Ref: Ex/PE/PC/B/T/315/2024(s)

Jadavpur University

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

Control Systems

Time 3hrs **Full Marks 100**

Group A (Answer Any Two)

1. Derive the ABCD Matrices for a Spring–Mass-Damper System with spring constant K, damping D and mass M with an input force $F(t)$ and output $x(t)$. Hence derive its output for ≥ 0 , if $F(t) = H\delta(t)$ with symbols having usual significance. **CO1(10) + CO2(10)**
2. Reduce the block diagram shown in Fig. 1 to obtain the transfer function between the input and the output

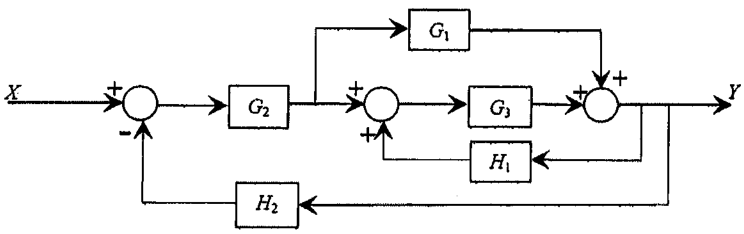

Fig 1 (Refer Q2.)

Check the result using a Signal Flow Graph and Mason's Gain formula **CO1 (10)+ CO2(10)**

3. A pulse train of height 2V ,frequency 0.5Hz and duty cycle 0.2 is applied to a circuit whose transfer function $G(s) = \frac{0.5}{(0.1s+1)}$. Model the pulse train and derive the output. **CO1 (10)+ CO2(10)**

Group B (Answer Any Three)

4. Represent the Pole-Zero map of the system $G(s) = \frac{4}{(0.2s+1)(2s+1)}$ in the complex plain. Calculate the corresponding output $y(t)$ for a a step input of 2 units at $t = 0$ applied to the system. What is the value of $\frac{dy(t)}{dt}$ for this system at $t = 0$. With suitable approximation deduce the PZ map if a delay of $0.2s$ is applied to the system. **CO3(4+6) + CO4(10)**

5. For the system with characteristic equation defined by $Q(s) = s^6 + 2s^5 + 8s^4 + 12s^3 + 20s^2 + 16s + 16$ use Routh-Hurwitz stability criterion to determine the stability of the system. Now, if the constant term (i.e. coefficient of s^0 is replaced by a variable gain K , determine the range of K for the system to be stable. **CO3(10) + CO4(10)**

6. Use Nyquist criterion to estimate the stability of **a unity feedback closed loop system** corresponding **to the open-loop system** defined by $G(s) = \frac{2}{(5s+1)(2s+1)}$ and interpret the stability of the closed loop system. Hence deduce if the closed loop system remains stable if a delay of $0.1s$ as added to the system **CO3(10) + CO4(10)**
7. Draw the asymptotic Bode plot for the system $G(s) = \frac{20}{(0.5s+1)(0.1s+1)(s+1)}$ and calculate the Gain Margin and Phase Margins .Using the Bode Plot, calculate how much delay the system can tolerate. **CO3(10)+CO4(5)+C04(5)**