MANIPAL INSTITUTE OF TECHNOLOGY
MANIPAL
(A constituent unit of MAHE, Manipal)

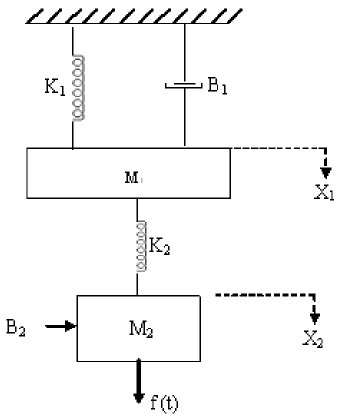
I SEMESTER M. TECH (EMBEDDED CONTROL AND AUTOMATION)
END SEMESTER EXAMINATION DECEMBER 2023
Advanced Control Theory (ICE 5114)

Note: Answer All questions.

Time:3 Hours **02-12-2023** **MAX. MARKS: 50**

Instructions to Candidates:

- Answer **ALL** the questions.

Q. No.	Description	M	CO	PO	BL
1A	Illustrate correlation between transient response and frequency response by deriving relationship between damping ratio and phase margin considering a general second order system.	3M	1	1-4	3
1B	Derive an expression for (i) frequency at which maximum phase lead occur, (ii) maximum phase lead and (iii) the gain at this frequency of a Lead compensator.	3M	1	1-4	3
1C	A unity feedback system with G(s)= $\frac{K}{s(s+7)}$ is operating at 15% overshoot. Design a Lag compensator using root Locus technique to yield Kv=50, without altering transient performance characteristics.	4M	1	1-4	5
2A	Compare the performance of PI and PD controllers. How are they tuned using Ziegler Nichols first Method.	3M	2	1-4	2
2B	Given K_p=0.45 K_{cr} and T_I= P_{cr}/1.2. Determing PI contoller transfer function for the system whose closed loop transfer function $\frac{Y(s)}{R(s)} = \frac{K}{s^3+10s^2+16s+K}$. Use Zigler-Nicholas tuning method 2.	3M	2	1-4	3
2C	 Obtain the state model of the mechanical system shown in Figure, considering motion of Mass M_1 as output.	4M	2	1-4	4

3A	Determine the transfer function of the system $\dot{X} = \begin{bmatrix} -6 & -1 \\ 5 & 0 \end{bmatrix} x + \begin{bmatrix} 0 \\ 1 \end{bmatrix} u; y = x_1$. Compare eigen values and poles of the transfer function. Comment on stability of the system.	3M	2	1-4	3
3B	Given A=$\begin{bmatrix} -3 & 2 \\ 0 & 1 \end{bmatrix}$, determine state transition matrix using Cayley-Hamilton theorem..	3M	2	1-4	2
3C	Determine the response of the system i) starting from initial condition$\begin{bmatrix} 1 \\ 0 \end{bmatrix}$ with no input. Also determine unit step response with B=$\begin{bmatrix} 0 \\ 1 \end{bmatrix}$.	4M	3	1-4	3
4A	Obtain the discrete time equivalent of the continuous time system described by Q3B and Q3C, choosing a sampling time of T=0.2 s.	3M	3	1-4	3
4B	Consider the system $G(s) = \frac{s^2-1}{(s-1)(s^2+4s+2)}$, determine whether the system is completely state controllable. Obtain a minimal realization of the system in state variable form.	3M	3	1-4	4
4C	Given the system equation $\dot{X} = \begin{bmatrix} 1 & 1 \\ 1 & 1 \end{bmatrix} X + \begin{bmatrix} 1 \\ 0 \end{bmatrix} u$; y=$[2 \quad -1]X$ Design a state feedback gain matrix K to place the closed loop poles at -2 and -3. Use Ackerman's formula.	4M	3	1-4	5
5A	Derive an expression for state transition matrix of a discrete time system by considering homogeneous system described by X(+1)=FX(k)	3M	4	1-4	3
5B	Consider a discrete time state equation described by $X(k+1) = \begin{bmatrix} 0 & 1 \\ -1 & -2 \end{bmatrix} X(k) + \begin{bmatrix} 0 \\ 1 \end{bmatrix} (-1)^k; y(k) = [-1 \quad 1]u(k)$ And X(0)=$\begin{bmatrix} 1 \\ 1 \end{bmatrix}$.Find closed form of solution for Y(k).	5M	4	1-4	3
5C	Explain with neat block diagram a typical digitally controlled system. Also mention the advantages of discrete system analysis.	2M	4	1-4	2