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CS/B.Tech (EIE-NEW)/SEM-5/EE-511(EI)/2010-11

2010-11
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.

Semi-log paper and Graph sheet will be provided by the Institute on demand.

GROUP – A

(Multiple Choice Type Questions)

1. Choose the correct alternatives for any *ten* of the following : 10 × 1 = 10

   i) A system has gain margin as – 5. The system is

      a) stable

      b) unstable

      c) critically stable

      d) insufficient information.

   ii) A system has 3 zeros & 4 poles. The number of root locus branches is equal to

      a) 3 b) 4

      c) 1 d) 7.

iii) Addition of a zero to the closed loop transfer function

a) increases rise time b) decreases rise time

c) increases overshoot d) has no effect.

iv) In force-voltage analogous system, displacement is equivalent to

a) current b) flux

c) charge d) inductance.

v) Derivative feedback control

a) increases rise time

b) increases overshoot

c) decreases steady state error

d) does not affect the steady state error.

vi) The Routh-Hurwitz criterion gives

a) relative stability b) absolute stability

c) gain margin d) phase margin.

vii) Signal flow graph approach is applicable to

a) linear system only

b) non-linear system only

c) both linear & non-linear systems

d) none of these.

viii) The effect of negative feedback is to

a) increase the sensitivity of parameter variation in forward path

b) reduce the overall gain

c) slow the dynamic response

d) none of these.

ix) The gain of a system is 10, in terms of dB, the gain is

a) 1 b) 10

c) 20 d) 100.

x) A potentiometer converts linear/rotational displacement into

a) current b) power

c) voltage d) torque.

xi) If torque T_1 is transferred from a gear with N_1 teeth to a gear with N_2 teeth, the value of the torque received at the shaft of second gear is

a) $(N_1/N_2)T_1$ b) $(N_2/N_1)T_1$

c) $N_1 T_1$ d) $(N_2/N_1)^2 T_1$.

xii) The error at corner frequency due to the term $(1+j\omega T)^{IN}$ is

a) ± 5 N dB b) ± 3 dB

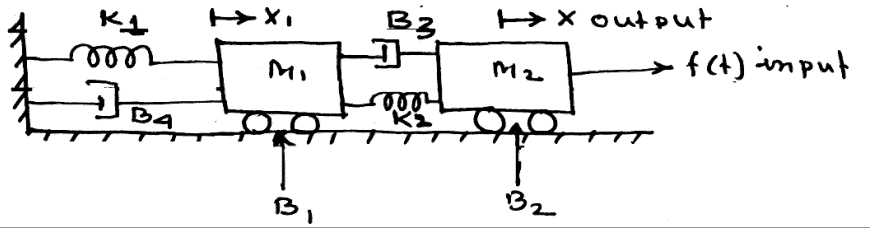
c) ± 6 dB d) ± 3 N dB.

GROUP – B

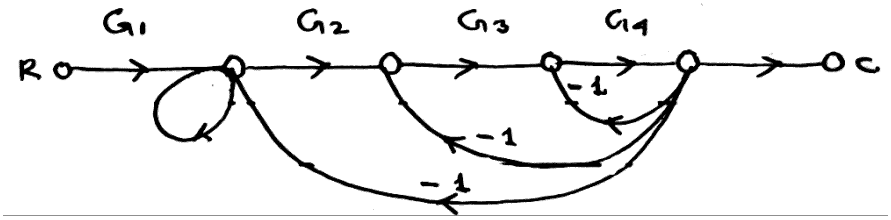
(Short Answer Type Questions)

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

2. Obtain the transfer function of the mechanical system shown in figure below.



3. Find $\frac{C}{R}$ for the signal flow graph shown below.



4. Consider the unit step response of a unity feedback control system whose open loop transfer function is $G(s)=\frac{1}{s(s+1)}$.

Obtain the rise time, peak time, maximum overshoot & settling time (2% criterion).

5. A linear time invariant system is characterised by the state variable model. Comment on the controllability & observability of the system

$$\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \end{bmatrix} = \begin{bmatrix} -1 & 0 \\ 0 & -2 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} + \begin{bmatrix} 0 \\ 1 \end{bmatrix} u$$

$$Y(t) = \begin{bmatrix} 1 & 2 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix}$$

6. Utilize the Routh table to determine the number of roots of the following polynomials in the right half of s plane. Comment about the stability of the system.

$$s^5 + 6s^4 + 15s^3 + 30s^2 + 44s + 24$$

GROUP – C

(Long Answer Type Questions)

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

7. Given $G(s) = \dfrac{k}{s(s+1)(s+3)}$. Sketch the root locus plot & comment on the stability. Show all relevant steps of calculation.

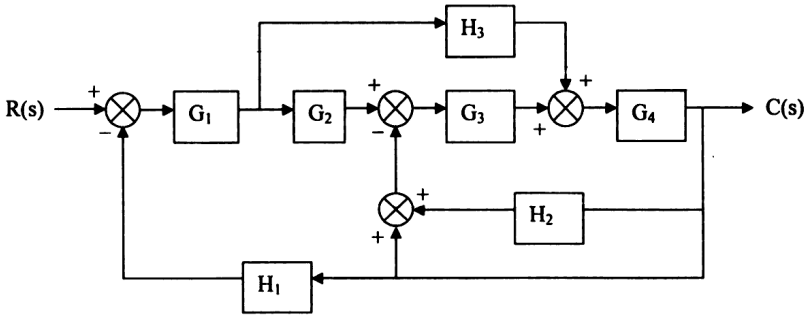
8. Sketch the plot showing the magnitude in decibels & phase angle in degrees as a function of frequency in logarithmic scale for the transfer function given by

$$G(s)=\frac{10}{s(s+0\cdot5s)(1+0\cdot1s)}$$

& hence determine the gain margin & phase margin of the system. Comment on the stability of the system.

9. Check the stability of the system, $G(s)$ by Nyquist criteria for the transfer function $G(s)=\frac{10}{s^2(1+0\cdot2s)(1+0\cdot5s)}$.

10. a) Obtain the overall transfer function of the block diagram shown below.



b) Evaluate the static error constants for a unity feedback system having a forward path transfer function $G(s)=\frac{50}{s(s+10)}$. Estimate steady state errors of the system for the input $r(t)$ given by $r(t)=1+2t+t^2$. 8 + 7

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

a) DC servomotors

b) Minimum phase & non-minimum phase systems

c) PID controller

d) Thermal control system.