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.

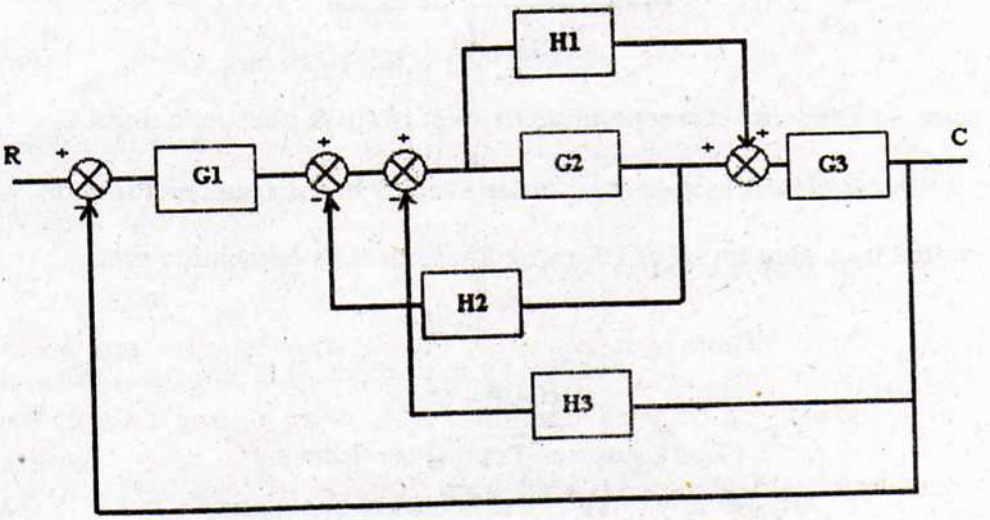

Fig. - 1

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.

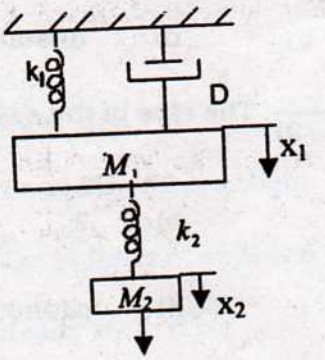

Fig. - 2

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

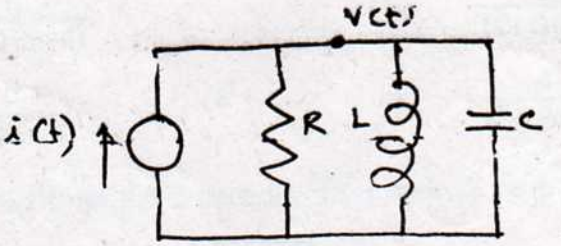

Fig. - 3

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