Ref:Ex/PE/PC/B/T/315/2024

Jadavpur University

BE(Power Engg.) 3rd Year First Semester Examination 2024

Control Systems

Time 3hrs | Full Marks 100

Group A (Answer Any Two)

1. Consider the following SIMSCAPE figure for a simple spring-mass damper system shown in Fig. 1 below:

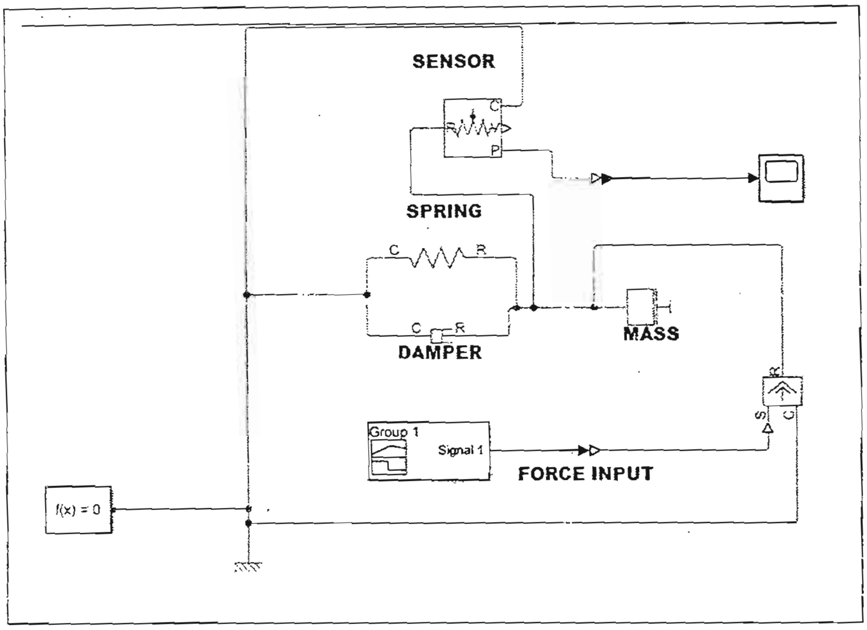

Fig. 1

Assuming that the mass is M, damping constant is D, the spring constant is K and the force input is $F(t) = \delta(t)$ (all in SI units) ,deduce the following from Fig.1

(i) The initial displacement and velocity of the mass

(ii) The A and B matrices for a state-variable representation of the physical model.

(iii) The C matrix (hint: look at the sensor node)

(iv) The steady state displacement and velocity of the mass for the applied force

CO1(10)+ CO2(10)

2. Reduce the block diagram shown in Fig. 2 to obtain the transfer function between the input and the output

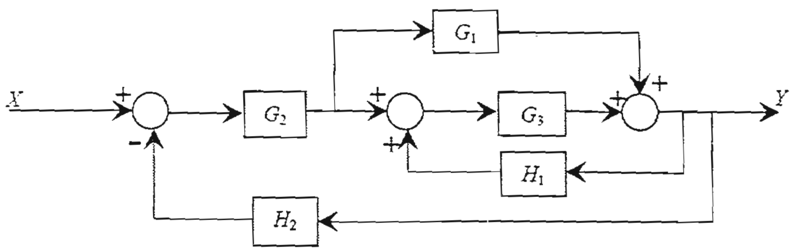

Fig. 2 (Refer Q2.)

Check the result using a Signal Flow Graph and Mason's Gain formulaCO1 (10)+ CO2(10)

3. Deduce the Laplace Transform of a Pulse-Train of Time period 5 seconds , Duty Cycle 0.4 and height 2V.
Deduce and sketch the approximate waveform you would see in a simulation if this wave-form is applied to a system with Transfer Function$G(s) = \frac{0.5e^{-0.1s}}{s+1}$.

CO1 (10)+ CO2(10)

Group B (Answer Any Two)

4. Represent the Pole-Zero map of the system $G(s) = \frac{4(s-0.5)}{s^2+2.4s+4}$in the complex plain.
Calculate the corresponding damping, natural frequency of the system. How does the output change because of the addition of a RH zero at $s = 0.5$ to the basic second order systemi.e.$G(s) = \frac{4}{s^2+2.4s+4}$?
If the system is controlled by a controller K , with a unity feedback, calculate the maximum value of K for which the closed loop system is stable using RH Criterion?

CO3(4+6) + CO4(10)

5. Use Nyquist criterion to estimate the stability of a unity feedback closed loop system corresponding to the open-loop system defined by $G(s) = \frac{10(s-2)}{(s+1)(s+1)(s+3)}$ and interpret the stability of the closed loop system. Hand-sketch the corresponding Nyquist Plot

CO3(10) + CO4(10)

6. Draw the asymptotic Bode plot for the system in Problem 5. Identify the corner frequency, the asymptotes and sketch a rough Bode Plot. Calculate the Gain Margin and Phase MarginUsing the Bode Plot, calculate how much delay the system can tolerate.

CO3(10)+CO4(5)+C04(5)

Group C

7. A valve in a Thermal Power Plant has a transfer function $G_v(s) = \frac{2}{0.5s+1}$and it is controlled by a controller with transfer function $H(s) = (1 + \frac{0.2}{s})$ in the forward path.
   (i) Represent the system with a schematic for unity feedback
   (ii) Draw the PZ map for $G_v(s)H(s)$
   (iii) Using Root-Locus, calculate a value of *K(if any)*, for which the system is unstable.

CO5(4+4+12)