ENGINEERING & MANAGEMENT EXAMINATIONS, DECEMBER – 2008

CONTROL SYSTEM

SEMESTER – 5

Time : 3 Hours] [Full Marks : 70

Graph paper and semi-log paper is provided at the end of this booklet.

GROUP – A

(Multiple Choice Type Questions)

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

i) The maximum overshoot, for an unity feedback system with open loop transfer function $G(s) = \frac{1}{s(s+1)}$ & unit step input, is

a) 0·14 b) 0·15

c) 0·16 d) 0·17. ☐

ii) A linear time invariant system, when subjected to an unit step input, gives a response $c(t) = te^{-t}$. The transfer function of the system is

a) $\frac{1}{(s+1)^2}$ b) $\frac{1}{s(s+1)^2}$

c) $\frac{s}{(s+1)^2}$ d) $\frac{1}{s(s+1)}$. ☐

iii) The characteristic equation of a system is $s^2 + 3s + 2 = 0$. The system is

a) critically damped b) underdamped

c) overdamped d) none of these. ☐

iv) The steady state error can be minimized by

a) increasing gain k

b) decreasing gain k

c) decreasing oscillating frequency

d) increasing settling time. ☐

v) The characteristic equation of a feedback control system is given by $2s^4+s^3+2s^2+5s+10=0$. The number of roots in the right half of s-plane is

a) zero b) 1

c) 2 d) 3.

vi) Integral error control

a) increases the order of the system

b) decreases the order of the system

c) increases steady state error

d) does not affect steady state error.

vii) The equation governing a control system is given by $\frac{d^2c(t)}{dt^2}+\frac{5dc(t)}{dt}+4c(t)=3r(t)$. The transfer function for the system is

a) $\frac{3}{(s+1)(s+4)}$ b) $\frac{5}{(s+1)(s+4)}$

c) $\frac{1}{s^2+3s+4}$ d) $\frac{4}{s^2+3s+5}$.

viii) The settling time for a second order system responding to a step input with 5% overshoot is

a) $\frac{4}{\xi W_n}$ b) $\frac{2}{\xi W_n}$

c) $\frac{3}{\xi W_n}$ d) $\frac{5}{\xi W_n}$.

ix) The Bode plot is obtained using

a) characteristic equation b) open loop transfer function

c) closed loop transfer function d) over all transfer function.

x) The electrical resistance is analogous to

a) viscous damper b) spring

c) mass d) none of these.

xi) If the root locus lies only on the negative real axis, then the time response is

a) overdamped b) critically damped

c) stable d) unstable.

xii) Given that $G(s) = \frac{K}{s^2(s+2)(s+3)}$. The type of the system is

a) 1 b) 3

c) 2 d) cannot be determined.

GROUP – B

(Short Answer Type Questions)

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

2. Find the transfer function for the block diagram shown below in figure-1.

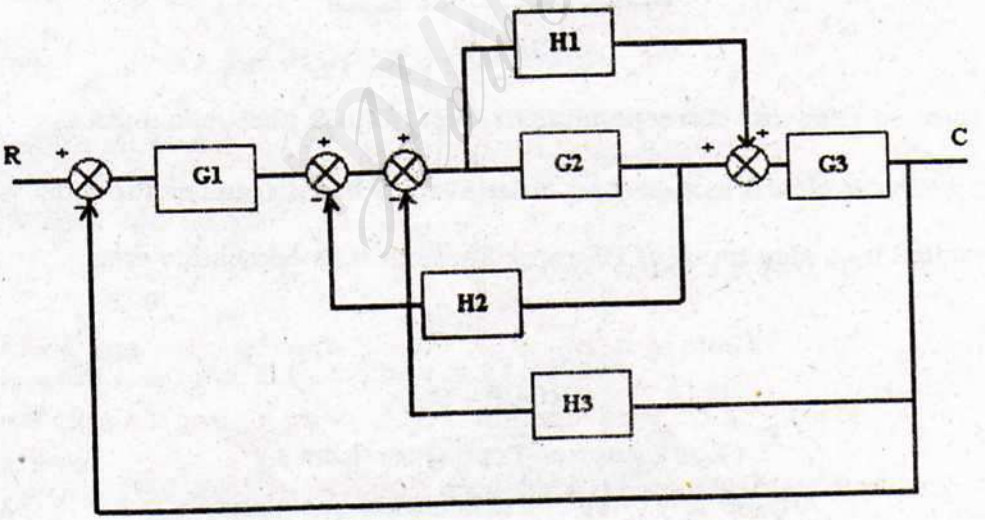

Fig. - 1

3. Apply R-H criterion to determine the stability of the system of which characteristic equation is given by : $s^5 + s^4 + 3s^3 + 3s^2 + 6s + 4 = 0$.

4. Draw the electrical analogous circuit using force-voltage analogy for the mechanical system shown in figure-2.

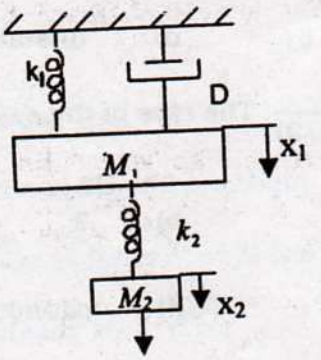

Fig. - 2

5. Find the transfer function of the system shown in figure-3.

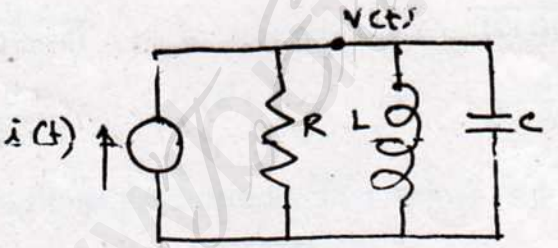

Fig. - 3

6. Define error co-efficients corresponding to step, ramp & parabolic inputs.

A unity feedback closed loop second order system has a transfer function $\frac{81}{s^2+0\cdot6s+9}$ & it is excited by a step input of 10 units. Find out its steady state error. 3 + 2

GROUP – C

(Long Answer Type Questions)

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

7. Sketch the root locus of the system with loop transfer function :

$G(s)H(s)=\frac{K}{s(s+2)(s^2+s+1)}$. Show all relevant steps.

8. a) State and explain Nyquist stability criterion.

b) The open loop transfer function of a unity negative feedback system is given by $G(s)=\frac{5}{s(s+1)(s+2)}$. Draw the Nyquist diagram & hence find out whether the system is stable or not. 5 + 10

9. a) Sketch the Bode plot of a unity negative feedback closed loop system of which open loop transfer function is given by $\frac{5(s+2)}{s(s+3)(s+10)}$.

Determine gain margin, phase margin, gain cross-over frequency & phase cross-over frequency.

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

10. a) A second order system has the following transfer function : $G(s)=\frac{16}{s(s+6)}$. It is connected with a unity feedback arrangement.

Evaluate i) W_n, ii) ξ, iii) W_d, iv) t_p and v) % M_p of the closed loop system.

b) Find the steady state error of the system for input $r(t)=1+t+\frac{t^2}{2}$ by static error co-efficient method. 10 + 5

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

a) PID controller

b) Servomotors

c) Polar plots

d) Speed control of D.C. motor using feedback.

END