has open loop transfer function

$$G(s)H(s) = \frac{2}{s(1-2s)}$$

Draw the Nyquist plot and determine closed loop stability.

c) The open loop transfer function of a unity feedback system is given by $G(s) = \frac{K}{s(\tau s + 1)}$, where K and τ are positive constants. By what factor should the amplifier gain be reduced so that the peak overshoot of unit step response of the closed loop system is reduced from 75% to 25% ? 2 + 8 + 5

9. Construct the Bode plot for a unity feedback control system having

$$G(s) = \frac{10(s+10)}{s(s+2)(s+5)}$$

a) From the plot obtain the gain margin, phase margin and gain cross-over frequency, phase cross over frequency.

b) Comment on the stability of the system. 8 + 5 + 2

10. Sketch the root locus of the unity feedback control system whose open loop transfer function is given by

$$G(s)H(s) = \frac{K}{s(s+2)\left(s^2+4s+13\right)}$$

Find :

i) the number, angle and centroid of asymptotes

ii) angle of departure

iii) the break-away point

iv) the condition for marginal stability

v) the value of K so that the system has a damping factor 0·5 3 + 3 + 3 + 3 + 3

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

a) Special cases of Routh-Hurwith stability criteria

b) Static error coefficients

c) Armature controlled DC servomotor

d) Correlation between time domain and frequency domain responses of a system

e) Principle of argument.