WEST BENGAL UNIVERSITY OF TECHNOLOGY

ME-803B

AUTOMATION & CONTROL

Time Allotted: 3 Hours | Full Marks: 70

The questions are of equal value.
The figures in the margin indicate full marks.
Candidates are required to give their answers in their own words as far as practicable
All symbols are of usual significance.

GROUP A
(Multiple Choice Type Questions)

1. Answer *all* questions. 10×1 = 10

(i) A system has the transfer function $\left(\frac{1-s}{1+s}\right)$. What is its gain at 1 rad/sec.?

(A) 1 (B) 0 (C) –1 (D) none

(ii) For a control system to be operated in overdamped condition, the value of damping ratio should be

(A) $\xi = 0$ (B) $\xi > 1$ (C) $\xi = 1$ (D) $\xi < 1$

(iii) The capacitance, in force-current analogy, is analogous to

(A) velocity (B) momentum (C) displacement (D) mass

(iv) A signal flow graph is a

(A) topological representation of a set of differential equations

(B) polar graph

(C) log-log graph

(D) special type of graph to analyze modern control system

(v) The "type" of a transfer function denotes the number of

(A) zeros at origin (B) poles at infinity

(C) poles at origin (D) finite poles

(vi) Root loci of a system has three asymptotes, the system can have

(A) Five poles and two zeros (B) Three poles

(C) Four poles and one zero (D) All of the above

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

(A) critically damped (B) under damped

(C) over damped (D) none of these

(viii) 20dB/decade corresponds to

(A) 3dB/octave (B) 6dB/octave (C) 9dB/octave (D) none of these

(ix) At which of the following root loci will end

(A) open-loop poles (B) closed-loop zeros

(C) closed-loop poles (D) open-loop zeroes

(x) State variable approach converts a *n*th order system into

(A) *n* second order differential equations

(B) two differential equations

(C) *n* first order differential equations

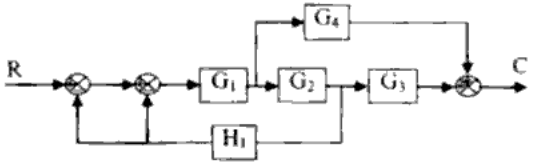
(D) a lower order system

GROUP B
(Short Answer Type Questions)

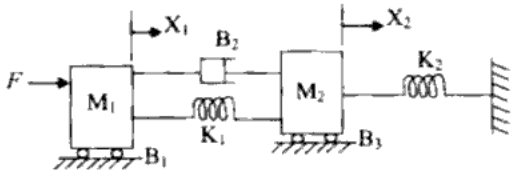
Answer any *three* questions. 3×5 = 15

2. For the transfer function $G(s)=\frac{1}{2}\cdot\frac{(s+4)(1+2.5s)}{(s^2+2)(1+0.5s)}$. Plot the poles and zeros in S-plane and determine the value of the transfer function at $s = 2$. 5

3. Use block diagram reduction technique to find out the overall transfer function of the system shown in figure given below 5



4. Consider the following mechanical translation system shown in figure below, F denotes displacement, M denotes mass, B denotes friction co-efficient and K denotes spring constant. 5
(i) Write down the differential equations governing the above system;
(ii) Draw the corresponding electrical equivalent circuit using force-voltage analogy scheme



5. Describe the procedure adopted in the design of a PID controller. 5

6. Define error co-efficient corresponding to step and ramp input. 5

GROUP C
(Long Answer Type Questions)

Answer any *three* questions. 3×15 = 45

7. (a) Explain the meaning and significance of phase margin and gain margins of a control system. How will you obtain the values of these margins from Bode plots? 8
(b) Sketch the Bode plot for the following function and find out the approximate values of the gain margin and phase margin. 7

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

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8. (a) Find the transfer function of a field controlled dc servomotor. 6
(b) Draw and explain the operation of a synchro error detector and synchro torque transmitter. 9

9.(a) Find the C/R of the following signal flow graph using Mason's gain formula. 7

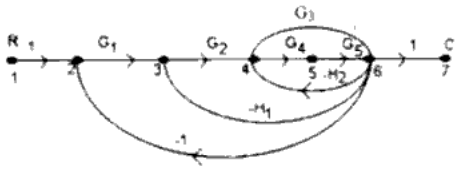

Fig-1

(b) A second order mechanical system is represented by the transfer function 8

$$\frac{\theta(s)}{I(s)}=\frac{1}{Js^2+fs+k}$$

A step input of 10 N.m is applied to the system and the results are given below:
(i) maximum over shoot = 6%
(ii) time at peak over shoot = 1 sec
(iii) the steady state value of the output 0.5 rad. Determine the values of J, f and k.

10. The open-loop transfer function of unity feedback control system is given by 5+5+5

$$G(s)=\frac{K}{(1+s)(1+2s)(1+3s)}$$

(i) Sketch the Nyquist plot
(ii) From the plot, find the value of K for which the system becomes unstable.
(iii) Compare answer of (ii) using R-H approach.

11. Write short notes on any *three* of the following: 3×5
(a) Lead-lag compensator
(b) PI Controller.
(c) Nicholas chart.
(d) Polar plots.
(e) Encoder.

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